Speculative design with urban nature: interpreting computational data

A laboratory investigating the impact of explorative mapping on design practices within academic context

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For Amparo & Víctor

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Preface

Trained as an architect, I began teaching architecture students to use Geographic Information Systems in the winter term of 2020, shortly after joining the Chair of Landscape Architecture at the Karlsruhe Institute of Technology. After more than fifteen years of professional experience, primarily in the construction detailing phase, this new role marked a significant shift in my career toward urban studies, specifically landscape architecture. This transition prompted a critical reflection on how urban planning had evolved since I began my studies in 1996 and how I could integrate emerging ontologies, concepts, and technologies into my courses.

At KIT, I observed that geographic data analysis was not firmly embedded within the architectural curriculum. Motivated by this gap, I initiated a series of courses that mirrored my own exploration of methods and tools, which I identified as valuable for design professionals working with urban nature. At the core of these courses were projects that aimed to foster new dialogues between the urban realm and the natural world—projects that adopted post-anthropocentric approaches and spanned multiple scales from the microscopic to the regional. Notably, I focused on projects that redefined the relationship between built environments and ecological systems.

These pedagogical initiatives significantly enhanced students' data literacy, receiving enthusiastic feedback: many students reported how GIS had been highly beneficial in advancing their careers. However, despite their ability to collect and manage more detailed datasets, I observed that more advanced computational, analytical tools were often underutilized in their subsequent work. While students excelled at data collection, they rarely employed more sophisticated tools to deepen their analyses and explore speculative design scenarios. This observation raised a critical question: why were students not engaging more deeply with these tools? This inquiry became the foundation of my research.

This research investigates the diverse design processes of students using GIS, aiming to demonstrate the methodological relevance, agency, and operational potential of these methods while identifying barriers to their broader adoption. I argue that these limitations must be systematically analyzed to facilitate a more effective integration of urban data science into design practice.

Urban planning and design challenges have traditionally been addressed through historical, environmental, and socio-economic lenses. In recent decades, the advent of computation and data analysis has given rise to the field of '*urban data science*'. Practitioners in this field typically fall into two categories: researchers and applied practitioners. Researchers focus on isolated parameters or specific urban phenomena, analyzing their implications for broader urban indicators. For instance, studies might explore the relationship between street width and air quality, generating academic knowledge disseminated through papers and communications. They push urban science development further, delving into the complexity of individual parameters. In contrast, applied practitioners aim to develop tools and processes that enable data-informed decision-making. They construct models to simulate urban scenarios and propose recommendations, which are then used to inform policy and guide future urban development. However, neither group engages in the drafting of planning and design proposals. Rather, they provide theoretical frameworks and technical tools that designers can potentially utilize –yet, in practice most designers possess extremely limited data proficiency in data analysis.

As a result, there is a significant gap between urban data science and the design process. Urban designers draw insights from urban data science and the recommendations that can inform their decissions. However, they rarely integrate advanced data analysis into the early stages of their work, particularly when defining and exploring the design problem. While some design offices effectively perform and integrate extensive data analysis into their practice, these architectural and urban planning offices remain exceptions rather than the norm.

Does this indicate that performing sophisticated urban data analysis lacks value? Or is the necessary technology and expertise too complex for designers to adopt? How do design practices evolve when certain geospatial techniques are incorporated? Can this integration encourage broader adoption of these tools and methods?

This thesis posits that urban data should not merely be seen as a tool for late-stage decision-making but as a generative catalyst for design, particularly within speculative design. It explores how urban data can serve as a starting point for creative, exploratory design practices, envisioning a future role for designers who actively engage with urban nature and data analysis. Rejecting both technocratic determinism and uncritical data reliance, this work proposes a series of strategies to advance creativity in design through data literacy, positioning technology as a means of unlocking new realms of designers' imagination.

"A map of the world that does not include Utopia is not worth even glancing at, for it leaves out the one country at which Humanity is always landing. And when Humanity lands there, it looks out, and, seeing a better country, sets sail. Progress is the realisation of Utopias."

Oscar Wilde
The Soul of Man Under Socialism

Abstract

This thesis situates itself at the intersection of speculative design, ecological theories, and computational technologies, interrogating how contemporary designers dealing with urban nature might reconceive their role amidst the twin pressing challenges of ecological crisis and digital transformation. Grounded in the acknowledgment of urban nature as neither fixed nor oppositional to the built environment, but rather as a fluid, hybrid construct, this work destabilizes inherited dichotomies between the natural and the artificial, the human and the non-human, the technical and the creative, the scientific and the '*designerly*'. It approaches urban nature as a dynamic assemblage shaped through reciprocal relations of culture, technology, and ecology—a notion synthesised in the concept of naturecultures.

Central to this inquiry is the proposition that urban designers and planners must cultivate a renewed epistemic and operative posture: one that mobilises computational tools not merely as neutral instruments of measurement, but as agents capable of reshaping spatial imaginaries. Specifically, the thesis advocates for a speculative design practice empowered by Geographic Information Systems, GIS, and digital mapping, wherein data is not passively consumed but actively interpreted, contested, and reassembled. In doing so, it reframes GIS beyond its conventional applications as an analytic device, asserting its potential as a catalyst for reflective, critical, and creative exploration. Mapping, here, becomes operative rather than descriptive—a practice of world-making as much as world-representing. The investigation is structured around the conviction that competence development in design is inseparable from fostering this epistemic shift. Drawing upon posthuman ecological theories and the paradigm of the Ecocene, it positions ecological literacy, systems thinking, and speculative imagination as interwoven facets of contemporary design practice. Competence is not conceived merely as technical proficiency, but as the evolving ability to navigate complex, multi-scalar, temporally fluid, and ethically charged urban landscapes.

Through a laboratory framework embedded within architectural education, the thesis operationalises its conceptual propositions. The laboratory becomes a microcosm where the abstract tenets of naturecultures, speculative design, and digital technology are activated, observed, and iteratively refined. It reveals how the introduction of GIS into students' workflows catalyses shifts not only in the tools employed but in the modes of thinking, imagining, and critiquing that undergird their design processes. Crucially, the work underscores that these shifts are relational—competences such as systemic thinking, synthesis, multiscalarity, and speculative capacity do not evolve in isolation but through their entanglement within a broader network of socio-technical and ecological considerations.

Rather than presenting technology and ecology as antagonistic forces, the thesis articulates a vision of design practice where computational tools mediate more nuanced, reflective engagements with urban nature. Rejecting both technocratic determinism and uncritical ecological romanticism, it navigates a third path—one where designers become agents of negotiation between data, ecological systems, and speculative futures. This negotiation does not aim to resolve complexity but to embrace it, repurposing digital mapping as a means to open alternative imaginaries and question dominant paradigms. Ultimately, this work contributes to a reconceptualization of the designer's role in the age of the Ecocene. It envisions a professional posture grounded in data literacy, ecological awareness, and speculative agency, capable of addressing the intertwined challenges of urbanisation, climate change, and socio-technical transformation. In doing so, it does not offer a prescriptive methodology but a conceptual and operative framework for reimagining design education and practice—one critically attuned, ethically engaged, and oriented towards fostering resilient, inclusive, and imaginative urban futures.

French abstract

Cette thèse se situe à l'intersection entre design spéculative, théories environnementales post-humanistes et technologies numériques. Elle interroge comment des designers travaillant avec natures urbaines doivent reconcevoir leur rôle entre l'urgence écologique et la transformation numérique. Reconnaissant 'nature urbaine' ni fixe, opposée ou contradictoire à l'environnement bâti, mais comme un assemblage fluide et hybride, ce travail vise à déstabiliser dichotomies héritées entre le naturel et l'artificiel, entre l'humain et le non-humain, entre la technique et la créativité. Cette thèse approche les natures urbaines comme un assemblage dynamique, modelé par relations réciproques de nature, technologie et écologie –une notion synthétisée dans le concept de *'naturecultures'*.

Au cœur de ces recherches se trouve la proposition selon laquelle les designers doivent cultiver une posture épistémique et opérative renouvelée. Cette posture mobilise des outils computationnels au-delà des instruments neutres de mesure, les considérant plutôt agents capables de donner nouvelle forme aux imaginaires spatiales du futur. Spécifiquement, cette thèse préconise une pratique de design spéculatif doté de pouvoir par des Systèmes d'Information Géographiques, SIG, et par le mapping digital. Dans cette pratique, les données ne sont consumées passivement, mais interprétées, contestées et rassemblées activement. De cette manière, SIG est reformulé au-delà de ses applications conventionnelles comme instrument analytique, en consolidant son potentiel comme catalyseur d'une exploration réflective, critique et créative. Ainsi, mapping devient opérative plutôt que descriptive.

Cette recherche est fondée sur la conviction que le développement de certaines compétences du designer est la base du changement épistémique proposé. S'appuyant sur des théories écologiques post-humaines et le paradigme de l'Ecocene, elle prend position par rapport à la pratique contemporaine du design, tissant postures environnementales récentes, *'systems-thinking'* et l'imagination spéculative. Ces compétences ne sont des pures expertises techniques, mais plutôt des capacités en évolution pour naviguer des paysages urbains complexes, multiscalaires, temporairement fluides et éthiquement chargés. Cette thèse opérationnalise ses propositions conceptuelles à travers un *laboratoire* intégré dans un cadre d'éducation académique. Ce *laboratoire* devient un microcosme dans lequel les principes théoriques du naturecultures, design spéculative et technologie numérique s'activent, sont observés et itérativement rapprochés. Il révèle comment l'introduction du SIG dans les processus de travail des étudiants catalyse des transformations dans les outils mobilisés mais, surtout dans leurs modes de penser, imaginer, et être critique. Ce travail met en évidence comment ces transformations sont relationnelles : les compétences isolées ne changent pas comme quand elles interagissent dans un réseau de rapports socio-écolo-techniques.

Rassemblant technologie and écologie, une nouvelle vision de la pratique du design est articulée. En elle, des outils numériques médient des rapports nuancés et réflectifs avec les natures urbaines. Refusant des technocraties déterministes et des visions acritiques d'une écologie romantique, ce texte parcourt un chemin dans lequel les designers deviennent des agents négociateurs entre données, systèmes écologiques et futures spéculatifs. Cette négociation ne vise pas à résoudre la complexité urbaine, mais à l'embrasser ; le mapping digital sert à déclencher des imaginaires alternatifs et questionner des paradigmes dominants. Finalement, ce travail contribue à reconceptualiser le rôle du designer vers l'Ecocene. Une posture ancrée dans l'alphabétisation des données, l'écologie post-humaine et l'agence spéculative. Cette thèse propose un cadre théorique, méthodologique et opérative pour réimaginer la transformation de cette pratique, ainsi que de son enseignement académique.

German abstract

Diese Dissertation liegt an der Schnittstelle von spekulativem Design, posthumanistischen Umwelttheorien und digitalen Technologien. Sie untersucht, wie Designer, die mit urbaner Natur arbeiten, ihre Rolle angesichts der ökologischen Dringlichkeit und digitalen Transformation neu definieren können. 'Urbane Natur' wird nicht als fest oder im Widerspruch zur gebauten Umwelt, sondern als fluides, hybrides Konstrukt betrachtet. Ziel ist es, geerbte Dichotomien zwischen Natur und Künstlichkeit, Menschlichem und Nicht-Menschlichem sowie Technik und Kreativität zu hinterfragen. Urbane Natur wird als dynamisches Zusammenspiel verstanden, das durch wechselseitige Beziehungen von Natur, Technologie und Ökologie geformt wird – ein Konzept, das im Begriff *naturecultures* zusammengeführt wird.

Im Zentrum dieser Forschung steht die These, dass Designer eine erneuerte epistemische Haltung entwickeln müssen, die computergestützte Werkzeuge nicht nur als neutrale Messinstrumente, sondern als Akteure begreift, die räumliche Imaginationen neu gestalten. Die Dissertation plädiert für eine spekulative Designpraxis, die durch Geographische Informationssysteme, GIS, und digitales Mapping gestärkt wird. In dieser Praxis werden Daten aktiv interpretiert, hinterfragt und neu zusammengesetzt, wodurch GIS über seine konventionellen Anwendungen als analytisches Instrument hinaus als Katalysator für reflektierende, kritische und kreative Explorationen fungiert. Mapping wird dabei operativ – eine Praxis des Welterschaffens ebenso wie der Weltrepräsentation.

Die Arbeit stützt sich auf die Überzeugung, dass die Entwicklung von Design-Kompetenzen die Grundlage des vorgeschlagenen epistemischen Wandels bildet. Sie bezieht sich auf posthumane ökologische Theorien und das Paradigma des Ökozäns, wobei ökologische Literacy, systemisches Denken und spekulative Imagination als miteinander verbundene Aspekte der zeitgenössischen Designpraxis betrachtet werden. Diese Kompetenzen entwickeln sich nicht als technische Fertigkeiten, sondern als Fähigkeiten, komplexe, mehrdimensionale und ethisch aufgeladene urbane Landschaften zu navigieren. Die Dissertation operationalisiert ihre konzeptionellen Vorschläge durch ein Labor im Rahmen der architektonischen Ausbildung. Dieses Labor wird zu einem Mikrokosmos, in dem die theoretischen Grundsätze von *naturecultures*, spekulativem Design und digitaler Technologie aktiviert und verfeinert werden. Es zeigt, wie GIS die Arbeitsprozesse der Studierenden verändert und ihre Denk-, Imaginierungs- und Kritikmodi beeinflusst. Diese Veränderungen sind relational: Kompetenzen wie systemisches Denken und spekulative Kapazität entwickeln sich durch ihre Verknüpfung mit einem breiteren Netzwerk sozial-technischer und ökologischer Beziehungen.

Die Dissertation formuliert eine neue Vision der Designpraxis, in der digitale Werkzeuge differenzierte, reflektierte Auseinandersetzungen mit urbaner Natur vermitteln. Sie lehnt technokratischen Determinismus und unkritischen ökologischen Romantizismus ab und verfolgt einen dritten Weg, bei dem Designer als Verhandlungsführer zwischen Daten, ökologischen Systemen und spekulativen Zukünften agieren. Diese Verhandlung zielt darauf ab, die Komplexität nicht zu lösen, sondern zu umarmen, wobei digitales Mapping genutzt wird, um alternative Imaginationen zu fördern und dominante Paradigmen infrage zu stellen. Abschließend trägt diese Arbeit dazu bei, die Rolle des Designers im Zeitalter des Ökozäns neu zu definieren. Sie schlägt eine professionelle Haltung vor, die in Datenkompetenz, posthumaner Ökologie und spekulativer Handlungsmacht verankert ist. Die Dissertation bietet ein theoretisches, methodologisches und operatives Rahmenwerk, um die Transformation der Designpraxis und ihrer akademischen Ausbildung neu zu denken.

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List of abbreviations

AI	Artificial Intelligence
ARC	Arturo Romero Carnicero
BA	Bachelor
BIM	Building Information Modeling
CAD	Computer-Aid Drawing
DEM	Digital Elevation Model
DNA	Deoxyribonucleic Acid
DIY	Do It Yourself
ECTS	European Credit Transfer and Accumulation System
ENSAS	École Nationale Supérieure d'Architecture de Strasbourg
ESA	European Space Agency
ESRI	Environmental Systems Research Institute, Inc
FOSS	Free and Open Source Software
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
KIT	Karlsruhe Institute of Technology
LLM	Large Language Model
LED	Light-Emitting Diode
MA	Master
MESSUN	Mapping Exploring Speculative Scenarios with Urban Nature
NSF	National Science Foundation
QGIS	Quantum Geographic Information System
RfD	Research for Design
SAGE	Semi-Automatic Ground Environment
SIG	Systèmes d'Information Géographique
SYMAP	Synagraphic Mapping Package

Ceci n'est pas un glossaire

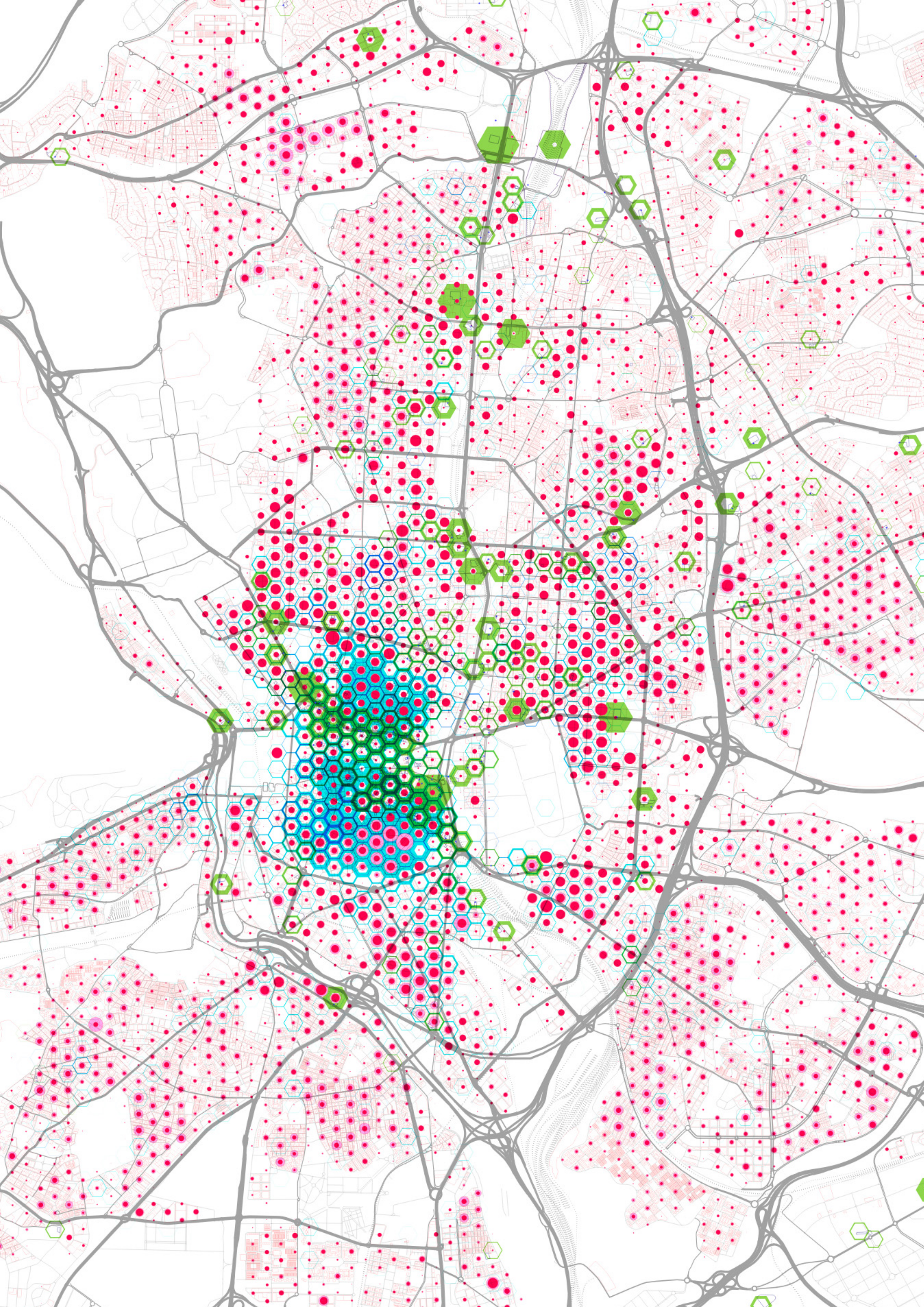
This thesis was developed under the cotutelle of two universities, one in Germany and one in France, discussed multiple times in four different languages, and written in English by someone whose mother tongue is Spanish. The constant need for translation of specific terminology has not only enriched the meaning of many concepts, but also often caused initial confusion for readers, sparking recurrent discussions about certain terms. In pursuit of a synthetic consensus as a foundation, the following paragraphs strive to consolidate some initial common ground. However, the entire thesis aims to explore the multifaceted aspects of each notion in greater depth.

First of all, the most difficult and elusive term: ***nature***. While its multiple facets are elaborated upon throughout Chapter 1, it can be initially be defined as referring to the biosphere: all living beings regardless their origin or level of wilderness, including those planted or produced by human activity. In French, the expression *'le vivant'* –meaning *'the living'*– serves as an appropriate equivalent.

This thesis aims to contribute to a form of research and practice that foster ecological stewardship, responding to human-originated planetary challenges. The ***Ecocene*** is framed as an epoch of where the generation of new futures is driven by ecologically informed ways of knowing, understanding and steering the design of sustainable transitions. The word ***design*** itself evokes multiple interpretations, leading to many misunderstandings when inserted without translation in different languages. In these pages, it refers to a specific architectural, urban or landscape proposal. It is equivalent to *'projet'* in French or *'Entwurf'* in German, signifying a task performed by ***design professionals***: a term used in this thesis to encompass all disciplines that operate at different scales on the planning of the nature in cities: architecture, landscape architecture, landscape design, urban planning, regional planning. They are in charge from the smallest plants growing over thin green roofs to solutions impacting peri-urban forests.

Lastly, some key terms relate to the technologies discussed within this thesis. The most important is ***GIS*** –Geographic Information System–, which serves as a framework for gathering, managing, and analysing data, is rooted in the science of geography. The practice of ***Geodesign*** is presented as a vision for using geographic knowledge to actively and thoughtfully design.

Staring with these first nuances of language and meaning, this thesis invites readers to uncover subtle distinctions and deeper interpretations woven throughout its pages. In order to ensure style correction, LLM proofreading has been used for the whole text.



Introduction

This is a map. It was created by a map maker, and interpreted by a viewer. It displays information spatially for accurate, intuitive, and visual comprehension. It contains data, pure statistical data distributed spatially. It would be laborious to create it by hand due to the exact geographic coordinates of each represented data occurrence, as well as the amount of information processed. Mathematical, geometrical and topological operators are applied within a computational environment, easing the task while assuring its consistent methodological application. Science at the service of spatial representation.

The tool: Mapping

However, this map claims no total objectivity. The parameters are carefully selected and measured per specific agreed standards, which already introduces a certain contestable bias, as well as the decision to combine them in this particular arrangement. Moreover, the scale, graphic traits, and colours chosen by the map maker to represent each parameter impact the viewer's lecture. This map culturally mediates the phenomena it describes, engaging the viewer in a bilateral relationship to interpret its possible meanings: the viewer starts asking questions about the map, trying to understand the message it conveys. In this interactive process of understanding, it is not only key what the map unambiguously displays: the viewer is also invited to extract knowledge from what it does not show explicitly. Patterns, trends, connections, threats and potentials can be perceived, interpreted and identified. The tacit invitation to look for possible causalities and correlations enriches the attentive lecture of the map, which was not a passive action of receiving objective information at any moment. This map does not represent reality; it constructs it.

Progressively, the eyes of the curious viewer not only capture what is represented, what it evokes, or what its graphic omissions may invite to infer. At one point, the map may trigger the viewer's imagination, causing them to actively envision possible transformations of the reality the map represents. The viewer starts formulating questions starting with *"what if…?"*: what if this parameter grew enough to affect the homogeneous distribution of another? What if a second parameter's evolution within time altered the relationships between other ones? Colours, sizes, and diverse forms progressively mutate in the viewer's mind, according to the imagined scenarios. Possible futures emerge from the dynamic interplay of data, spatiality and the creative and scientific imagination of the viewer. Could this triggering capacity be more valuable than its supposed objectivity? Particularly for design purposes.

Of course, not all maps have the same capacity to engage in such an exciting process. This thesis investigates spatial representations of scientific data that have the potential to foster the formulation of possible futures, providing methodological guidance to empower map makers and viewers to achieve such a goal successfully. Maps that can engender transformation. The drawing on the previous page belongs to this kind of map. It is part of an atlas about Madrid's touristification, investigating how tourist accommodation transforms the urban landscape and unleashes gentrification processes. Two architects were the map makers: Mar Santamaría and Pablo Martínez, founders of the Barcelona planning office 300'000km/s. They gathered information from AirBnB open data, Madrid's open data portal and Cadastre, and the Spanish National Institute of Statistics. They prepared the datasets, made them comparable, arranged their representation and fabricated a set of cartographies for an event they were participating in. In their own words, this atlas *"served as the basis for a public conversation with experts and citizens to understand the causes and consequences of these transformations and predict and respond to citizens' needs through urban planning"* (300'000km/s n.d.). With this statement, they made clear that their maps are used as a medium to engage with other specialists –and the broader public–

in the cultural and contextual interpretation of a complex phenomenon, touristification. Numeric, tabulated data is subjectively and purposefully selected, arranged and displayed in a form that becomes knowledge, transmitted and discussed intersubjectively. These graphic choices leverage a certain distance thanks to their abstractness and a certain proximity due to their precision.

Considering the invisibility of computational processes, it is reasonable to suppose that the map makers were not absolutely positive of the exact outcome of the graphic representations of the data before starting. In this sense, this document emerges from certainties and uncertainties. It dives into the complex heterogeneity of the urban realm, capturing contextual occurrences. The unexpectedness of the mapping outcome converts the map maker into the first map viewer. The architects of 300'000km/s were the first to evaluate the results and pose questions to the map. They engage with the map in an inquiry through scientific knowledge, but also through spatial thinking (Bednarz and Lee 2011) and *'designerly'* ways of knowing (Cross 2001), the design intuition consolidated after many years of practice. All these forms of human cognition are simultaneously assembled to reflect not only about the map's content, but trying to imagine future possibilities that the map raises.

In this case, the ethical engagement of these map makers inspires them to highlight the future risks and challenges of the most vulnerable population groups suffering the effects of massive tourism. However, digital data mapping skills are more frequently used for less benign reasons, such as initiatives to increase future economic exploitation when analysing land use and real estate development or to capture customer behaviour to propose cost-efficient commercial facilities. This statistic and mapping know-how is broadly extended for these purposes, but not as much as a design tool. Moreover, the complex design object that this thesis investigates, nature, requires a specific theoretical framework.

The theme: nature

Current sustainability awareness is fuelled by contemporary posthuman ecological theories (Morton 2007, Latour 1993, Descola 2013, Haraway 2015), de-centring human perspective in favour of relational, interconnected views of ecosystems, technology and non-human actors. These relational ontologies of ecology offer frameworks to rethink nature design as a symbiotic, collaborative interspecies act. Acknowledging non-human agency implies trying to understand multispecies perspectives, imagining urban futures, and integrating them and their relationship with their environment. However, whatever action involving non-human beings in the urban realm implies a form of design, a mechanism to impact the future of urban ecosystems. These actions produce *'naturecultures'* (Haraway 2003), a concept emphasising the inseparability of humans, non-humans, technologies and ecologies. Their entangled relationships advocate for the inability to separate biological, technological, and cultural processes.

The method: speculation

The emergence of contemporary ecological sensibilities fosters transformative change towards the Ecocene (Boehnert 2018), a regenerative Era prioritising ecological literacy, systems thinking and design practices that restore and sustain planetary life systems. While this may be perceived as a utopia, in fact, it is an exercise of imagination, profoundly situated and linked to reality. Envisioning subversive future scenarios is not a form of escapism or an end in itself. Instead, it is considered a driving force for change: designers imagining unlikely futures are, in fact, reflecting on the forces and challenges shaping our present. Designers' firm engagement with critical thinking is the motor of structural change. This is how speculative design (Dunne and Raby 2013) operates and why it is relevant to facilitate ways to reach the Ecocene.

The core conceptual triad of this thesis is then set:

– nature, and the creation of naturecultures towards Ecocene is the theme,

– speculative design is the method to imagine those naturecultures, and

– mapping is the technological tool used by designers to trigger those futures

This triad operates at all scales simultaneously, from the constructive detail allowing green roofs to support biodiversity to trans-regional policies fostering balanced ecosystems. This is why the wording *design professionals* or just *designers* encompasses in this text incorporates all disciplines that operate at different scales in the planning of nature: architecture, landscape architecture, landscape design, urban planning, and regional planning. They all engage with data, digital mapping, and the biosphere to design better futures. The evident tension between nature and its datafication entails an emerging but still developing technosensibility, bringing nature and technology closer. The digital revolution of the last decades has significantly impacted art and the practice of architecture, transforming their workflows as much as their outcomes. However, computational thinking has not resulted in manifest changes in the practice of landscape architecture and other design tasks dealing with nature (Picon 2013, Fricker 2021, M'Closkey and VanDerSys 2017). Neither their design processes nor their resulting proposals have been altered as substantially yet. Why is that?

Generative tools such as parametric design have been used in architecture with different applications. For instance, as a path to form-finding through complex geometry, as structural optimisation in performance-driven design, or as an enabler for digital fabrication and mass customisation. Compared to urban design or landscape architecture, the number of parameters and stakeholders that parametric architecture can address is reduced. Most importantly, architecture can be designed as an end product, a form, but urban design deals instead with shaping an ever-evolving transformation process. Using parametric software such as Grasshopper for this goal is certainly possible but different from form-finding. Are there other valuable instruments that could help designers imagine transformation processes for naturecultures towards Ecocene?

This thesis takes a clear, proactive position investigating the potential of computational critical mapping as a generative engine for design. Operative mappings (Paez 2020) are not just representational tools but an active, generative process that transforms spatial reality. Operative mapping is interventionist, using spatial analysis and speculation to imagine new futures. In its production, designers mobilise and assemble diverse forms of knowledge production: scientific, spatial, critical, speculative and, of course, *'designerly'*. Geographic Information Systems, GIS, are the foundations of this mapping practice. The initial hypothesis can now be formulated: computational mapping can be a valuable design tool for the elaboration of speculative scenarios with urban nature. This perspective represents an original insight into this investigation, particularly in its connection with leveraging the professional competences of designers, explored through *'research by design'* methodologies.

Definition of the research questions

This approach finds its origin in appreciating how the design practice of the students of the Chair of Landscape Architecture at KIT changed after learning some elementary mapping tools. Of all available technology, they only learned GIS-based analytic methods, taking advantage of GIS' increasing widespread adoption, user-friendly operability and widespread availability. In contrast to high-end methods requiring absolute technical mastery of computational methods, nowadays' more widespread access to GIS technology –and its training– allows design professionals to engage with sophisticated forms of investigations that can significantly impact their design processes. However, in light of the currently limited use of digital data analysis as an explorative tool for design, it is pertinent to enquire into the competences that designers may need to effectively produce speculative and critical proposals encompassing the goals of contemporary posthuman ecological theories. This thesis explores these ideas, vertebrated by a pair of research questions. The first one is:

R.Q. 1 : *When imagining new urban naturecultures, how does incorporating GIS-based methods influence professional competences necessary for merging computational analysis with design practice?*

This question allows to explore the potential impact of GIS tools on the competences of the designer speculating about futures with urban nature. This is reflected in two simultaneous processes: the acquisition of competences thanks to the introduction of the tools, and the development of additional skills enabled by the use of digital mapping. The focus is not on high-end, advanced methods that demand significant computational power and coding expertise—areas already well-covered by existing research. Instead, it explores how independent practitioners' design practice could be enhanced by introducing straightforward technical tools. This thesis concentrates on these practices as applied to the design of nature and their benefits for designers. They will pursue their career as professional designers and *'data-aficionados'*.

Competence development

The suitability of the identified competences is not only measured by the pertinence of the resulting proposals but by their capability of unveiling emerging insights, new perspectives and possible futures. At this stage, it is key to note that mapping is a form of reflection within the design process, and not an instrument to draw future proposals. Instead, mapping is investigated as a force to leverage speculative and critical reflection. Can they unleash design schemes that open different and unexplored paths? Can we better understand the design process incorporating these tools, methods and practices? What are the advantages and opportunities of using urban data analyses to formulate speculative scenarios with urban nature? How does this use affect the design process?

These questions inquire into a new GIS operative epistemology of design, inscribing this thesis in the field of *'Research for Design'*, a type of research that directly supports and informs the design process (Roggema 2017). Investigating a contextual design reality, Research for Design aims to align design manoeuvres with societal, cultural, technological and environmental factors. The insights that inform and guide the creation process are gathered and analysed here. Bridging the gap between designers, their needs, and the context of use, this thesis explicitly manifests its primary goal of making a methodological contribution to design practices dealing with urban nature by architects, landscape architects, and urban and regional planners. This contribution operates in two simultaneous environments. First, providing a new epistemology of mapping, enriching the perspectives shaping the role of cartographic practices with urban naturecultures and spatial imaginaries. And secondly, by proposing a series of operational changes in the praxis to empower designers with adaptable, speculative and critical mapping methodologies that integrate computational and socio-ecological dimensions.

The second research question emerges as a consequence of the first one. If introducing spatial data analysis enhances the designer's toolbox's competences, how does this shape a new posture in design practice? How would the metier of *'data-literate'* designers look in the future? Building upon speculative design ideas, could formulating possible futures for these designers help us critically discuss the current situation? All these enquiries are investigated through the second research question:

R.Q. 2 : *How might speculative design practices reimagining urban-natural interactions evolve by interpreting computational data?*

This exercise of speculation outlines a new posture for design professionals: people who can perform computational spatial analysis using GIS-based tools and create critical mappings to trigger speculative scenarios with naturecultures. Their work builds bridges between science and design, between research and practice, between data and speculation, between nature and cities. This thesis provides these design professionals with a robust theoretical framework, learning from the competency development of a group of students and proposing how their practice could be shaped in the future.

Structure of the thesis

The thesis is structured in three parts: the theoretical framework, the empirical experience, and the conclusion. In **Part one**, the research questions are contextualised within the conceptual foundation that the three entangled axes build: nature, design, and technique. Nature is one of the themes that designers investigate through mapping. Building up from contemporary posthuman ecological theories, the notional development of the ideas of nature is followed, providing the foundations of future imaginaries with urban nature. The methodology to produce such new naturecultures is speculative design, a transformative approach questioning the core grounds of design action, fostering critical reflection about the origins of the problems to react to, as well as the impacts of possible proposals. Finally, the proposed technical tool is digital mapping. Acknowledging maps' capacity to construct reality culturally and critically, this tool effectively triggers future scenarios with urban nature in the times of the Ecocene. This practice is here defined as *Mappings Exploring Speculative Scenarios with Urban Nature*, MESSUN, an approach that embodies this theoretical framework.

Within this theoretical framework, **Part two** sets up the '*laboratory*', an empirical dispositive exploring the transformation of design practices' workflows in response to ecosocial and technological changes. The setting of the *laboratory* is Academia, due to the author's access not only to the mapping outcomes of the students but also to the privileged position to observe the whole process. The parameters to observe the shift in design practices must be set for its analysis. A series of professional competences are identified as pivotal references to monitor this change. With them, it is possible to portray an in-depth analysis of architecture students' exercises, discovering how competences develop in relationship with the tools, methods and notions learnt. The students introduced geospatial computational tools into their design processes, altering them considerably from their conventional routines. Each exercise is examined in the light of the considerations developed in the theoretical framework described in the first three chapters. The goal is not just to examine the functional suitability of the results of the exercises, but to inquire into their design processes, evaluating the impact of the deployed methods in the flow of the design. This methodology encompasses '*research by design*' approaches, using design proposals to build research knowledge.

While the enquiry described above allows to understand the development of the design approach of the students during the courses, a complementary methodological approach is required to capture the effect of these changes in their following career. The evolution of the students' competences in the years after the design course is investigated through a qualitative analysis conducted via a series of interviews and a focus group, in the months and years immediately after the course.

Finally, **Part three** compiles and problematises the key findings of the combined methodologies, reacting directly to the first research question, providing a better understanding of the relationship between GIS-based methods and the evolution of professional design competences. The challenges and opportunities related to these competences are then critically discussed, making it possible to imagine a speculative evolution of this new kind of professional designer and *'data-aficionado'*, who produces *Mappings Exploring Speculative Scenarios with Urban Nature*. This transformation of the praxis' posture is captured in three manoeuvres, outlining the perimeters of a novel form of data-literate design practice, answering the second research question. Finally, the possible transfer and application of the postulates of this thesis into practice are critically discussed, imagining a future where these methods were not the exception but an integral part of day-to-day practice.

To conclude this introduction, the following goals describe the orientation of the thesis in two simultaneous scales, a general and a specific one. This may serve as a form of intentional corollary.

General research goals

Generate systematic knowledge and a theoretical framework for contemporary thought and techniques that speculate with urban nature.

Provide an accessible platform for designers that would like to incorporate computational data analysis in their design workflows.

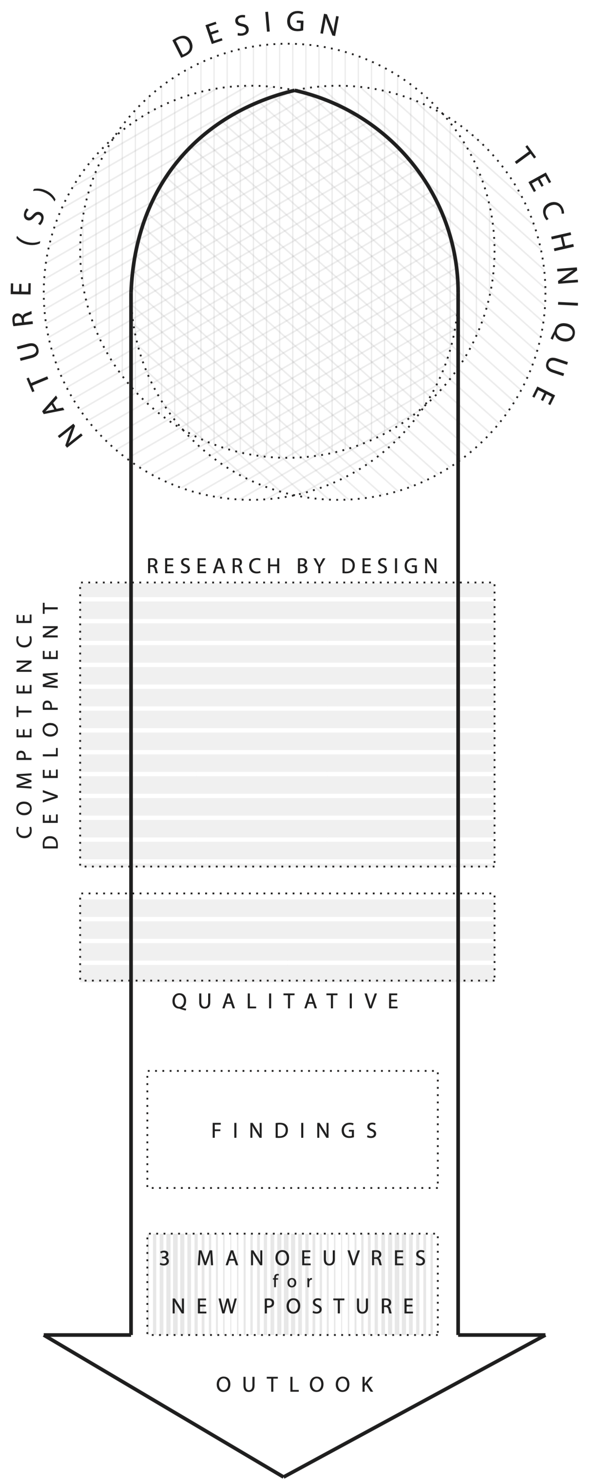
Create bridges between design disciplines and research groups working with computational data about urban nature.

Specific research goals

Investigate a new epistemology of GIS and mapping to the service of speculative design and naturecultures in times of the Ecocene.

Analyse a series of design exercises that use digital mapping tools to explore the mobilised competences and understand their interplay.

Outline and propose a series of manoeuvres towards the professional posture of designers producing *Mappings exploring Speculative Scenarios with Urban Nature*.


DESIGN
NATURE (S)
TECHNIQUE
RESEARCH BY DESIGN
COMPETENCE
DEVELOPMENT
QUALITATIVE
FINDINGS
3 MANOEUVRES
for
NEW POSTURE
OUTLOOK

Part one
Nature, technique, design

Theorical framework describing an emerging form of computationally informed design practice, that speculates with new forms of urban nature.

Nature (s) through history and towards Ecocene

Design as a speculative and critical practice

Technique as computational spatial enquiries

Part two
The laboratory

The theoretical framework enables the definition of a series of relevant competences for designers

An in-depth analysis of exercises performed by architecture students. The key parameters are the relevant competences

A series of interviews and a focus group enquire the further use of computational methods during the next years after the exercises

Part three
Findings, discussion, outlook

The double methodology leads to findings, structured in different groups

These findings allow to propose a posture for future design practice, taking form of three manoeuvres

Finally, a critical look to the limits of the thesis and its possible transfer is presented

Part one

Nature, design, technique

Historically, the interaction of the triad of nature, design, and technique has been the origin of many of the developments of civilisations. Leonardo da Vinci observed the natural world and used advanced representational techniques developed for painting to portray scientific discoveries. He investigated the human body through dissection, drew with cross sections, and overlapped the different elements. He pushed forward the science of anatomy, with new understandings of its laws for proportion and function, imagining not only new devices such as orthopaedic prosthesis, but also medical instruments, such as scalpels. In this thesis, the triad of nature, design and technique corresponds to the theme, the method, and the tool, which are explored in detail in the following three chapters.

The theme: evolving relationships of nature and culture

The overreaching theme studied is the complex relationship between nature and society, between human and non-human, between wilderness and cities, between nature and culture. Chapter 1 explores this relationship beyond simplistic binary oppositions, making possible to tackle the dynamic evolution of the notion of nature –or *'nature(s)'*, accepting its manifold manifestations. The historical shift of its meaning and the perspectives inquiring into it evince how such continuous transformation has massively impacted human activity: from spiritual manifestations to economic paradigms or urbanisation approaches. The ideas about nature are not static, but somewhat actively shaped and reshaped by different cultural forces and historical figures. This sets the stage for the following discussions, taking an active position by acknowledging contemporary theories that bring non-human entities to the focus.

A call for new thinking

Post-human ecological theories de-center the human perspective and favor relational, interconnected views of ecosystems, technology, and non-human actors, informing future relationships. These theories offer frameworks to rethink stewardship as a symbiotic, collaborative interspecies act and acknowledge non-human agency, integrating multispecies perspectives and their relationship with their environment to imagine urban futures. While Anthropocene is a recognised analysis of the current situation, it hardly hints how to move forward. The notion of the Ecocene proposes a re-evaluation of the relationship between humans and nature, which is a robust framework to imagine new forms of exchange between them. Beyond metabolist imaginaries, synergetic approaches are key to the urgent mission to transform ecological stewardship in a purposeful form, such as redefining the role of nature in urban environments. As Johanna Boehnert (2020) states: *"the generation of new futures is driven by ecologically literate ways of knowing that inform the design of sustainable transitions"*.

Design beyond problem-solving as a response

The Ecocene is a design paradigm, a goal for expected transformations to achieve, operating beyond problem-solving approaches. The complexity of the urban realm requires methodologies that incorporate scientific and analytic approaches but also reflective, critical thinking to better understand the historical, social, and ecological context. These last insights, in combination with the scientific analysis, empower designers to redefine the goals of their practice.

The method: speculative design

To attain such a target, the method that this thesis proposes and investigates is speculative design, a key methodology for exploring alternative possibilities beyond current paradigms. It is not oriented to predict the future, but rather to be the origin of discussions about the present. In the context of urban design, providing a platform to assess and challenge current assumptions while exploring new ways of cohabitating with nature. Chapter 2 explores design methodologies, delving into the relationship between design, science, and speculation. It investigates design as a practice and the factors impacting its capacity to address complex problems. It also explores forms of design that focus on problem redefinition, integrating forms of science, not only relying on it. It considers speculative design as a transformative approach questioning the core grounds of design action, fostering critical reflection about the origins of the problems to react to, and the impacts of possible proposals.

The tool: mapping

The tool that this thesis investigates is digital mapping: beyond neutral representation of reality, mapping becomes a mechanism for meaning making. It constructs new understandings and complex cultural, historical, ecological, and social assemblages. Digital mapping becomes an instrument that actively contributes to the design process and guides intervention in urban spaces. Learning from the historical evolution of digital mapping, it is possible to set up the core values of this kind of mapping in formulating speculative scenarios with urban naturecultures. Chapter 3 extensively discusses mapping as a specific tool for speculative design. Acknowledging maps' capacity to construct reality culturally and critically, this tool perfectly shapes future scenarios with urban nature in the times of the Ecocene. The position taken towards mapping lies beyond aseptic representations of reality, or allegedly neutral analysis of the urban realm. The mappings that this thesis enquires about are complex layered assemblages that construct meaning and provide novel lectures on cityscapes.

Speculating the reshaping of design practices

Embracing complexity and uncertainty in the design process is key for forms of practice that lead towards transformative change. Pursuing a goal beyond deterministic problem solution, this new practice opens up a discussion on the problem definition and, at the same time, on the methods and tools to achieve such a goal. This can be understood as a form of transformative research and sets up the context for **Part two**, a *laboratory* where these notions, methods, and tools are explored through design exercises of architecture students.

1 Urban nature

In this first chapter, the evolution of the idea of nature is critically investigated, particularly when confronted with and in relation to the idea of city. What is considered to be *'nature'*? How has humankind defined and redefined its comprehension of nature, and what are the new technical tools and methods that influence and emerge from this evolution? Building on theories that avoid essentialist oppositions and understand *'natureculture'* as a complex dynamic network, the tools that could serve best to understand these forces are explored. Conversely, it is interrogated how certain tools and methods could shape future imaginaries of socio-natural alliances. These considerations reveal numerous definitions of nature, potentially making the plural *'natures'* more appropriate. Despite this multiple character, this text predominantly uses the singular form for linguistic economy.

Nature(s)

Four historical moments explore the tensions within the contemporary city–nature relationship. Then, the idea of the Ecocene is introduced as an operative framework for future design with nature. Four key notions for design in the Ecocene are then discussed, ultimately converging in a limited number of different and compatible approaches to urban ecology.

1.1 Nature, a concept in flux

Cultural theorist Raymond Williams states that the word *'nature'* is one of the most complex in English (Hermitix 2023); it even has no translation in certain languages (Descola 2013). It refers to an abstract concept, historically and geographically situated, requiring context to be defined. The etymological origin of the word *'nature'* is Latin, from the form *"nasci"*, which means to be born or to grow. Thus, it is not an essentialist definition rooted in the birth of living species like plants or animals, but it also encompasses their growth and evolution through time. The words *"le vivant"* are commonly used in French nowadays, often replacing the more technical term *"biosphère"*, which merges all living beings with the medium they inhabit and constitute. However, none of these words have really replaced the word nature, even in scientific discourse (Ducarme & Cuvet 2020), and it remains the name of one of the most renowned scientific publications.

There is no singular definition of nature. The word has undergone a dynamic evolution of meaning over time and across different civilisations, which have used it to describe diverse events. As Foucault (1966) suggests, what is considered natural in each moment and place is the product of historical and social constructions. The relationship between humankind and nature has been fundamental throughout almost all historical periods, from religious beliefs to the dominant technologies of each era. For instance, many ancient cultures considered nature to be something connected to divinities: from the ancient Greek and Roman civilisations, who looked for the favour of gods like *"Gaia"* –Earth– or *"Pan"* –Nature and the Wild–, to native Americans, who considered plants and animals to be a gift from the divine. Similarly, Hinduism includes the concept of *"Brahman"*, which represents the ultimate reality or cosmic spirit, believed to manifest in different forms, like natural elements. Therefore, the veneration of Gods and Goddesses such as *"Varuna"* –Water– is broadly widespread. The understanding of the idea of nature has evolved, and its shift has shaped humankind's relationship with it. Acknowledging these differences, this thesis focuses exclusively on Western culture.

For Romans, cities were seen as places of filth and sin, and Christians, in describing the perverted Babylon, opposed them to the wilderness and to holy nature, the place of God (Ducarme & Cuvet 2020). During the Middle Ages, the vision of nature was still linked to spirituality through religion. This changed during the more human-centric culture of the Renaissance, which explored nature as an object of study through direct observation and empiricism, as seen in Luca Ghini's botanical garden in Pisa. The idea of Renaissance gardens, designed as microcosms that tried to reproduce the order and beauty of the natural world, was paradigmatic of the idea of nature at that time. In parallel, the representation of nature changed, introducing scientific approaches and techniques to portray perspective and its complexity better. During the Renaissance, the revision of Roman and Greek classical thought awoke an interest in nature as a source of proportion and harmony (Lazzaro 1990): it was considered perfection from God's creation. While serving as a source of many allegories and symbols, scientific inquiries and direct observation of nature paved the way for the following scientific revolution.

The separation of the human realm –culture, reason and agency– from the non-human realm –nature, passivity and mechanistic processes– is addressed by Philippe Descola (2013) with his notion of *"the Great Divide*". This division is, for him, not a universal truth, but a historically and culturally specific construct, highly influenced by the Cartesian dualism, which separates mind and body, and by extension, humans from the natural world. During the scientific revolution of the 17th century, natural laws that enabled the prediction of behaviour were formulated through mathematics and physics. This mathematisation of nature is, according to Philippe Descola (2013), the product of a transformation in the idea of nature: it was no longer seen as '*animistic'* or divine anymore, but as something that could be quantified mathematically. Descola's view on this change is supported by the ideas of Merleau-Ponty (1951), who asserts that it is not the accumulation of scientific discoveries that has changed the idea of nature, but the other way around. This differentiation is crucial because it implies that it is a new ontology of nature that shapes novel technical approaches to it, not conversely. Take taxonomy, for instance, which can be considered a form of domestication of nature. This classification-based understanding of species led to developing technologies that supported this vision in the 18th century. Therefore, an imaginary about nature fosters the technical development needed to inquire into it.

Mathematisation of nature

Regarding urban nature, its aesthetic and practical values were key for ancient cities. During the Middle Ages, it was situated *extra-muros*, where agriculture took place. In the Renaissance, it reappeared as private gardens that symbolised wealth and control over nature. In the context of the Enlightenment, nature was increasingly seen as something that could be understood, organised, and improved upon through rational principles. These principles formed the basis of the creation of Karlsruhe in 1715 as the new capital city of Baden-Durlach. Its radial design demonstrated how humankind could dominate nature, incorporating it as an integral component of the town, coexisting in harmony with the urban plan. This shift in the idea of nature required new design methods to plan and imagine cities as they had not been conceived before. Nature was infiltrated in cities as a hygienic measure in the form of '*squares'* with vegetation or gardens, reflecting the desire of a *"normative urbanity"* (Picon 2024) of the bourgeoisie, the only social class that used those spaces at that time.

1.2 The city – nature divide: a historical perspective

The evolution of the role of nature in cities as described above can be considered gradual up to this point, responding to Leibniz's New Essays' principle of *"Natura non facit saltus"* –nature does not make jumps. Nevertheless, the revolutions that followed accelerated this process and catalysed profound change, particularly in the relationship between nature and urbanisation. The Industrial Revolution shaped the predominantly agricultural world into a territory with an increasing number of ever-larger cities, which led to severe new social and health issues.

Planning new forms of urban nature –such as parks for the people, not just for the aristocracy– contributed to regenerating and strengthening social links, while introducing new ways to improve social health. This efficiency was already observed during the Enlightenment (Picon 2024).

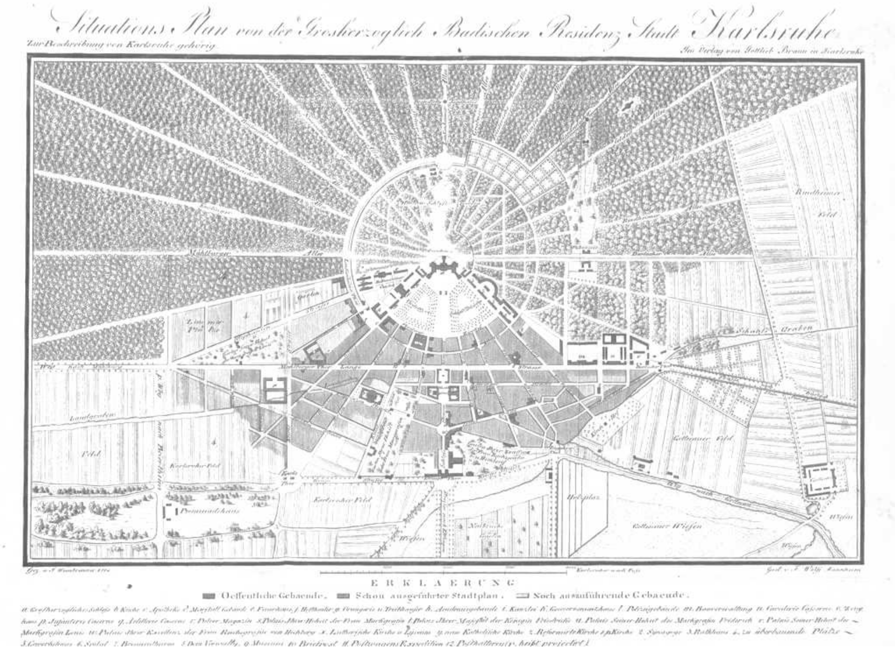


Figure 1.1: Statistisches Gemälde der Residenzstadt Karlsruhe und ihrer Umgebungen. Public domain.

Nature as infrastructure

This effectiveness was reinforced and systematised during the 18th Century, as a certain idea of infrastructural value was conferred to many projects dealing with nature: infrastructure understood as a platform enabling the necessary conditions of city life. Perhaps the most remarkable example was *"les Promenades Parisiennes"*, a metropolitan network of greenery designed by Adolphe Alphand. This vision of *'network of nature'* –*"nature en réseau"* (ibid.)– expanded the scale of nature-based interventions, which were no longer limited to gardens or squares. Moreover, a certain vision for the regional planning was now required to organise the growth of cities. New urban elements, such as America's parkways or France's parks systems, reveal nature's key role at this scale. Disciplines such as cartography, levelling and hydraulic sciences became crucial, assembling a body of techno-professional competences to accomplish such undertakings.

The following sections examine four key historical moments of the 20th century regarding the relationship between rapid urbanisation and nature. They explore the impact of newly developed techniques. Here, the term *'technique'* refers to the tools that enable new forms of planning rather than the technologies used to accomplish their physical implementation. This focus on technique is thus less oriented towards engineering and construction and more on conceptualisation, strategic thinking and spatial organisation. These four watershed moments are contrasted and put in dialogue here with one particular tool, highlighting the relationship between techniques and each vision of urban nature. These four moments represent more than a historical sequence; they capture the conceptual mutation of the relationship between nature and the urban: moving from an initial opposition, to a phase of immersion, followed by an interdependent equilibrium, and, ultimately, to a stage where nature emerges as the driving force behind urban development.

1.2.1 Nature as opposition to the urban

From an urban metabolism perspective, David Wachsmuth (2012) argues that the Industrial Revolution was the process that created the separation and opposition of nature and cities in Western culture. He identifies *"the social separation of town from country in the rise of industrial capitalism, and as a consequence, the perceived separation of human society from non-human nature".* In this sense, towns, the place of society, were opposed to the countryside, the place of nature. This differentiation would have been incomprehensible only a hundred fifty years before, and it is crucial for the further development of cities. This opposition is particularly problematic for Karl Marx: *"What requires explanation is not the unity of living and active human beings with the natural, inorganic conditions of their metabolism with nature... What we must explain is the separation of these inorganic conditions of human existence from this active existence"* (Marx 1864).

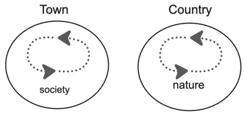


Figure 1.2: Human Ecology diagram. David Wachsmuth, redrawn by ARC

This separation has been crucial to understanding the shift of three consecutive key moments and ontologies in the social and natural relationships that Wachsmuth describes as: *'human ecology'*, *'industrial ecology'*, and *'urban political ecology'*. The first one, rooted in the Chicago School of Urban Sociology, is illustrated by Ernest Burgess' Concentric model. For Matthew Gandy (2022), *"this is the starting point of urban ecology as a systems-based science"*. Intellectually grounded on ideas derived from ecology (Wolch et al. 2002) and neo-Darwinian theories, it creates a model influenced by concepts such as competition, invasion, or equilibrium. These biological analogies stayed at a reference or metaphorical level, as in the writings of the School of Chicago, there is not much of a place for nature in its own right (Gandy 2022). This conceptual use of the idea of nature without really integrating it, is paradigmatic in the naturalisation of the urbanisation process: city growth was considered *'natural'*, ignoring human agency and depoliticising decision-making processes (Wolch et al. 2002).

However, as in many previous periods, and even today, the aesthetic value of the planned urban nature was very relevant. While the ideas of *'sublime'* and *'picturesque'* were first introduced during the Enlightenment, they profoundly influenced garden design during romanticism. The growing suburbs absorbed many of these values and looked for a balance between urban life and countryside, resulting later in the utopian idea of the garden city. Economic and financial constraints set the limits of this utopian vision, as well as the pressure of faster growth and competition with other suburban models that could integrate the personal automobile.

The proposal of the School of Chicago, Burgess' *"Concentric zone model"*, integrated the car, and approached firmly the idea of growth. Cities would be organised in concentric rings, which hosted different sociocultural activities and incorporated principles of urban metabolism. Nevertheless, the lack of nature was both internal and external. As a self-contained system utterly independent of its surroundings, the city did not consider the necessary exchanges and extractions required for its growth: resources, agriculture, or farming. Moreover, no green infrastructure concept traversed the different concentric sectors. Nature became a consumable amenity, available to those who could afford the suburban lifestyle. A desirable feature for the inhabitants of the city's periphery, who found it a relief to city life.

Sociological mapping

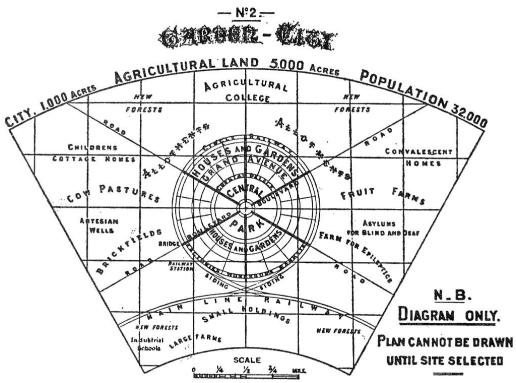
This vision established demarcation within cities, separating functions in an early form of zoning, and compartmentalising urban life. Topographic and cartographic methods were key to determining the areas where cities expanded, serving industrial and accommodation needs rather than understanding ecosystems. However, it was in the use of sociological mapping that the Chicago School of Sociology pioneered a new form of analysing and visualising social phenomena. This ground-breaking work in urban sociology aimed to understand how urban spaces were socially organised by cartographing the spatial distribution of social groups, economic classes, and diverse communities. The striking similarity of a 1931 map of Chicago (figure 1.3) with current representations of the smart city, such as Foursquare, illustrates the profound understanding of the social reality as a complex web of functions and interrelations. Although they were not the first to use maps in social science, this approach, often called *'human ecology'*, was pivotal in applying systematic mapping to study social issues in cities. This method was, however, profoundly anthropocentric, understanding the urban realm as an enclosed social system, just surrounded by a nature that was, if anything, a catalyst for the green belts that appeared around cities later.

Figure 1.3: Left: Concentric zone model. Redrawn by ARC. Right: Central Business District Map, 1931. Ernest Watson Burgess Papers. Public domain.

1.2.2 Nature as the 'milieu' for the new urban

At the turn of the nineteenth century, the idea of garden city developed by Howard Ebenzer –see figure 1.4– advanced Burgess' concentric model. The agricultural land required to feed the city is considered, and central parks and green avenues are infiltrated into the urban tissue. This offered people a better balance between green areas and built volume. However, the architectural or urban planning strategies were, in this case, less important than the innovative form of financing these cities (Picon 2024). Accepting a generic circular and concentric model, the key conceptual change was living in an extensive garden with communal parks and certain private green zones. Nature becomes the *'milieu'* in which to build cities.

Addressing the conservativeness of the architectural and urban planning of the garden city, but strengthening its hygienist values, the city of the modern proposed a new form to reconcile humankind and nature. The image of Le Corbusier's *"Ville contemporaine de trois millions d'habitants"* (Le Corbusier 1933), a vast cultivated garden with massive high-rise buildings connected with private car motorways, portrayed a radical shift in the vision for urban nature. Le Corbusier saw nature as ordered and harmonious and there was no need to tame or order it, as the scientific revolution aimed to (Dummett 2008). For him, cities were *"the grip of man upon nature"*, and he manifested clearly: *"the whole city is a park"* (Le Corbusier 1929). This *'garden'* is the infinite *'game board'* where the urban takes place, the perfect backdrop for a new, hygienist society. The first environmental schematic models were carried out to assess micro-climate, allowing sunlight, ventilation and the proper humidity.



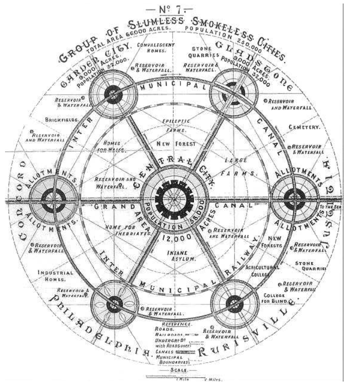


Figure 1.4: Left: Diagram of garden city, Howard Ebenzer 1898. Wikimedia Commons. Right: Garden City model, Howard Ebenzer 1898. Public domain

This vision was to be attained through rationalism and a tailored approach to optimising efficiency in all aspects, from transportation to waste management. The grid becomes the formalisation of the scientific methods that support functional principles rather than historical styles. The cartesian grid is often criticised as a hegemonic imposition to nature (Ingraham 2006), ignoring the original characteristics of the virgin land (Agrest 1991). However, it could also be understood as a form to reflect nature, rather than repressing it (Dummett 2008). Besides, the city's functional compartmentalisation aims for optimisation, segregating residential, industrial or commercial areas. This is implemented through new urban planning tools, such as zoning regulations and urban design guidelines.

Aerial pictures

The cartographic imaginary is established in Europe through the work of Jules Verne, with books such as *"Five weeks in a Balloon"* (Desbois 2015). In it, the visual experience of ballooning is connected with the perspective of a map. In 1858, the first aerial picture was taken from an aerostatic globe flying over Paris. As aviation technology advanced in the early twentieth century, and cameras became more sophisticated, aerial photography for mapping and urban planning purposes spread. This technique increased a certain distance to the object for design: *"The three decades between the mid-1910s and the mid-1940s saw the emergence of a modern urban visuality based on the increasing detachment of the observer from the scene depicted"* (Deriu 2004). These bird's eye images of the territory supported a systems-based approach that broke down the city into discrete, functional zones. The paradigm of controlling cities and regions, which functionalism was promising, finds a parallel in these images that operate as Foucault's Panopticon.

1.2.3 Nature as interdependent equilibrium

During the 1930s, botanist Arthur Tansley proposed the notion of *'ecosystem'*, including the living forms, the biome, as well as the physical factors of the environment (Tansley 1935). Tansley added the human dimension to them, which overlaps, interlocks, and interacts with other sub-ecosystems (Gandy 2022). It was a key moment to fully incorporate human actions into the equation as the impact of humankind over ecosystems was about to become devastating. Urbanisation accelerated dramatically after the Second World War due to economic prosperity and immense population growth. The extractionist model that began with the industrial revolution became what Wachsmuth describes as a key second moment to understanding urban metabolism. He calls it *"industrial ecology"*, corresponding to a form of *"urban metabolism fuelled by nature"*. The city –the society–, extracts resources from the countryside –from nature–, as

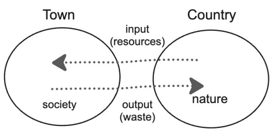


Figure 1.5: Industrial Ecology diagram. David Wachsmuth, redrawn by ARC

input. The input, before seen as *"cheap nature"* (Moore 2014), is now considered limited. The output, waste, is again thrown back to the countryside, degrading the original nature. The paradigm changes from an independent opposition to a domination and colonisation structure. Cities are where resources are converted into the production of conditions for urban life, and wastes are rejected to nature.

The botanist Paul Duvigneaud first defined ecology as the science of ecosystems, which are composed of a biocenosis: all living beings in the particular conditions of a place and within a particular moment. The environmental factors can be divided into three: climate, water and soil, and he states that they conform a functional scheme that can become a mathematical model (Duvigneaud 1974). He defined urban ecology as a science that considers cities as an ecosystem composed of several sub-ecosystems, such as the ecosystem *"Urbs"*, in interaction with other ecosystems around them, such as the agro-ecosystem. The holistic theory of the American ecologist Eugene Odum influenced Duvigneaud's representation of the urban ecosystem as a flow model, which contributed to conceptualising the contemporary city as a *"bounded and measurable socioecological system"* (Gandy 2022). Duvigneaud's agreement with Le Corbusier and the Athens Charta –characterised explicitly by him as *"urban ecological"* (Lachmund 2020)– in the search of fresh air and sunlight in cities, was accompanied by a series of ontologies and tools to achieve such goals.

This metabolist paradigm is considered valuable to understand energy and material flows nowadays and as a key asset to produce urban spaces after Anthropocene (Handtschoewercker 2024). In the metabolist paradigm, nature is a key part of many of the intertwined –eco– systems that conform the urban reality, and is looking for a durable balance, which could be empirically measured. This datafication of the urban flows leads to new forms of thinking, leveraged by emerging technologies in computation.

Computational modelling

Duvigneaud (1974) remarks that biochemists did not acknowledge ecology as a science during the interwar period. The emergence of ecological movements in the United States was necessary to pay more attention to this world vision. In fact, Ian McHarg's 1969 foundational work, *"Design with nature"*, starts with the sentence: *"There is still only a small shelf of books that deals with man's relation to his environment as a whole"*. The first assessments of ecological impact debuted parallel to the first steps of computation, a novel tool used to create computer simulation models that analysed complex interactions between global systems. The report of the Club of Rome, *"The limits to growth"* (Meadows et al. 1972), became a methodological landmark, exploring the long-term consequences of global population growth and its associated impacts. It became a pioneering use of systems dynamics, a modelling technique developed by Jay Forrester, which analysed how changes in one variable affect others. The report mobilises a data-driven approach within a scenario-based methodology. This became a precursor for many future modelling efforts, such as digital twins. This technological advancement intimately entangled the shift towards systems thinking within a holistic approach.

1.2.4 Nature as driver for the urban

After the decade of the 1970s, the word nature is often replaced with another concept, *'ecology'*, which is by no means a straightforward shift (Gandy 2022), but rather a complex cultural and historical process. The striking and undeniable image of *"Spaceship earth"*, a limited planet with limited resources, questions the infinite extractivist model and its continuous rejection of residues. How should urban design react to such a situation? While McHarg tries to provide ecological guidelines to urbanisation, the Club of Rome warns against unchecked global growth. The idea of an endangered planet establishes an alliance with another movement during the last decades of the twentieth century: nature could heal territories. Nature becomes at once threatened and healing – *"nature menacé, nature reparatrice"* (Picon 2024)–, being the paradigmatic of the recovery of old industrial sites, such as the coal mines of the Ruhr. In these abandoned infrastructures, polluted soils are treated with Nature-Based Solutions and given back for public use as metropolitan parks. These transformations align with a shift towards understanding cities as part of larger environmental systems. In them, nature becomes an integral aspect of urban infrastructure and not only a passive element. It becomes its driver.

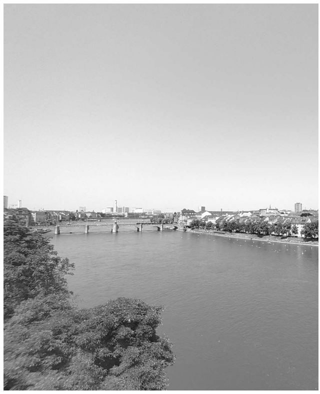


Figure 1.6: Rhein river in Basel. ARC

"Landscape has emerged as model and medium for the contemporary city" (Waldheim 2016). During the last decades of the twentieth century, landscape urbanism arises as a practice that guides urban growth management to incorporate geological, climatic and biological processes better. Its goal is to design the city from the landscape, and the landscape architect takes responsibility for the shape of the city (ibid.). This wholly fresh approach avoids composition, which imposes external geometries to the territory while seeking an ideal control. Landscape urbanism works instead with the definition of strategic transformation, which integrates both urbanisation and natural processes, human and non-human. This perspective is also shared by urban ecology, a discipline encompassing different elements such as socioecological dynamics of urban space at various scales or the material and metabolic dimensions of urbanisation.

Landscape urbanism

This concept is helpful in describing Wachsmuth's last period: urban political ecology as a socio-natural metabolism of the city. *"The key transition has been from the proposition that social worlds —including cities— are constructed on natural foundations and subject to natural constraints (the 'new ecological paradigm' perspective) to the proposition that nature does not stop at the foundations: the city is constitutively social and natural from the bottom to the top, and urban nature is just as political as urban society".* For urban political ecology, contrary to industrial ecology, the city is not only the place where resources are converted into products, but rather a product of socio-natural metabolism. The introduction of the neologism *"socio-nature"* avoids futile binary oppositions of human life and nature and assumes that *"all the features of modern urbanisation are socio-natural"*. Not only has urban political ecology escaped from those binarisms, but it also looks for the forces and processes that have caused the current state and perception of the urban socio-natural environment. However, it seems unable to formulate the same level of proposal for the countryside, which somehow finds itself outside of all considerations.

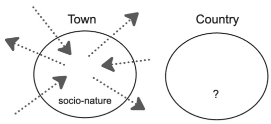


Figure 1.7: Urban Political Ecology diagram. David Wachsmuth, re-drawn by ARC

To illustrate the entanglement of social and natural processes in urban political ecology, the concept of *'rewilding'* is discussed in detail hereafter. The domestication of nature for extractive purposes has been considered part of the origin of contemporary ecological deterioration. From a control and optimisation perspective, urbanisation has applied geometrical, mathematical and statistical rules to the territory. As a reaction, a trend emerges to 'rewild' tamed natures. While the concept of *'wild'*, as an unpredictable, free, creative and self-organised entity could effectively be considered of value to promote biodiversity and restore ecological connections, the concept of *'re-'* is questionable (Hermitix 2023). It certainly implies the return to a previous moment, but it does not specify exactly which one. It is often implied that it is the moment before human impact altered its state, which somehow is influenced by a romantic image of nature, a dangerous motivation to come back to a particular form of nature that is impossible to confirm existed as such. It is instead a human ideal of it. Thus, the firm human hand in shaping this idea of rewilded nature leads to the conclusion that rewilding is a profoundly anthropocentric concept that does not incorporate enough non-human agency, as it will be discussed in detail in the following sections.

Various techniques are entangled with this last paradigm of nature as driver of cities: from GIS analysis to digital mapping, correctly interpreting the context. Hydrological and

Computational design thinking

environmental modelling help to create scenarios and study their evolution through time. However, computational design thinking represents a set of tools whose potential *"lies in the possibility to unveil the rules and drivers of topological behavioural patterns. Articulating these important forces and relationships will help the designer create adaptive design proposals, which work at the site's scale and integrate and support larger systems"* (Fricker 2021). Using such methods to conceptualise future forms of urban nature may foster the imaginaries to come.

1.3 Towards Ecocene

The last four sub-sections identify four key moments in post-industrial urban planning that capture how the notion of nature evolved for designers: from an initial opposition to the metropolitan, it became the *'milieu'* for the urban. Then, the quest for an ecological equilibrium between city and biosphere was key, and finally, nature became a key driver for urban planning to restore that balance. As presented, these moments are profoundly entangled with different technological advancements. The entanglement of both does not take the form of direct causality: it is not one technique that generated a particular vision of nature, nor did a new notion of nature trigger the creation of specific forms of technical development. Both nature and technique evolve hand in hand, shaping one another.

Once explored recent history, it is legitimate to ask what awaits in the coming years and decades and speculate about possible futures for the intersection of urban design, nature and planning techniques. The current historical moment is dramatically impacted by climate change, resulting in two turning points: one for technical developments to face it and a second one, a shift in how humankind imagines future forms of relationship with nature, both inside and outside urban environments. These turning points are not independent of one another, but intimately entangled. How could they co-evolve towards a world fostering climate justice?

The climate crisis is not a new concept, but it was not until the turn of the millennium when a word tried to define its causes: Anthropocene. The previous epoch, the Holocene, is an era characterised by relatively stable climatic conditions, allowing agriculture and urbanisation to develop over millennia. When the atmospheric chemist Paul Crutzen made his speech on receiving the Nobel Prize in Chemistry in 2000, he used the term Anthropocene to describe a new epoch, in which human activities have a dominant influence on climate, ecosystems and even geology. The term emphasises that human actions from the Industrial Revolution onward have generated irreversible effects on the planet. This is a common and accepted answer to the question *'what is happening?'*. Environmental historian Jason W. Moore coined the term Capitalocene as a critique to the distributed responsibility of all human beings that the Anthropocene suggests. With it, he instead tries to explore the causes of this situation, *'why is this happening?'*. The diagnosis points to capitalism's relentless drive for accumulation, leading to environmental degradation and resource exhaustion. These two neologisms may help diagnose the situation, but their *'mythos'* do not facilitate imagining better futures (Boehnert 2018). The following logic question would be *'what should happen now?'*. This would be a speculative storytelling exercise that describes possible futures for the planet where urban nature may play a key role. Donna Haraway (2015) coined the term *'Chthulucene'* to describe a planet as a *'sympoietic'* system, integrated by different entities interacting in interdependence and co-creation. Beth Dempster (1998) describes *'sympoiesis'* as *"collectively-producing systems that do not have self-defined spatial or temporal boundaries. Information and control are distributed among components. The systems are evolutionary and have the potential for surprising change"*. Sympoiesis emphasises the interconnected, collaborative, and co-creative nature of life on Earth. Haraway's Chuthulucene is an epoch marked by entanglements between species, ecosystems and technologies. In

Chuthulucene, humans are just another agent in a large ecological community in collaborative co-creation. All agents have responsibility to repair and regenerate damaged ecosystems through a form of *"Ethics of care"*. It becomes a viable framework that avoids Anthropocene's and Capitalocene's *"cynism, defeatism and self-fulfilling predictions, like the 'game over, too late' discourse"* (Haraway 2015).

Not without humour, Johanna Boehnert (2018) describes Ecocene as Chuthulucene, but easier to say and remember, and less frightening than Haraway's. The term Ecocene, first coined by Rachel Armstrong, implies a cultural shift prioritising ecological stewardship. It embodies an ontology, epistemology, and ethic emerging from ecological thought and ecological literacy, with the aim of shortening the Capitalocene as much as possible. A decisive difference between this and other frameworks is its position on the agency of design, emphasising design's ability as a tool for transformative change. Boehnert explores the reasons *"why current design practice is stuck in the reproduction of unsustainability"* (ibid.) and explores paths to act differently. For British geographer Matthey Gandy, *"Insights from ecocriticism and other fields reveal that the urban ecological imaginary is in a state of flux between dystopian conceptions of destroyed worlds and the recognition of new kinds of socioecological assemblages"* (Gandy 2022). He proposes the use of the phrasing *"ecological imaginary"* (Hermitix 2023) to set a path towards alternative futures that reconceptualise relations between nature and human society. How to foster these future visions? For Gandy, the city and the peri-urban spaces are where new visions emerge: *"some of the most progressive ideas about nature seem to be generated by Metropolitan political cultures"* (ibid.). With this, he shifts the vision of the urban as only the origin of the problem towards a comprehension of it as the pertinent *laboratory* to imagine new forms of urban nature and new relationships between culture and nature.

Many recent visions of ecology have oscillated between technological solutionism and a nostalgic return to traditional values and forms of practice (Picon 1998). Boehnert's Ecocene escapes reductionist dichotomies, criticising solutions that rely solely on technological advances such as geoengineering, because they seem to fail to address deeper structural issues – particularly, systemic inequalities and exploitative practices present in the current framework. Boehnert's concept aligns more closely with socio-ecological or systems-based ecological approaches and with American social theorist Murray Bookchin's ideas on how environmental and social crises were intimately entangled.

Considering the urban as a complex network of socio-natural forces, defining new imaginaries for urban nature towards Ecocene is crucial. With this, researchers, professionals, and most importantly, designers, define the contours of this idea of Ecocene, and how it can supersede the Capitalocene. Not only from a conceptual perspective, but also from an operational perspective: design. The change that the Ecocene requires is not a gradual fine-tuning of the current design decisions. Instead, a profound shift is needed. *"Changing the answer is evolution; changing the question is revolution"* is a quote often wrongly attributed to Albert Einstein, who made a point about the nature of scientific progress instead (Howard 2005). However, it sets a framework where design for the Ecocene can be most helpful: challenging the questions, which design should react to. Which set of tools would be useful in such a quest?

Designers must act with ethical responsibility and ecological literacy, redefining the questions and frameworks they operate in, and not only creating inclusive and sensitive designs. In this way, they act as activists for systemic change towards Ecocene.

1.3.1 The natural and the social

Before further exploring the impact of the ideas of the Ecocene to urban nature, it is key to formulate the position of this thesis towards the societal implications of all the concepts that emerge from these pages. Design, urban design and mapping have a long and established anthropocentric tradition. As explained before, this is at the origin of many of the ecological crises that the planet faces, in particular in its cities. To deepen on the impacts for non-human entities, avoiding human-centred perspectives, the social impact of the matters discussed in this thesis is not investigated in the extent and detail that it required.

However, the entanglement of the social and ecological crises' causes and effects is well documented (Pickles 1995). For example, social theorist Murray Bookchin (1982) developed the ideas around the concept of *"social ecology"*. For him, the social and the ecological crises are intimately interwoven, both produced by the forces of hierarchy and domination. They not only share the same origin but are also interdependent, and the improvement of one relies on the enhancement of the other. Bookchin's ideas provide a robust conceptual framework to continue this study, expanding the research area towards social impact. This could be an interesting logical continuation of this research work, which focuses primarily on non-human, as a conscious decision to investigate less explored territories.

1.4 Conceptualising urban nature towards Ecocene

Contemporary environmentalism goes far beyond conservation and preservation, questioning the path towards durable sustainability in particular. Late 20th-century postmodernism deconstructed traditional concepts of nature, seeking a more fluid understanding and communication between humans and their environment. Paraphrasing the philosopher Timothy Morton (2007), the concept of nature is anthropocentrically scaled and, therefore, designed for humans. How can we overcome imaginaries of nature that are no longer viable to transition towards Ecocene?

The Ecocene represents a cultural and epistemological shift, transforming the exploitative logic of the Capitalocene through ecological literacy. It promotes a relational ontology, recognising that humans are deeply interconnected with non-human life, and embraces multispecies justice, ensuring that decision-making considers the needs of all living beings and not just human interests. This requires a profound political and systemic change that must be guided by regenerative practices advocating ecological healing. The development of ethics of care is key to move forward. The Ecocene is a normative vision, proposing an alternative way of organising human-nature relationships. Its goals encompass the following –although this list should not be considered comprehensive:

– implement ecological governance models, such as rights of nature,

– develop ecological infrastructures that support both human and non-human life,

– prioritise regenerative practices beyond green capitalism and superficial sustainability,

– expand ecological literacy through systems thinking and endemic knowledge systems,

– challenge technological solutionism, which often reinforces human control over nature.

Design practices working with urban nature can support and foster mechanisms towards these goals. To root the discussion into exact terms, Ecocene is discussed through an inquiry into four key concepts to defining current and upcoming understandings of urban nature: agency, cohabitation, hybridisation, and interconnectedness.

1.4.1 Agency

The notion from which the other three derive is non-human agency. Western culture is profoundly anthropocentric, and positions human beings as the sole actors in shaping the world. Philippe Descola distinguishes four different cultural approaches that challenge such principle, highlighting, for example, how some tribes confer a certain *"animism"* to plants and animals (Descola 2013). The idea of conferring intentionality, subjectivity and social agency to non-human forms of life implies an ontological pluralism that needs to be addressed differently by society. Thus, nature is no longer just a resource or backdrop for human activities. Recognising the validity of non-humans' perspectives and subjectivities allows geographer Matthew Gandy to formulate the idea of *"ecological pluriverse"*. This term describes the *"shifting ontological and epistemological ground of urban ecology"* (Gandy 2022), and implies, to start with, the importance of the perspectives of non-human entities and their capacity to impact ecosystems. An example is mutual shaping of humans and non-humans through domestication: dogs, tamed along history, are not passive objects, but active participants in co-creating human-animal relationships (Haraway 2003). They participate actively in the shaping of these interactions. This implies that agency is not individual, but relational: it emerges from multispecies entanglements.

Challenging anthropocentric perspective

This idea of interconnectedness is even taken further by Bruno Latour, who does not only acknowledge agency, but also describes it as distributed across networks of human and non-human actors (Latour 2005). Thus, a virus can shape global health policies, and technological innovation can transform social or ecological behaviours. Latour's *"actor-network theory"* explores how every entity can influence the networks they are part of. Haraway includes technology as part of non-human entities and also recognises its agency to shape processes. As with Haraway, machines are also considered part of the non-human agents by Latour. Other objects, such as bridges, are seen not simply as passive structures, but as actors facilitating or limiting movements and relationships. This implies a decentralised distribution of power. While Latour is particularly interested in these networks' political and social dimensions, Timothy Morton is interested in the ecological implications of these interrelations. This aspect is key in this thesis, which investigates the agency of technology in chapter 3 and empirically investigates it in chapter 5.

Actor-network theory

Beyond agency, recognising hon-human intelligence further challenges anthropocentric visions that prevalently guide urban planning. Many species exhibit sophisticated problem-solving, communication and environmental adaptation. For example, mycorrhizal fungi form vast underground networks, facilitating nutrient exchange between trees and functioning as an organic information system (Simard 1997), an underground communication network of trees often called the *"wood wide web"*. Similarly, certain birds and insects use collective decision-making to optimise habitats, influencing ecosystems structures. Acknowledging these forms of intelligence invites designers working with urban nature to incorporate multispecies knowledge, moving beyond static planning to co-evolutionary urban environments, where both human and non-human actors shape ecological futures. But how can such intelligence be effectively incorporated into the designer's workflow?

Despite its capacity to enunciate a complex system of relationships and agencies, Latour's theory's flat ontology does not effectively portray humans' power structures or structural political power. It would be interesting to think of a more nuanced approach merging material networks with cultural and epistemological dimensions. The descriptive nature of this theory is not accompanied by a prescriptive dimension that could, for instance, help urban designers to apply it. Decisions about managing urban ecosystems are inherently political and reflect power dynamics and societal values. Truly recognising non-human agency requires an inclusive approach, shaping anew urban governance and accounting for the diverse perspectives of both

Political dimension

human and non-human stakeholders.

Ethical dimension

It is also key to consider the ethical dimension of non-human agency. The idea of *"ecological pluriverse"* emerges from *"geographer Jennifer Wolch's striking neologism zoöpolis[...]. The 1996 essay in which she coined the term invites an imaginative encounter between the cultural history of modernity and insights from the biological sciences, marking a key intervention in the emerging field of 'animal geographies' and the development of 'transspecies urban theory'"* (Gandy 2022). Several questions about human responsibilities towards other species and their habitats arise within this paradigm. They urge a re-evaluation of practices prioritising human convenience or economic gain over the well-being of non-human entities.

Environmental personhood

Recognising agency of the biosphere is a crucial shift with political, ethical and legal implications. Many natural features, such as rivers or forests, start being recognised with *'environmental personhood'* in different parts of the globe, such as Bolivia, Ecuador, India and New Zealand (Gordon 2018). The influence of indigenous worldviews has been key in developing new rights for nature. For instance, in New Zealand, the Maori concept of a river or a mountain as an ancestor played a crucial role (Whanganui River Claims Settlement Act 2017). Understanding that natural elements have legal rights, such as their well-being and health, is still a challenge in today's western societies, which nevertheless conceded legal personhood to corporations and firms, or governments and public bodies, such as municipalities. Corporate could be a model for developing environmental personhood (Gordon 2018), but the real implications of these first cases, such as Whanganui River, are just starting to be addressed in detail. The question of how this shift of mindset affects urban planning has not been appropriately faced yet, but it is possible to imagine that technology will play a key role in describing such concepts as urban rivers' well-being and how to contribute to its improvement.

Agency and urban planning

The implications of the acknowledgment of non-human agency for urban planning are manifold. It certainly implies a shift from a form of control to a form of coexistence. This idea of cohabitation is discussed in the next section. Moreover, it implies a change of the extractive or instrumental paradigm towards a reciprocal model: nature is not the resource anymore, but it is entangled in a web of relationships with all the other actors –taking Wachsmuth's *'urban political ecology'* to a further level. These ideas also foster biodiversity over homogeneity and contribute to open the question of the aesthetics of nature. While blossoming flowers are considered *'pleasant'* for humans in urban environments, moist dead trees decomposing in a park are an ecosystem where multiple species thrive symbiotically. Accepting the *'dark'* parts or images of nature is key here.

A last consideration inquiry deepens into the dialectical pair of *'domestication'* and *'wilderness'*. For Descola, this distinction is not universal, but a product of particular historical and cultural trajectories. Like those two concepts, *'rewilding'* is also historically and culturally contingent, and it has become a contemporary mantra about urban nature, as discussed before. The idea of it is more often than not human-centred, conceiving exclusively to the human being the capacity to decide what form of nature is desirable.

1.4.2 Cohabitation

The Modern Movement constructed the notion of a landscape object. It can be looked at, admired, used, or exploited, but it is never possible to establish an equal relationship with it. The only possible interaction with nature is in a form of *"fetishist peep-show"* (Ábalos 2004). In contrast to a natural background, this vision of society –and its place, the city–is not inherent for many non-western cultures, which do not draw a strict boundary between humans and nature (Descola 2013). The segregated vision of nature as abstract green *'milieu'* of plan Voisin is found in Le Corbusier's masterplan for Chandigarh, a more rooted and entangled form of relationship between the urban and the natural infrastructure.

Cohabitation as ontological intertwining

This cohabitation of culture and nature does not only rely on physical proximity, but encompasses a deeper ontological entanglement, blurring the frontier between human and non-human. This implies that the ways humans perceive and relate to the non-human world are not universal but shaped by specific cultural and historical context (Descola 2013). Acknowledging diverse perceptual realms of non-human nature can *"problematize many of the conceptual categories that are routinely deployed in Eurocentric modes of analysis"* (Gandy 2022). This can be a powerful approach to question the status quo of urban nature.

Cohabitation as forms of interaction

As Matthew Gandy points out, *"At the heart of Descola's project is the search for new modes of cohabitation that can accommodate 'the whole immense multitude of actual and potential existing things'"* (ibid.). Today, the interaction between nature and culture is not only possible, but can even become symbiotic, as Donna Haraway (2008) explains when describing how species rely on one another for survival. Adopting a form of ethics of care implies responsibility to other human and non-human forms of life, which leads to better states of multispecies justice and liveability. With them, instrumental visions of nature, such as *'ecological services'*, where nature is classified in four anthropocentric categories as per their capacity to serve to humans –and other ecosystems–, can be superseded. The idea of domestication of nature is also questioned, not without difficulty when discussing the idea of rewilding, as discussed above.

Cohabitation as adaption and negotiation

The botanist Paul Duvigneaud points out that there are 35'000 tons of people in Brussels, whereas there are 16'000 tons of earthworms, and in middle-sized cities such as Charleroi, the balance wins for the worms, so the question of for whom should cities be planned seems pertinent (Duvigneaud 1974). The interactions that cohabitation generates take different forms, but in the urban realm, they tend to evolve over time, with various stakeholders adapting and negotiating positions and actions. Synanthropic species are animals, plants or organisms that thrive in human-modified environments, often associated with human settlements. These species are not exactly domesticated, nor entirely wild: instead, they adapt to the conditions of urban –or agricultural– landscapes, benefiting from resources provided inadvertently by human activity. These species oblige us to reevaluate human relationships with the biosphere, committing to living with the different, and imagining new forms of adaption and negotiation.

The spatialities of cohabitation

This cohabitation is not only punctual, but also reticular. The philosopher Timothy Morton describes humans in continuous interaction with the non-human through multiple and diverse connections, that he calls *"mesh"*. This non-centralized structure –particularly not anthropocentric– embodies a relational spatiality in infinite interconnection, that is discussed in detail in section 1.4.3. This reticular inter-relationality takes place in what Bruno Latour describes as *"critical zones"*, the thin layer of the earth where humans have impact: from some kilometres below the ground level to the atmosphere. Latour describes it as a closed system, reducing *"spaceship earth"* almost to its thin epidermis. Within it, the quest for balance between human and non-human must occur.

Technology and cohabitation

Haraway includes technologies within what is considered non-human, together with animals, plants and microbes. Thus, technology becomes an enabler of cohabitation, facilitating multispecies relations: it can be used to understand their challenges better, caring for and collaborating with them. This non-hierarchical approach also facilitates to blur the boundaries between human and non-human, mediating the forms of cohabitation. The incorporation of technology to the body engenders the concept of the *'cyborg'*, a hybrid form that claims that technological advancements are not external to human nature but embedded in it. However, it is key to acknowledge the danger of reinforcing anthropocentrism by technology: *"Even robots* *capable of modulating their actions following an autonomous learning period find no favor in their eyes, for their mechanism is inspired by connectionist models of the mind. And, as Ingold writes, connectionism 'is still grounded in the Cartesian ontology that is basic to the entire project of cognitive science—an ontology that divorces the activity of the mind from that of the body in this world.'"* (Descola 2012). This distinction risks perpetuating hierarchical relationships with nature, such as deciding which species to protect or control, often technology driven. Critical awareness of the political and ethical consequences –attended and unattended– is crucial when applying technologies to the study or plan of cohabitation.

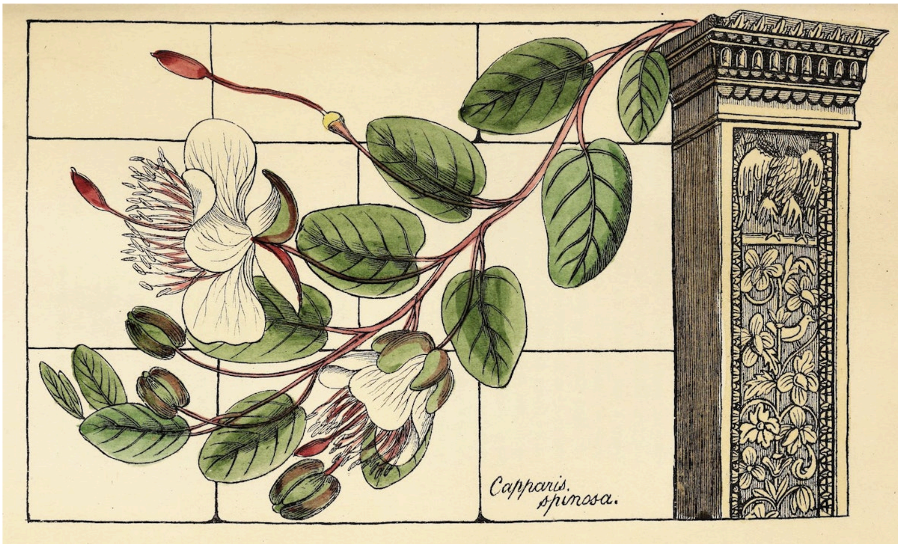


Figure 1.8: Flora of the Colosseum of Rome, 1855. Richard Deakin. Public domain.

1.4.3 Hybridisation

This coalition of technology, humans and the biosphere contrasts with Otto Shülter's definition of *"Naturlandschaft"* –landscapes shaped only by tectonics, climate or geomorphological processes– and *"Kulturlandschaft"* –those transformed by human actions and their impacts. It is today difficult to argue that there are any natural landscapes on the earth's surface, as even glaciers or deserts suffer the consequences of the climate change caused by human production. The dissolution of the natural-artificial opposition is effective at different scales, and it *"implies a working program, which is nothing other than re-describing, via architecture, the position of contemporary man vis-à-vis the world" (*Àbalos and Herreros 2002). Based on this hypothesis, professional designers draw the limits of a new hybrid naturalism throughout scales. Juan Herreros describes the work of the architect and the urban planner as finding novel forms of balance that make the Earth work (Herreros 2006). He urges the construction of a *"second nature"*: far from that in paradise, which allegedly opposes the city, or the one to be conserved in nostalgic discourses. He pleads for constructing nature defined as artificial, to which agriculture, infrastructure and cities already belong. The artificialisation of the Earth is considered pervasive and effective: *"todo es ciudad"* –everything is city or *"Kulturlandschaft"*–, as Herreros states. He nevertheless claims that the next pertinent statement should be *"todo es naturaleza"* –everything is nature: *"The city is not only part of nature, but it is nature in itself"* (ibid.). Within this paradigm, the process of the artificialisation of nature has been understood and accepted, but it should be opposed to another process, that of the naturalization of the city. He defines this new or second nature as *"set of rules, laws, processes and systems able to describe and construct the balance between the artificial and the natural worlds that constitute Earth"*. In the landscape of

Everything is city, everything is nature contemporary technique, it is not relevant to understand what is natural and what is built by humans, but instead *"what makes sense in their hybridation"* (Picon 1998).

Naturecultures

To achieve this hybridation, Juan Herreros names three primary resources: transformation, energy and information, which are intrinsically linked to the main topics of this dissertation and will be discussed in the following two chapters: transformation through design –chapter 2– and information from digital datascapes –chapter 3. As a guide to categorise the hybridation of the *"critical zones"*, geographer Erle Ellis formulated the *"anthropogenic biomes"* (Ellis 2008). While *'natural'* captures the dominant vegetation types of an area –rainforests, grasslands, savanna, for example–, Ellis' classification reorientates instead environmental analysis towards a form of *"synthetic ecosystems"* (Gandy 2022), highlighting the entangled hybridity of ecosystems, and redefining landscapes as *'anthromes'*, anthropogenic biomes where natural and cultural processes are deeply intertwined. This shift emphasises the need to reorient the analysis of ecosystems not only through their natural characteristics but also through their socio-ecological transformations. A new *"feral urban ecology"* studying hybrid assemblages emerges: *"feral can be characterized as a liminal state between wild and domestic that unsettles dualistic conceptions of nature and culture"* (ibid.).

Donna Haraway's idea of *"natureculture"* enriches the visions on hybridisation, challenging the *"Great Divide"* described by Descola. She argues that nature does not pre-exist, independent of our explorations of it. It is continuously shaped and co-evolves with human cultures. It is impossible to define one independently of the other, and human and non-human actors co-constitute each other through interactions and shared existence. Haraway describes a continuum, where humans, non-humans and technology interact co-producing, for example, the urban realm. New hybrids emerge, for example, in urban ruins, where the alkalinity of mortar contributes to the blossom of plants, endemic of places with entirely different substrate than urban soils, such as high mountain and rocky environments. These hybrid conglomerates are the product of a combination of natural and cultural processes within time, facilitated by technology.

The idea of naturecultures has profound implications for how hybridation is understood. First, because it identifies technologies, plants, animals, microbes and human beings as active participants in the co-production of reality. Besides, the symbiotic relationships between different stakeholders are multidirectional, shaping one another. This leads to Haraway's concept of *"companion species"*, continuously evolving in complex assemblages: entangled networks of human and non-human elements functioning together. Synanthropic species, those organisms thriving in human-modified environments, illustrate how urban planning must account for multispecies justice, ensuring that cities are not solely designed for human benefit but also for other life forms. This idea sets the foundations of many of the exercises examined in chapter 5, which seek design expressions that can foster hybridized naturecultures.

The blurred boundary between human and non-human also extends its interdependence to technological systems. In urban environments, technology increasingly acts as a mediator of naturecultures, shaping how we interact with the biosphere. Inspired by Haraway's *"Cyborg Manifesto"* (1985), it would be possible to suggest a form of *'cyborg ecologies'* for cities, where hybrids of biological, digital and material flows co-evolve rather than exist in opposition. This brings the discussion again to the relationship of technique and nature. In the past, technology had to evolve to adapt to the new visions of nature, as it happened with computation and the ecological awareness of the seventies –see subsection 1.2.3. Looking towards future naturecultures, which technologies should be imagined for or by designers to embody the principle of agency, cohabitation and hybridation? How to overcome control paradigms, prevalently dominating urban planning and smart cities, and orient practices toward symbiotic multispecies collaboration?

1.4.4 Interconnectedness

Alexander von Humboldt's vision of nature redefined how humanity understood its relationship with the natural world. His idea of nature as a unified interdependent whole emphasises the intricate connections between climate, geology, flora and fauna (Wulf 2015). This pioneer work inspired generations of thinkers to view the planet as an integrated system: such a vision is the germ of the development of much of the ecological and systemic thought over time. Urban metabolism, as discussed above, owes much to Humboldt's contribution. *"For the geographer Erik Swyngedouw, the process of urbanization is founded on 'the perpetual metabolic transformations of nature'"* (Gandy 2022). This emphasises how production and transformation of urban spaces are intertwined with natural processes, in a form of *"socio-natural flows"*. From this perspective, cities are not static entities imposed upon a passive natural environment, but the product of interconnected socio-ecological flows.

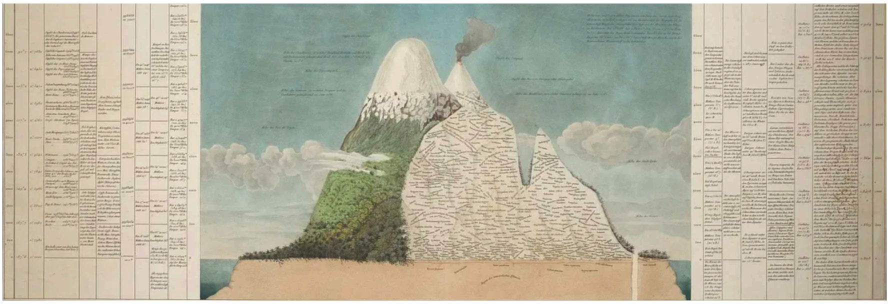


Figure 1.9: Chimborazo, Alexander Humboldt. Public domain.

Perspective shift

The idea of interconnectedness is profoundly linked to the three notions presented in the last sections, agency, cohabitation and hybridisation. It refers to the intricate web of relationships and dependencies between diverse system elements. This challenges anthropocentrism, shifting the perspective from fragmentation to integration: instead of understanding separate elements, they are situated, put in context and understood in relation to it. This also means abandoning linear thinking and embracing systems thinking, acknowledging the dynamic character of the interactions. Finally, it also implies abandoning the idea of individual responsibility and considering the shaping forces of collective responsibility.

Permeable boundaries

As cohabitation and hybridation, interconnectedness questions the idea of boundaries between the different elements of a system. Cohabitation and hybridisation imply no impermeable boundary between humans and non-humans –between culture and nature. It is then crucial to better understand the intertwined relationships and forces between both stakeholders. This brings up the question of multiplicity –of actors– and relationality. Timothy Morton questions the existence of nature independently from humans and connects every instance –human and non-human– through a dense grid of interrelations called *"mesh"* (Morton 2007). It is no coincidence that this word evokes representations of complex networks commonly related to digital culture, which will be discussed further in the following chapters. Morton goes beyond this idea of interconnectedness with the concept of *"hyperobjects"*: massive and spread phenomena, distributed across the entire planet and spanning from past to the future, that cannot be fully grasped within traditional categories. Morton uses plastic or climate change as an example, phenomena that challenge conventional ontological categories, blurring the boundaries existing between natural and artificial, or living and non-living. Such complex realities require different tools and complementary methods to delve into their origins, development and possible impact of design on them. Could digital mapping and speculative design be one of those tools and one of those methods?

These four concepts are key for the Ecocene, and their impact on design practice is introduced briefly at the end of each sub-section. They challenge anthropocentric urban planning practices, offering a framework for designing cities within planetary ecological limits. Nature is considered more than an aesthetic element or a resource: these four concepts guide designers toward adaptive ecological systems and relational urbanism. Then, how would the future practice look like for professional designers who deal with these ideas? What would be the result of such practice? Which tools and methods are helpful in this quest for a form of practice towards Ecocene? The last section of this chapter reflects on four perspectives within ecological thought that could be relevant to identify possible design methods and technological tools that the designer towards Ecocene may aspire to acquire.

1.5 Designing the Ecocene in urban environments: tools and methods

Different ideas of nature and the techniques to operate with them have been specific to each era. Alberti and Brunelleschi used geometry and proportion to create harmonious, human-centric gardens. Francis Bacon pioneered the scientific method to understand and control nature through experimentation. Donna Haraway uses the image of the cyborg to express the embedded techniques that operate in the relations between human and non-human entities. Nature, *"which used to be the core concept of philosophy and science, is nowadays not considered as a philosophical concept or a scientific term anymore. Strikingly, it is absent from most lists of philosophical concepts in high school and academic programs and manuals"* (Ducarme & Cuvet 2020). It is key, though, to question what nature exactly means today for designers and how this vision influences technical advancements. If Ecocene is a valuable paradigm for designers to define their relationship with nature, which techniques, tools, and methods could be helpful in achieving a form of design towards Ecocene?

The four abovementioned concepts make planning new urban naturecultures very difficult with the tools used in the twentieth century, or, at least, how they were used. These new perspectives define a more elusive, networked and diffuse form of nature, and the design practice itself. This new framework requires new methods and tools to work with them. How does this new framework alter the process of design? Which kind of design can work best to create novel urban naturecultures? What are the mechanisms of those designs? How can those design processes be modified to make them more suitable for the framework of Ecocene?

Urban ecology has become one of the hegemonic discourses to study nature in cities. In *"Natura Urbana"*, Mathew Gandy (2022) identifies four perspectives within urban ecological thought, which can be linked with different methodologies and tools. The first stems from systems thinking and a metabolic understanding of the urban space, as started by botanist and ecologist Paul Duvigneaud, who defined ecology as the science of ecosystems. It focuses on the interconnectedness of ecosystems, the study of the flux of matter, energy and refuse. This approach relies on an analytical framework, superposing complementary studies performed by diverse disciplines. The result is a form of assemblage of all these knowledges, often performed by computational analysis of ever larger datasets. The tools required for this span from GIS-technologies to computational modelling, such as digital twins, are discussed critically in the next chapter.

The second perspective identified by Gandy derives from nineteenth-century observation of nature: taxonomic knowledge applied to specific areas, learning from Humboldt's trips and his methods to classify and understand the natural world. This *"observational tradition now extends to aspects of behavioural ecology, ethology, and more sophisticated readings of human-*

animal relations" (ibid.), and has actualised its methods through what has been called *'citizen sensing'*. With it, how knowledge is produced, distributed and acted upon is being reinvented (Hecker et al. 2018): people from specific communities become sensing actors armed with simple technologies or just their mobile phones. It is key to understand this task beyond pure data collection, but as a form to understand the environment. Like Humboldt did. Several examples of this practice are presented in chapter 5.

The third approach is *"urban political ecology"* –presented already in section 1.2.4–, synthetising elements of political ecology and alternative traditions in urban history. In it, neo-Marxian insights are considered to interpret environmental degradation. This approach incorporates further forms of study that may be unseen by the metabolist approach, as they are less quantifiable in terms of flows and accountable precise figures. Coupling both contributes to a more complete form of ecological study.

The fourth and final strand of urban ecology introduces the term *"ecological pluriverse"* (ibid.), highlighting the idea of non-human agency, and the exploration of assemblages of human and non-human life forms. The goal in this case is to gain non-anthropocentric perspectives, fostering the understanding of further subjectivities. Building up from Descola's theories about agency, Gandy proposes acknowledging ontological diversity as a method to *"problematize many of the conceptual categories that are routinely deployed in Eurocentric modes of analysis"* (ibid.), that is, to question the reflection process. In chapter 5, several exercises are examined, where the recognition of plant and animal agency has contributed to a critical reformulation of the initial hypothesis.

By combining these four approaches –along with their methodologies, tools and other forms of inquiry– designers can generate operative knowledge across different scales and temporalities, shaping urban environments towards Ecocene. These approaches, methods and tools accompany contemporary thinkers and designers in the ideating new ecological imaginaries. As discussed at the beginning of the chapter, for Merleau-Ponty, it is a different idea of nature that fosters new methodologies and tools to investigate this new idea. Which design methodologies and technological tools can foster the creation of these urban naturecultures?

If design methods traditionally seek to define a problem and propose a solution, Gandy's perspectives seem to plead for an alternative approach that questions the problem itself. The systems-based approach of the first perspective highlights how urban environments function as complex adaptive systems, making it difficult to isolate a singular design challenge without considering the more significant metabolic flows. The third perspective, focusing on reasons, causalities and consequences, introduces a method of profound political and interrelational inquiry, requiring designers to engage with the evolving dynamics of urban nature before intervening. Finally, the fourth perspective disrupts conventional design logic by embracing ontological plurality, recognising that different species, materials, and technological systems have distinct ways of experiencing and shaping the urban realm. Together, these perspectives align with speculative design, a method that challenges existing assumptions and projects alternative futures rather than providing immediate, solutionist responses. In this way, speculative design becomes a strategy to critically engage with urban nature, allowing designers to construct new imaginaries where multispecies entanglements and ecological agency are prioritised. This is discussed in depth in the next chapter.

Tools designed to integrate Gandy's perspectives should operate at the intersection of data-rich analysis, situated observation, and speculative inquiry. They should model urban nature as a metabolic system and incorporate field-based ecological sensing to register the complexities of non-human presence and agency. Additionally, they should be able to simulate alternative scenarios, enabling designers to explore different configurations of multispecies urbanism. Such tools would need to be adaptable, integrating real-time data processing, participatory inputs, and generative modeling techniques to facilitate new ways of perceiving and interacting with urban ecologies. This thesis will consider digital mapping as one of these tools that can serve this purpose, offering a means to visualize, analyze, and speculate on urban nature through an expanded, multi-perspective lens. This tool is contextually presented in Chapter 3.

2 Design methodologies

This chapter explores the multifaceted relationship between design, science and speculation. It delves into the nature of design as a practice, investigating the factors that impact its capacity to address complex problems. The mechanisms of knowledge production of science and design are distinct, the former contributing to gain certainties, and the latter, as a methodology to explore uncertainties: *"Since the consequences of design lie in the future, it would seem that forecasting is an unavoidable part of every design process"* (Simon 1969). This idea of imagining the future as a method does not imply an escapist position from reality towards ideal and fantasy-inspired fabulations. Instead, it is possible to use design as a reflective tool to critically assess the challenges, risks and opportunities that societies face today. That is the value of speculative design, a methodological approach to tackle and redefine the subjects to which design should react. Such an insight is particularly valuable for urban design, a task without a clearly defined goal. Embracing the approaches of speculative design empowers designers to undertake the challenging mission of imagining new urban naturecultures. Such practice becomes transformative, moulding a new form of professional, critically assessing the tasks that urban design should react to.

2.1 Science and design

What is design?

The etymology of the word *'science'* leads to the Latin form *"scientia"*, meaning knowledge. It derives from the verb *"scie"*,which describes having understood something. It definitely embodies a form of certainty, regardless of its source. On the other hand, the word *'design'* comes from the Latin form *"designare"*, which could be translated as point out, mark out, or designate. It is a passive voice, with the prefix *"de-"*, meaning from, and the suffix *"signare"*, to mark. It is derived from *"signum"*, identify mark or sign. The Italian form *"disegnare"* was already used in the sixteenth century to indicate an intention, a plot, and also to draw or paint something. The nominal form of design has evolved to the idea of a plan or an outline, or a scheme to realise something. In this sense, the verb to design also communicates the creative process of design development. The French voice *'projeter'* or the Spanish one, *'proyectar'*, is used in these pages as a synonym for design. Their etymology comes from the Latin form *"proicere"*, meaning to throw forward. It then reflects the idea of planning something that will be executed in the future. The German word to describe the same concept is *"Entwerfen"*, whose suffix also brings up the idea of throwing. The different languages' etymology indicates a form of uncertainty: design is understood as a process to, indeed, approach some degrees of certainty, but differently as science would attain. Design deals with what is not there, as much as with what is there.

Design may certainly mobilise and incorporate different scientific methods, but nowadays, it is rarely considered merely objective. It proposes a possible plan, action or solution, incorporating the designer's vision, intentions and proposals to achieve the goals defined in the first stages of design. But isn't even the setting of the target quite a subjective process? The designer chooses the data and methods to analyse it, incorporating personal biases into the process. The confrontation and the cooperation of science as objectivity and design as subjectivity have defined the evolution of societies over the last few centuries. Nigel Cross (2001) comprehensively describes this development in his work *"Designerly ways of knowing"*, which conceptually informs the following recap.

The term design gained more modern meaning during the industrial revolution, precisely around the exact moment as the conceptual separation of nature and cities, as described in the previous chapter. Before, craftsmanship and artisanship were built on empirical knowledge, using rudimentary forms of design thinking like treatises or geometry. However, from the second half of the 19th Century, it became necessary to meticulously plan and conceptualise product manufacture. Nevertheless, it was still not seen as a profession. At the turn of 20th century, design started to be considered a discipline whose goal was creative problem-solving. Van Doesburg or Le Corbusier refused subjective speculation in art and gave excellent value to rationality and science. The *"machine à habiter"* is an excellent example. During the seventies, described by Buckminster Fuller as *"design science decade"* (ibid.), the principles of Design Thinking emerged. Fuller addressed complex problems of incorporating knowledge from different disciplines. It was systematic and goal-oriented, focusing on tangible, efficient and scalable solutions. Three different approaches to the interaction between science and design are investigated below: they provide an operative framework to situate the design exercises that will be analysed in chapter 5.

2.1.1 Design as problem-solving

How do we design?

The Roman architect Vitrubius outlined the three core principles of architecture: *"firmitas, utilitas, venustas"*, that is, durability or stability, functionality and beauty. These values still guide many of the design paradigms today. There are as many design processes as designers, but design has often been described as a problem-solving practice (Simon 1969). It creates objects, environments, systems and processes that respond to specific functional and aesthetic needs. Its principles are utility, durability, efficiency and economy, with special emphasis on the technical aspects, its form and function, rather than its societal or cultural implications.

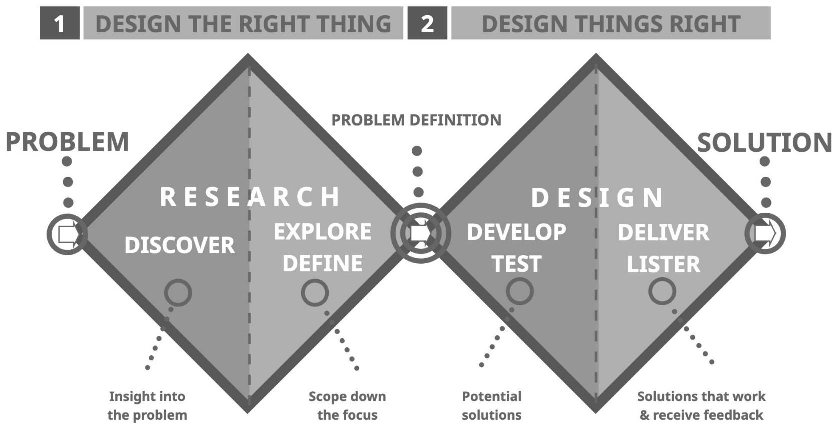


Figure 2.1: Double diamond (design process model). Double Diamond is the name of a design process model popularised by the British Design Council in 2005 and adapted from the divergence-convergence model proposed in 1996 by Hungarian-American linguist Béla H. Bánáthy. Redrawn by ARC.

Considering design as a problem-solving practice, the British Design Council proposed a double diamond of divergence and convergence, that has been adapted to describe the design process –see fig. 2.1. Most scholars differentiate two consecutive phases: research and design. The former tries to define the subject of design clearly: the problem. The latter tries to offer the best solution to the well-defined problem, as defined in the first phase. Both phases comprise two consecutive processes: first, a divergent one, then, a convergent one. During the early research phase, all possible options are considered, to gain insight into possible connections with other disciplines, subjects, and problematics. Then, the exploration is refined to formulate a precise definition of the problem, different from the original starting point, as it has been enriched through the divergent study of possibilities, relationships, and considerations. The design phase also starts with a divergent movement, where several potential solutions are proposed, compared, and assessed. It continues with a convergent process, selecting the proposals that best fit the previously established criteria until this refinement work leads to a final design proposal.

This closed-system, fixed-goal design task is ideally suited to parametrising with computational methods. The parameters must be set along with the goals for each parameter until the optimal combination of parameters is reached. This principle has been extensively used in industry, and its expansion into work on a larger scale has led to the Smart Cities paradigm, which will be discussed in depth in the next chapter.

American technology researcher Herbert A. Simon made in *"The sciences of the artificial"* (Simon 1969) a clear distinction between the natural and the artificial, and the disciplines that scientifically studied them. While he stated that *"natural science is knowledge about natural objects and phenomena"*, he questioned if there could be a form of *"artificial science knowledge about artificial objects and phenomena"*. In a contemporary world that is mainly man-produced, a form of procedure to deal with its product is needed. If natural sciences were concerned with how things are, design is concerned for Simon with how things ought to be (ibid.). Thus, he defined design as the science of creating artificial systems to achieve desired outcomes, implying that design is a problem-solving activity, which must be grounded on rationality and systematic processes. Design would then synthesise knowledge from multiple disciplines such as engineering, social sciences, mathematics, which provide scientific methods to explore possible solutions. In this sense, design operates in a goal-directed behaviour, where scientific insights inform and steer solution finding.

This idea of science informing design practice has been an extended narrative. It has been crucial for expanding practices such as Smart Cities, which looked in forms of computational science the keys to direct a specific design. However, several scholars have raised their voice against this vision of design, building up from John Dewey's *"theory of inquiry"* about the relationship between the construction of rational decisions and the logic of an investigation. Building up from Dewey's work, Donald Schön (1982) questioned how academia claimed to own the key scientific knowledge that practitioners would simply have to apply. This confrontational idea leads to a distinctive approach for design.

2.1.2 Design as reflection-in-action

In *"The reflective practitioner"*, Donald Schön (1982) investigates the causes of the crisis of confidence in professional knowledge. For him, it stems from technical rationality limitations, which fail to adequately address the complexities and uncertainties that professional practice must deal with. Particularly, the unanticipated consequences of professional actions and technological advancements introducing unforeseen risks and ethical dilemmas. Science is reliable to face well-defined problems, but real-world tasks such as urban design are often messy and ill-defined, which for Schön defies neat solutions derived solely from technical expertise. The unanticipated segregation effects of planned urbanisation, as per scientific knowledge, are a good example of the system's failure.

For Schön, the shift of the meaning of the word *'professionalism'* is paradigmatic, transitioning from its early associations with guilds and skilled craftsmanship towards a modern conception based primarily on the application of scientific knowledge. Technical rationality became a dominant epistemology ascending alongside the scientific revolution and shaped the structure of professional education and practice. There is a clear distinction between scientific knowledge –objective, universal– and practical application, which becomes a straightforward application of this knowledge in a predictable manner. The core of this professional paradigm is problem-solving.

Schön, convincingly arguing these assumptions, introduces the concept of *"reflection-in-action"*, cornerstone of an alternative framework for understanding professional knowledge. With it, he imagines an iterative process in which professionals engage in a *"reflective conversation"* with the situation they face. Drawing from their experience, intuition and tacit knowledge, they frame the problem, experiment with different approaches and evaluate their outcomes, reflecting and reframing the problem, which leads to a further cycle of experimentation.

A positivist approach of *'directly'* applying science to inform design, such as Herbert A. Simon's, disregards the practical knowledge gathered by designers. This discipline relies heavily on tacit understanding, intuition, and the iterative adaption of solutions to context-specific challenges. *"Reflection-in-action"* bridges the gap between two forms of knowing, one theoretical, and one emerging from experience. It fosters a form of design in constant interaction with science, that fully recognises the value of the action of design as a form of reflection and creation of knowledge.

2.1.3 Design as a distinct discipline

Whereas it is commonly accepted that there are two main areas of education: the sciences and the arts or humanities, British design researcher Bruce Archer (1979) identified a third area that is independent but connected to the preceding two: design. Each area deals with a different phenomenon of study through its own set of methods, highlighting different values. Table 2.1 captures the classification design researcher Nigel Cross (1984) identified.

	Science	**Arts / Humanities**	**Design**
Phenomenon of study	The natural world	Human experience	The artificial world
Methods	Controlled experiment Classification Analysis	Analogy Metaphor Evaluation	Modelling Pattern-formation Synthesis
Values	Objectivity Rationality Neutrality	Subjectivity Imagination Commitment	Practicality Ingenuity Empathy
Type of knowledge	*Scientific*	*Artistic / Humanistic*	*'Designerly'*

Table 2.1: Comparison of the three education areas, Nigel Cross (1984).

Following the discussion of the previous chapter, it has been stated that design in the Ecocene not only concern the artificial world but also looks for forms of cohabitation, hybridation, and interconnectedness of the biosphere and the man-built world. The phenomenon that design deals with the artificial world, encompassing the natural world, the built realm and the human experience. A city is also constructed with trees and ecosystems, profoundly impacting the social tissue of its population.

However, the key point here is identifying what makes knowledge *'designerly'*. It is not as evident or has as much consensus as defining what artistic or scientific knowledge is. Nigel Cross (1984) considers design a unique epistemological domain, separate from but complementary to science and art. He acknowledges that design draws from science and humanities, but they cannot encompass its full scope. Three of the five aspects of designerly ways of knowing that he identifies are key for this research. First, *"designers tackle 'ill defined' problems"* (ibid.), they try to solve situations with blurry conditions, where it is difficult to optimally satisfy all parameters or even precisely identify the problem. Second, *"their mode of thinking is 'constructive'"* (ibid.). In contrast with scientists, who have an analytical approach, designers know that solutions are not to be found just somewhere among the initial data: they must be actively constructed with their own efforts, they have to be synthesised. And third, *"their mode of problem-solving is 'solution focused'"* (ibid.): unlike scientists, who look for the fundamental law defining the problem, designers approach problem definition through proposing and constructing solutions. The iteration through variations of solutions generates knowledge about the problem.

Schön's and Cross' approaches towards science integration in the design process provide a robust theoretical framework for this thesis. Science cannot offer all answers for ill-defined design tasks. Besides, there is a *'**designerly**'* form of knowledge that is valuable to refine and redefine the problem definition. The design paradigm of Ecocene looks for precise solutions. Still, it acknowledges the difficulty of unambiguously defining the problem to react to, as not only cultural and social impact must be considered, but also the multi-faceted interrelation with the biosphere. This shift of focus even tries to incorporate non-human agency, which has been recurrently ignored by solution-oriented design, and is often a profoundly anthropocentric practice.

Building on the work of Schön and Cross, the following sections explore forms of design that focus on problem redefinition, and integrating science, not only relying on it. Tools often drawn from the humanities, such as narrative thinking or storytelling, can also be powerful to refine the task that design must react to. They can be the origin of speculative design. The left hemisphere of the brain is primarily analytical and verbal, dealing better with the subjects of science and humanities. On the other hand, *"the right hemisphere is believed to be more rapid, whole-patterned, spatial-perceptual, global and non-verbal"* (Cross 1984). Cognitive maps, those internal mental representations of geographical space, do not emerge from scientific analysis or narrative techniques but from visual aspects. This particular notion of Cross's designerly ways of knowing is key for the discussions about digital mapping in chapter 3: *"This culture relies not so much on verbal, numerical and literary modes of thinking and communicating, but on nonverbal modes. This is particularly evident in the designer's use of models and 'codes' that rely so heavily on graphic images – i.e. drawings, diagrams and sketches that are aids to internal thinking as well as aids to communicating ideas and instructions to others"* (Cross 1984). Visual representation, spatial relations and cognitive mapping must be trained in relation to science and humanities, but respond to a completely different neuropsychological form of idea construction. For Nigel Cross (2001), it is key to imagine pedagogical situations that help develop this form of thinking. A proposal of this kind of courses and the competences to be developed by designers in them is presented in detail in chapter 4.

2.2 Design, path towards problem definition

"Myths taught at design school: (i) Design is good, (ii) Design makes people's lives better, (iii) Design solves problems" (Auger 2013) is a compilation of design myths by design researcher James Auger, highlighting with irony how the lack of critic of its own history may lead to an aberration of design practice. If design does not solve problems, what is it valuable for? Herbert A. Simon, even believing firmly in applying science to guide design unmistakably, states:

“A paradoxical, but perhaps realistic, view of design goals is that their function is to motivate activity which in turn will generate new goals” (Simon 1969). With this statement he joins Cross’s and Schön’s vision of design’s iterative process. It circularly leads to the starting point, but with new knowledge, which redefines the contour conditions. This capacity of design to reformulate its own goals is a form of dealing with uncertainty. Urban and regional planning researcher Karen S. Christensen (2007) links this idea with the uncertainty of planning motivated by conflicting goals in changing contexts. It is no longer accepted that both the starting and the end points of design are known or agreed.

Besides, the current technological context, in permanent evolution, leads Christensen to consider the relationship of constantly redefined goals and technologies that are known or to-be-imagined. Table 2.2 captures different positions depending on the certainty of goals and technologies to reach them.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">GOAL</td></tr>
<tr><td>agreed</td><td>not agreed</td></tr>
<tr><td rowspan="2">TECHNOLOGY</td><td>known</td><td>A
Programming
- predictability
- equity
- accountability
- efficiency
- effectiveness</td><td>C
Bargaining
- accommodation of multiple preferences</td></tr>
<tr><td>unknown</td><td>B
Experimentation
- innovation
- responsiveness</td><td>D
Chaos
- discovery
- creation of order</td></tr>
</table>

Table 2.2: Expectations of government associated with prototype conditions of and responses to planning problems, Karen S. Christensen (2007).

When the goal is known and agreed upon, and the technology to reach it is available, the type of resulting design corresponds to Simon’s scientific design assessment. This is instead an ideal and not realistic situation when talking about urban design: different goals such as real estate profit, social justice or ecological stewardship may conflict with each other, even if it is considered that every goal would be reached through a well-known technology –field C of the table. To face this situation, Christensen proposes that all stakeholders negotiate to accommodate multiple preferences. This cooperation to come up with a solution requires common ground for the methods and the representation of the design, so that all stakeholders can consider the trades. An example of this procedure is geodesign, which will be described in subsection 2.4.4.

However, even if the goal was agreed upon, such as increasing biodiversity in urban spaces, the required technologies to reach such a goal may not be available, as reflected in field B of the table. In this case, trial-and-error is often the only way forward, focusing on proposing solutions that contribute to getting closer to the goal, as defining the origin of the problem seems almost impossible. An example would be reducing inequality between close neighbourhoods. In formulating possible design solutions, it may be possible to tackle some of the factors originating the situation. In the worst-case scenario, neither goal is clearly defined, nor is technology available to face it. This leads to a process of action and reaction without a clear direction, that Christensen identifies as chaos.

The impermeable limits between the four fields of the table do not exactly correspond to the complex situations that design faces, particularly urban design. Urban design would occupy predominantly fields B and C, and also sometimes field A. Christensen acknowledges that even clear set and agreed goals may change in the future, and technologies that were considered reliable may be questioned some time later. The interaction of rapidly evolving digital tools and the ethos of the Ecocene evinces a panorama where both design goals and the technologies to reach them must be in permanent revision. The following sections explore design paths that can push towards a better formulation of the problematics and the goals to achieve. At the same time, the pertinence and challenges of one specific technology –digital mapping– are discussed in chapter 3.

2.2.1 Critical design

As described above, problem-solving design operates as a methodology to find a solution to well-defined problems. This is the case when the object of the design and its implications can be isolated from other considerations, for example, in *'fordist'* chain production: the goal is to increase benefit by reducing costs and production time. Understanding the interconnectedness and behaviour of the different parameters is the cornerstone of systems thinking. Instead of looking at individual components, isolated from anything else, it highlights the connections between parts and how these connections impact the overall system. In its application to design, feedback loops –similar to Schön's– and non-linear dynamics are key. Leverage points (Meadows 2008) are particularly relevant to design: places within a system where small changes may produce significant effects.

Systems thinking

As described by Capra and Luisi (2014), systems thinking provides an interesting framework to tackle key concepts for Ecocene, such as those discussed in chapter 1: cohabitation, hybridisation, and interconnectedness. Moreover, this approach has profoundly impacted the development of computation, as it will be addressed in the next chapter. However, completely isolating the matter of study as in a confined *'fordist'* conceptual factory may lead up to replicating existing societal structures, power dynamics and ideologies: for example, the limited number of variables and impacts on society or the environment –such as factory's worker well-being or pollution– are not necessarily considered or treated as relevant drivers. Frankfurt school's Critical Theory challenges the temptation of reductionist approaches by questioning the underlying structures of power, ideologies and societal norms embedded in systems. Unlike methodologies isolating problems to achieve efficiency (Habermas 1984), Critical Theory highlights the need to consider a broader social, cultural and ecological context and the resulting consequences of design decisions. This fosters a holistic vision about how systems perpetuate inequalities, exploitation or environmental degradation. Industrial systems' mechanistic and instrumental rationality is criticised (Horkheimer & Adorno 1944) for its impoverishing mindset, which reduces human creativity and autonomy while reinforcing oppressive dynamics.

Applying this critique to design reveals an uncomfortable tension: systems thinking provides powerful tools to map and influence complex systems, but without a critical framework, the risk of sustaining dominant narratives and overlooking marginalised perspectives is too high. This is particularly acute for the narratives and ethics of the Ecocene, which are not driving design yet. This insight paves the way towards critical design, which does not try to solve problems but rather questions whose problems are being solved and at what cost to any other stakeholder or contextual parameter. Integrating systemic logic with critical awareness encourages designers to move beyond technocratic solutions and to challenge the status quo that actively underpins harmful systems.

Critical design converts critical thought into a physical design that seeks to provoke a reaction. It concerns the social, political, and cultural aspects of being able to challenge the status quo and conventional design thinking. Furthermore, it opens up a debate about the role of design in shaping societies and the impact of design on people's lives. The focus is not on the functional response, but on its meaning and interaction with its context and environment, offering alternatives that are not yet considered today. Anthony Dunne and Fiona Raby first coined this term in the early 2000s, who went on to develop the principles of speculative design a decade later.

This form of design pushes *"the cultural and aesthetic potential and role of electronic products and services to its limits"*, as explained by design researchers Dunne and Raby (2013). The profound link between critical design and technology development is, for them, as for technology critic James Bridle, key to developing strategies that engage with and challenge industry's technological agenda. If we consider its parallel in urban planning, it is not an opposition to industry –or real estate development. It is an awareness call for designers to engage in a more responsible, proactive societal role. Dunne and Raby believe that *"designers will have to redefine their role, embracing and developing new methods and approaches that simultaneously appeal and challenge in the way a film or book does"* (ibid.). This thesis fully aligns with this statement and explores methods and tools that contribute to a redefinition of the designer's role, as discussed in chapter 8. Speculative design enables reflection about the future and provides a form of articulating a critique to current design practice (Auger 2013).

2.2.2 Speculative design

The risks of trying to make reality fit into systems have been addressed in recent years by James Bridle (2018), particularly when those systems are modelled with algorithmic and computational thinking. Although the interest and value of computational thinking are widely recognised, as will be discussed in the next chapter, Bridle doubts that the world really works as a computer understands it today. But most importantly, he believes that its oversimplifying mechanisms can be limiting. For him, critical thinking beyond computation is key to formulating *"new metaphors"* (ibid.). These metaphors are new ways of conceptualising and describing the world, acknowledging the interconnectedness, uncertainty and opacity brought by technological systems. He advocates for engaging with technology proactively, in a tech-literate way, questioning critically the information people consume. With this methodology, these new metaphors can be created: they would operate as a reflection of the world, mediated by technology. Bridle's *"new metaphors"* could take advantage of the tools and methods of speculative design, which offer an operative framework to elaborate them. The European Commission acknowledges the capacity of speculative practice to broaden the discussion on *"the domestication of new technologies in the European Community"* (Mitrovic et al. 2021).

The word speculation comes from the Latin term *"speculationem"*, a form of contemplation or observation. The Latin word *"speculum"* means mirror, or a vision assistant, an apparatus to afford a view –a vision. Beyond the basic mirroring, the goal of speculation is not as much to reproduce an identical image of reality, but to work out new shapes for the environments in which people live. The term speculative design was first used by Anthony Dunne and Fiona Raby (2013), who describe it as *"an activity where conjecture is as good as knowledge, where futuristic and alternative scenarios convey ideas, and where the goal is to emphasize implications of 'mindless' decisions for mankind"*. Speculative design formulates and anticipates possible futures and also fosters critical reflection about the present. Often, the trigger for these investigations is a question starting with *"what if…?"*. Contrary to result-based design, it works not only with best-case scenarios but also with undesired and dreaded future situations, which allows for a critical

"what if…?" questions

rethink of the present. Moreover, speculative design reaches its highest prospective qualities when it avoids utopian and/or dystopian scenarios, building platforms for discussion and debate about what possible futures are. For instance, Le Corbusier's *"Plan Voisin"* (1925), rather than a realistic design scheme to solve Paris' urban situation, is considered as a provocative and visionary statement about mobility, urban hygiene, and, of course, integration of nature in the city. Reading it as a manifesto, rather than a masterplan, triggers key questions about the city before the modern.

Speculative design, as a current or a historical movement, is related to a diverse group of similar practices such as Critical Design, Design Fiction –using the methods of narrative and literature–, Future design or Transition Design. Van Gaalen (2018) gathered more than eighty movements dealing with the definition of futures, that could be linked with speculative design. But this effort to describe forms of future is related to better understanding our present and imagining how to impact its transformation. In Dunne and Raby's definition, this transformation affects '*mankind*', but speculative design has traditionally been deeply involved with the effects of design actions on the biosphere. Imagining futures involving multispecies symbiotic cohabitation and environmental justice is at the core of speculative practices.

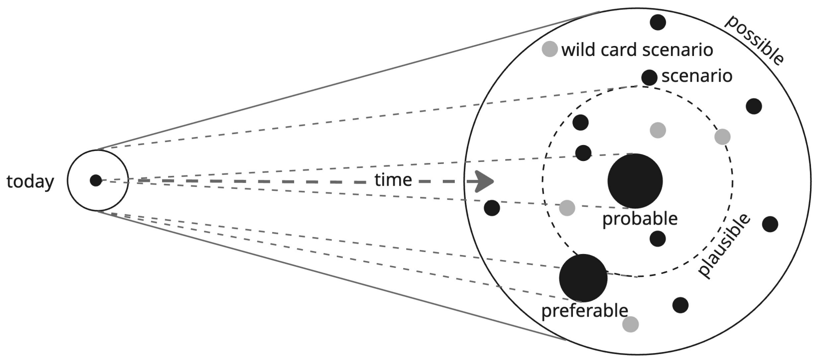


Figure 2.2: The Future Cone (Voros via Dunne and Raby, via Revell). A diagram of potential futures. Redrawn by ARC

The *"Future cone"* –see fig. 2.2– is a graphic conceptualisation of different types of future possibilities. They are linked to the present time with a dotted line, that could be understood as a projection from today towards future scenarios. They represent the designer's vision forward, but they also indicate that these imagined futures are deeply anchored in a present reality. In fact, it is possible to read the line as feedback towards the current situation: imagining different scenarios helps formulate valuable critiques of the status quo. The lines do not delimit the path to a specific future but serve as a reflection platform to discuss the present challenges. This brings back to the idea of designing what is to come to understand better and formulate the initial conditions: a method to define the problematic that design aims to react to.

Design critic Cameron Tokinwise believes the adjectives '*critical*' or '*speculative*' should not be applied to design (Mitrovic et al. 2021), as a form to imply that those characteristics should be inherent to design. Concerning speculative design practice, each project is very distinct, hindering the task of describing and categorising the territories of speculation. It is not only because of the diversity of subjects, contexts and perspectives. Besides, the fast and unstoppable development of technologies complicates understanding what speculation clearly is. To provide some guidance, Dunne and Raby propose a very clear image of what speculative design is and is not in the *"A/B Manifesto"* shown in figure 2.3. Both columns are not opposed, they are not confronted realities, but rather two perspectives that can be added one to the other. In fact, it would be interesting to imagine new columns C, D and so on, to gain vision on superposed facets of reality. Ultimately, speculative design *"allows us to think about what is preferable"*, regardless of the perspective or technology a project is built upon (ibid.). This helps designers to set their work goals, and with them, be able to better formulate the problematic they think they should react to.

A	B
Affirmative	Critical
Problem solving	Problem finding
Provides answers	Asks questions
Design for production	Design for debate
Design as solution	Design as medium
In the service of industry	In the service of society
Fictional functions	Functional fictions
For how the world is	For how the world could be
Change the world to suit us	Change us to suit the world
Science fiction	Social fiction
Futures	Parallel worlds
The "real" real	The "unreal" real
Narratives of production	Narratives of consumption
Applications	Implications
Fun	Humor
Innovation	Provocation
Concept design	Conceptual design
Consumer	Citizen
Makes us buy	Makes us think
Ergonomics	Rhetoric
User-friendliness	Ethics
Process	Authorship

A/B, Dunne & Raby

Figure 2.3: A/B manifesto (Dunne & Raby, 2013, p. vii). The column "A" lists what "speculative design is not", and the column B describes what "Speculative design is" and operates with. Redrawn by ARC

Speculation is often linked to the mechanisms of narrative to create fictions, and can be considered as artistic or humanistic kind of knowledge –see table 2.1. Geography, history, and social sciences can be key to formulate robust speculative scenarios. However, it is also tightly entangled with the evolution of technology and the cultural interpretation of the values, perils and challenges of teaching a new form of technology. Not only do new technologies allow for novel forms of speculation, but speculation serves as reflection to question the use designers make of a particular technology. In this thesis, both aspects are investigated, how digital mapping enables valuable forms of speculative design with urban nature, and how the use of speculation methods fosters the critical reflection of designers on their own use of this technology.

Future tools should be shaped by learning from design experiences, giving feedback about their use.

2.2.2.1 Methods of speculation

Firstly, it is essential to distinguish between methods and tools. Tools are devices we engage with to achieve a precise goal. They try to make a specific task easier and gain agency while operating in one or several simultaneous planes of interaction. They may encompass several of the following: the general approach or the principle that a tool mobilises, its main aim and/or its most distinctive characteristic. Methods may also be composed by the concatenation of the use of several tools, to achieve a goal. This thesis deals with a subject, nature, discussed in chapter 1, a method, speculative design, and a specific tool to work with, mapping –that is extensively discussed in chapter 3.

Speculative design as a position

Although speculative design is often described as a position rather than a methodology (Johanssen 2019), several attempts have been made to understand its mechanics. It has been defined as an *"attitude, an approach open to various methods, tools techniques and instruments as well as other practices and disciplines"*, moving away from the consumerist role of design (Mitrovic et al. 2021). Dunne and Raby rely on examples to define the contours of the practice of speculative design, which is a form of *'research by design'*, but the task of defining the process of creating speculative design is not simple. Nevertheless, some steps are commonly agreed upon (Mitrovic 2015, Dunne & Raby 2013). The first step is to define the debate's context, with special attention to the societal, environmental, cultural or technological implications. The second step is to explore problems and ideate a scenario, usually addressing questions starting with *"what if…?"*. This step is helpful for revealing possible futures, but also for critically informing our presents, a potent tool to question the current status quo. The last step would produce a materialised scenario. A provoking narrative looks for reaction from a specific audience –urban stakeholders, politicians, professionals, academics, etc. A sense of reality and attention to detail is needed to generate a broader debate.

2.2.2.2 Making operative the outcome of speculative design

Speculative scenarios aim not exactly to find alternatives, but to test the implications of those futures (Dunne et Raby, 2013). Gaining such understanding, producing speculative knowledge about the consequences and the origins of the possible scenarios, make possible to engage in a reflection-in action design dynamic (Schön 1982). While the production of speculative scenarios has value in itself, and can be considered a complete design task, this thesis proposes an operative use of them to inform more solution-oriented design. But how can speculation really impact solution-oriented design?

Taking as a starting point the British Design Council's double diamond –fig..1–, a solution-oriented design process is considered. It could be argued that imagining possible futures belongs to the divergent part of the second diamond. In that moment of design, potential solutions are tested, in a similar dynamic to how speculative futures are interrogated to question the present. However, although some potential solutions may not work, they are imagined as getting closer to the design solution. On the other hand, possible futures may be dystopian or undesirable, as the goal of the exercise is not to produce an end product, but to investigate the implications of those futures. This thesis proposes a key shift, separating design-oriented design from speculative design, but proposing a functional articulation between both.

Fig. 2.4 merges the British Design Council's double diamond with Voros' future cone, articulating both around the problem definition. While the starting point remains on the left side, the path towards the final proposal is not only composed of two consecutive divergence-convergence moments. Instead, a series of meandering loops perambulate both diamonds and the cone, representing the successive iterations that designers must travel during the design process. This articulation highlights speculative scenarios' value to reflect on the problem definition. In this sense, design is not considered *'reactive'* to a series of fixed constraints analysed in the first diamond, but *'proactive'*, as it anticipates the implications of future scenarios. Integrating the design cone at that stage makes design processes more future-oriented, speculative and adaptable.

Introducing speculative design expands the scope of *'design the right thing'*, the first diamond. The discovery phase typically examines current problems, based on present conditions and known constraints. However, the problem itself may evolve over time, and considering long-term trends, risks, and opportunities allows designers to become proactive. Similarly, the scope of *'design things right'* also benefits from speculation, typically focused on efficiency and feasibility rather than transformative solutions. Using speculative design to reflect about power structures and the possible beneficiaries of the design proposal empowers designers to break the status quo and question unjust situations. By merging both design cultures, thinking beyond immediate constraints and anticipating future challenges is possible. The resulting design solutions can be efficient and transformative, as designers assure to work with preferred futures rather than merely reacting to probable ones. This scheme fosters the development of relevant and impactful innovations over time.

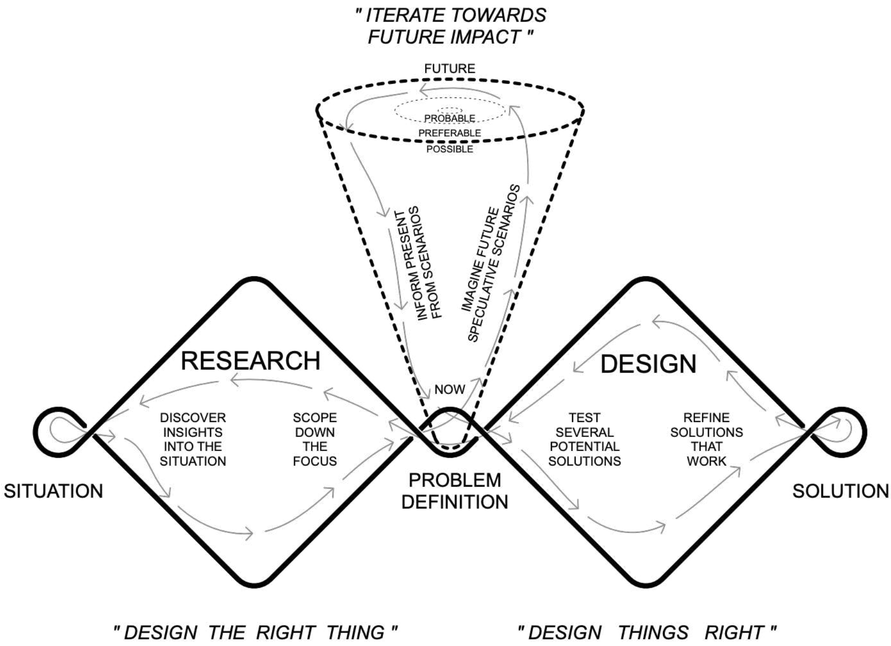


Figure 2.4: Future cone informing problem definition. Concepted and drawn by ARC.

Designers adopting this iterative workflow navigate in a multi-disciplinary knowledge ecosystem. Different forms of knowledge –scientific, speculative and *'designerly'*– work together to enhance problem-defining and problem-solving. While the three knowledge types are present in each phase, they may impact each phase differently. In the first diamond, *'design the right thing'*, scientific knowledge can be invaluable for data analysis, systems thinking, quantitative research or statistical modelling. Tacit knowledge and design intuition provide insights into possible preferences based on real-world conditions. Moreover, speculative knowledge is key to understanding the problems' origins and implications. Similarly, speculative scenario-building can take advantage of modelling and computational simulations, allowing forecasting of possible futures. Humanistic knowledge is key here to interpret the meaning and ethical dimensions of the resulting futures. Historical analysis and postcolonial approaches may reveal long-term implications for more just futures. Finally, mobilising the three kinds of knowledge in the second diamond, 'design things right' can also prevent aesthetic and functional solutions that lack a holistic and impactful insight.

Considering the Ecocene, the design goal to reach, as enunciated in Chapter 1, this approach reveals an enormous potential for designers. With it, the formulation of possible urban futures critically questioning current challenges of metropolitan nature can be taken to a different level. The next chapter explores the setting in which these challenges operate: urban design.

2.3 Urban design, a wicked problem

The current fragmentation of contemporary metropolis or the *"ville-territoire",* can be understood as the spatial translation of a crisis of collective life (Picon 1998). This fragmentation and its complexity can be difficult to apprehend and study, and utterly impossible to formulate *'a solution'* to it. *"Wicked problem"* is a concept first coined by Horst Rittel and Melvin Webber, theorists of design and social planning respectively, at the University of California, Berkeley, in 1973. A wicked problem defies any standard attempt to find a solution because it is a symptom or result of multiple, contingent, and conflicting issues. Environmental degradation, social and economic inequity, or terrorism are some of the classic wicked problems that the 21st century faces. Designers often work on specific problems that comprise or contribute to a complex wicked problem. However, an isolated design solution –or that of any discipline– arrived at through an established process will almost by definition make the overall situation worse. Due to their complexity, wicked problems require the work of collaborative teams of people with a range of expertise over space and time. A process designed to address a wicked problem typically has no definitive solution, but can, at best, achieve positive impact. Urban design is commonly considered a wicked problem, where direct and single problem-solving strategies frequently worsen the problem or other related problems.

This vision of cities as a complex web of interactions, dependencies and impacts is often described by a metabolist understanding of the world. Metabolism is considered a robust and operative framework for contemporary urban design (Handtschoewercker 2024), as it captures the dynamic and cyclical nature of material, energy and information flows within urban systems. The goals and perspective of metabolism are aligned with concepts from ecology and systems theory, which encompasses several theories discussed in the previous chapter. These theories, as well as metabolism, insist on interconnectedness and dynamic equilibrium and, as Haraway insisted, optimistic use of technology. This understanding makes digital computation a commonly used tool for urban design, as it can incorporate multiple parameters, and massive datasets. The ethos of such use of technology must be critically discussed, though; the basis for this discussion is set in chapter 3.

2.4 Speculative urban design

Once the opportunities and challenges of speculative design have been explored, it is key to investigate what speculative design means for urban planning, specifically when reimagining the role of nature in urban environments. Dunne and Raby focused on speculative product design, but their ideas infiltrated many urban design practices. However, the planning of future cities presents many specificities that must be acknowledged when working with speculative urban design.

2.4.1 Challenges of the contemporary city

Cities and metropolises have become highly complex subjects. Throughout history, the city has been figuratively described as a machine, organism, or a process. Cedric Price used the metaphor of the egg –boiled, fried, scrambled– to convey its organisational evolution and incremental complexification. Contemporary urban challenges are multifaceted, reflecting the complexity of rapid urbanisation, climate change and social inequalities. The 2030 Agenda for sustainable development identifies in the Sustainable Development Goal 11: *"Make cities and human settlements inclusive, sage, resilient and sustainable"*. Such a task encompasses an endless list of subjects, from infrastructure to transportation, from governance to public health, from sustainability to biodiversity, many of those connected to the role of nature in cities.

The limitations of traditional urban design have led to many failed approaches in addressing metropolitan complexity. Many attempts to apprehend urban complexity finally isolate some factors, indicators, or aspects and study them separately or in relation to others –systems thinking. The generation of an accurate unitary model of the urban realm was considered impossible to reach. However, current developments towards quantum computing claim to get closer to reproducing the encountered forces that coexist in a city: the emotional and the rational, the planned and the spontaneous, the objectivities and the subjectivities, the explicit and the implicit. Beyond technological advancements, or perhaps in symbiotic collaboration with them, the following sections explore how speculative design can contribute to tackling urban complexity.

2.4.2 Speculative design as a method for critically navigating urban complexity

The 1956 conference at Harvard Graduate School of Design *'Urban design'* provides the following definition: *"join work of the architect, landscape architect and city planner"*. Urban design is a complex discipline that deals with high complexity –historical, political, technical, social– and generates spatial situations that must interact with a specific environment. From more compositional approaches that relied on the power of geometry to confer order and sense, contemporary urban design tends to a strategic approach that is less formal. That is, the goals are intended to be reached by applying specific measures that may be formalised in different ways.

As discussed in section 2.1, urban design deals with significant uncertainty. Working with *"what if…?"* questions fosters reflective forms of practice, expanding perspectives, challenging conventional thinking, and trying to incorporate diverse viewpoints. Moreover, it contributes to visualising the impacts of technologies and urban shifts along time. Using systems thinking in synergy with critical thinking is a powerful asset to understand the forces that shape cities and critically assess the implications of their effects on each system, society, and the biosphere. Applying speculative design to urban planning is not univocal, but some diverse approaches can be identified.

2.4.3 Approaches of speculative urban design

There are numerous approaches to speculative design. From ambitious forms of *'world-building'*, where immersive speculative worlds integrating urban, social and ecological dimensions are constructed, to more limited *'design fictions'*, which develop artifacts such as prototypes or visuals representing future systems or environments. Using supercomputers to model digital simulations is a form of speculation that is becoming more and more extended. This work focuses on the work that independent designers with limited means could perform; in this framework, *'scenario building'* is one of the most common approaches.

2.4.3.1 Leitbild and scenario

'Leitbild' is the German word to define *"pictorial concretisation of complex objectives [...], which gives individual designs, planning concepts and personal design preferences a common background and integrates them into an overarching consensus on 'value standards'"* (Durth et al. 1998). It could be translated as the *'guiding principle'* or *'guiding image'* –*'image directrice'* in French. It refers not only to the goals, the programming and the content, but also to the path, process and strategies to follow to reach them. A *'Leitbild'* has no specific form, but sets directions, coordination and motivations. It must present a high level of abstraction, while generating vivid images of the city that can be realistically implemented. They are not produced by a single actor, but rather embody the consensus of all urban stakeholders, who agree on a series of values that should be reached. A *'Letibild'* can work with different scenarios.

Speculative urban design

A scenario refers to a simulation of a possible future. It often operates with qualitative approaches rather than quantitative. It tries to reveal a specific knowledge by comparing possible and suggestive developments. The capacity to imagine visions and futures that have not been described yet is a valuable tool to question the status quo. An example would be to consider maximal density, or maximal amount of open spaces in the city, or many of the proposals from the Think Tank *"The?factory"* from the University of Delft. An example within the design of nature in the city would be the article of Sébastien Marot (2022) *"URBI / ORBI: Four Competing Narratives on the Possible Evolution of the Relationship between City and Country"*, where he describes four different speculative futures, that help us to formulate projects that react or correspond to each one of those speculative visions –see section 2.4.4.

2.4.3.2 Top-down and bottom-up

Le Corbusier's machinist vision of his *"Radiant City"* centralises planning control, based on efficiency and optimisation, guided by a certain technological determinism. It is an example of a top-down form of urban design. In contrast, Rem Koolhaas celebrates the chaos and unpredictability of urban life (Koolhaas 1995). Based on cities' constant evolution and adaptation, he argues that too much order can lead to a loss of human agency and homogenisation of urban spaces. Pleading for an *'assembled'* approach that convokes diversity, spontaneity, and experimentation, the methods that emerge from this vision speak for bottom-up initiatives. Can speculative design work with both approaches? How?

Advantages of speculative urban design methods

Speculative practices are often considered top-down, or the imposition of the designer's personal and subjective vision, and it can usually be the case. However, depending on the tools and data used in the speculative methodology, the opportunity to incorporate other perspectives is affordable and, thanks to computation, possible in amounts that some decades ago were unthinkable. Therefore, the capacity of incorporating bottom-up strategies rests in the hands and the methods used by the designer. With them, it is possible to consider societal, cultural and socio-environmental interdependences into the design process.

Moreover, speculative design is a tool to encourage society to debate dissident approaches. Many speculative designs use fiction or science fiction narratives to reach a wider public. Data analysis, display or mapping have become a standard graphic narrative nowadays, that have a profound impact on the public. Producing documents –mappings, proposals, representations– that accompany society in questioning the status quo can also be interpreted as a bottom-up strategy. It empowers citizens and all urban stakeholders to participate in a profound discussion.

2.4.3.3 Colonising and decolonising futures and practices

Designers working with speculative design are performing a critique to the practice by *"working to 'decolonise' the approach, or by moving beyond 'a human point of view' altogether in the words of artist-designer Fara Peluso"* (Mitrovic et al. 2021). Shifting from the anthropocentric perspective towards a form of practice that successfully integrates the agency of non-human being is a form of decolonising design practices. However, other forms of colonialising through design have been raised recently.

The relationship of architects and urban planners to the future has always been a controversial subject. How to plan for the future, when the forthcoming user, program or needs are unknown? The scale of these questions in architecture dramatically increases when planning for a city. The legitimacy of the planned futures and their designers is questioned within that framework. Over the last decades, multiple scholars and social groups have manifested an incremental interest in decolonisation. Is it possible to consider a *"colonisation of the future"* through planning practices? Even if the speculative scenarios that this thesis investigates are not blueprints to be carried out but rather tools to question current status-quos, they are creating future frameworks that can be portrayed as colonising actors. The design tools to be developed in the future should address their decolonising capacities.

2.4.4 Geodesign: a structured methodology

Geodesign represents a very structured workflow incorporating scenarios and, to a certain extent, speculation. It is interesting here to understand how speculative scenarios are not a goal in themselves, but they can be successfully integrated in a fully solution-oriented design process. Carl Steinitz played a crucial role in pioneering GIS-based landscape analysis and the use of computational methods for spatial planning at Harvard's Graduate School of Design during the 1960s and 70s. Later, he developed a framework for Geodesign (Steinitz 2012), a valuable set of methods for multiple tasks: site selection, feasibility studies, data-informed decisions, facilitating site suitability assessment and risk mitigation, community planning, or improving communication and cooperation between the different stakeholders responsible for a design. Its collaborative approach drives decisions about potential changes. The speculative nature of geodesign is rooted in the recognition that the future is uncertain and multiple scenarios are possible, while the final goal is to produce a robust design proposal. The methodology encourages the development of a range of plausible future scenarios, based on different assumptions about factors such as growth or environmental conditions. Exploring alternative futures allows for a comprehensive understanding of the potential impacts of the choices and decisions that the stakeholders have to meet.

Steinitz proposes a straightforward method for the Geodesign team to perform the best results, based on three consecutive iterations through six questions. These questions are:

1 How should the study area be described?
2 How does the study area operate?
3 I s the current study area working well?
4 How might the study area be altered?
5 What differences might the changes cause?
6 How should the study area be changed?

The first iteration tries to understand the study area and investigates '*why*' any action is needed – *"design the right thing"*. The questions are studied and discussed in the proposed order, and the answers to the first ones are key to deepening the consequences of the next ones. During this phase, it is essential to discuss with the local experts, who provide valuable information, and avoid the urge to look for data to start the project. For Steinitz, Geodesign is not data-driven, but decision-driven; thus, it is key to prevent mechanistic data responses and define the scope of the task first. By the end of this phase, a series of scenarios will be enunciated to guide the team through the following steps. This stage, similar to British Design Council's first diamond, *'design the right thing, '* is crucial for setting the context for speculation: gather information about the site, identify potential areas of change, and understand the factors that might influence future development.

The second iteration covers the same questions, but this time in reverse order. This change in order allows Geodesign to be design-driven and not data-driven. The goal is to design the study methodology and respond to the question of *'how'* to perform the study –decide the design method. After reviewing all the questions, the last one defines the data to be gathered. The next iteration will conduct the study with that data and the described methods, tools, and instruments. This second iteration aims to guide the team in developing models for decision-making, ensuring that the speculative scenarios are grounded in a robust understanding of the area's dynamics.

The last iteration through the questions follows the initial order and considers the questions *'what'*, *'where'* and *'when'* –British Design Council's second diamond *"design things right"*. The result is a proposal or a series of proposals to be discussed with the stakeholders (the municipality, the client, the inhabitants, the local experts...), who would eventually approve the scheme's implementation. The fourth question deals with changes, and it is the most profoundly related one with design and the agency of design. Which changes are possible? Which scenarios can they provoke? How would these scenarios be formalised?

This iterative process ensures that the speculative scenarios are not static but evolve based on a continuous dialogue between experts, stakeholders and the evolving understanding of the complex dynamics at play. The robust structure of this methodology ensures that speculative scenarios are grounded in a rigorous understanding of the context. However, Geodesign focuses on plausible futures, limiting its potential for radical critique, and its emphasis on stakeholder consensus can lead to reinforcing existing power structures. The ambition of Geodesign to act as problem-solver limits its potential for exploring alternative ways of being.

To take advantage of the structure of geodesign, while reenforcing its capacity to criticise the status quo, it would be possible to imagine incorporating some of the techniques proposed by Dunne & Raby. First, the use of design fiction to formulate alternative futures that challenge dominant narratives and provoke critical reflection. Shifting the focus from optimisation to provocation animates a debate pivotal to Geodesign but incorporates a more nuanced engagement. This is particularly key when defining a desirable outcome, avoiding predefined criteria.

Finally, and more importantly, Geodesign could incorporate critical theory methods to analyse power dynamics into its core functioning. Critical theory provides strategies and tools to better understand how power operates in society and how it shapes our understanding of the world. A complete integration of these methodologies in Geodesign would contribute to uncovering hidden assumptions, challenging power imbalances, and creating more equitable scenarios.

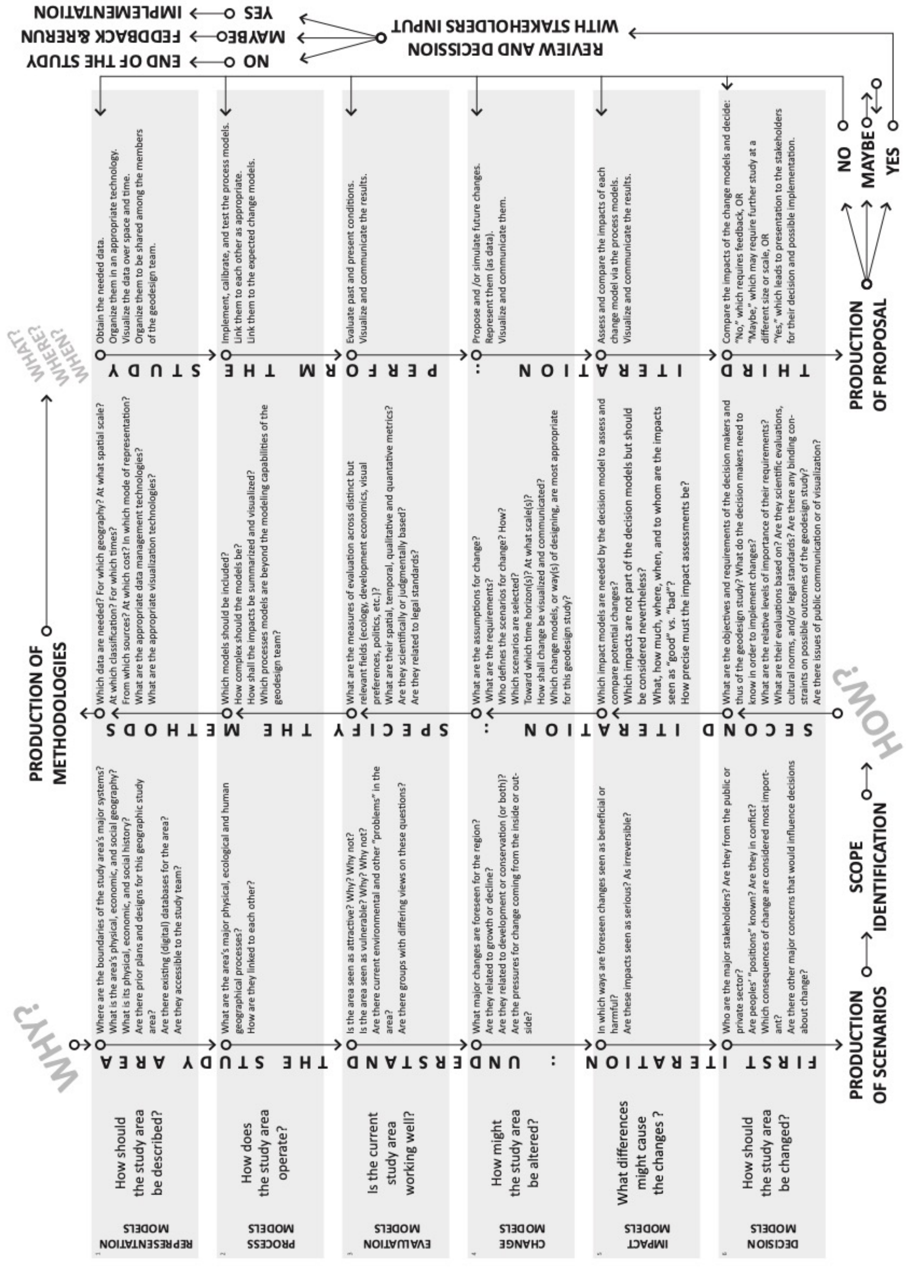


Table 2.3: Geodesign Framework (Carl Steinitz 2012).

2.4.5 Design disciplines speculating with urban nature

Different disciplines have been working with urban nature for the last decades. Architects incorporate green roofs and facades into their buildings, urban planners organise their schemes by incorporating watercourses and existing biotopes, and landscape architects have overcome their horticultural origins. They are becoming a discipline that articulates the relationships between ecology, social well-being and planning. Nevertheless, the challenge of designing for the Ecocene cannot be achieved by requalifying some brownfields and abandoned industrial facilities, greenwashing building's envelopes or decorating traffic circles with beetroot plantations. It is necessary to rethink urban metabolism as a complex system (Picon 2014) that includes the city's built realm, humans and all non-human entities.

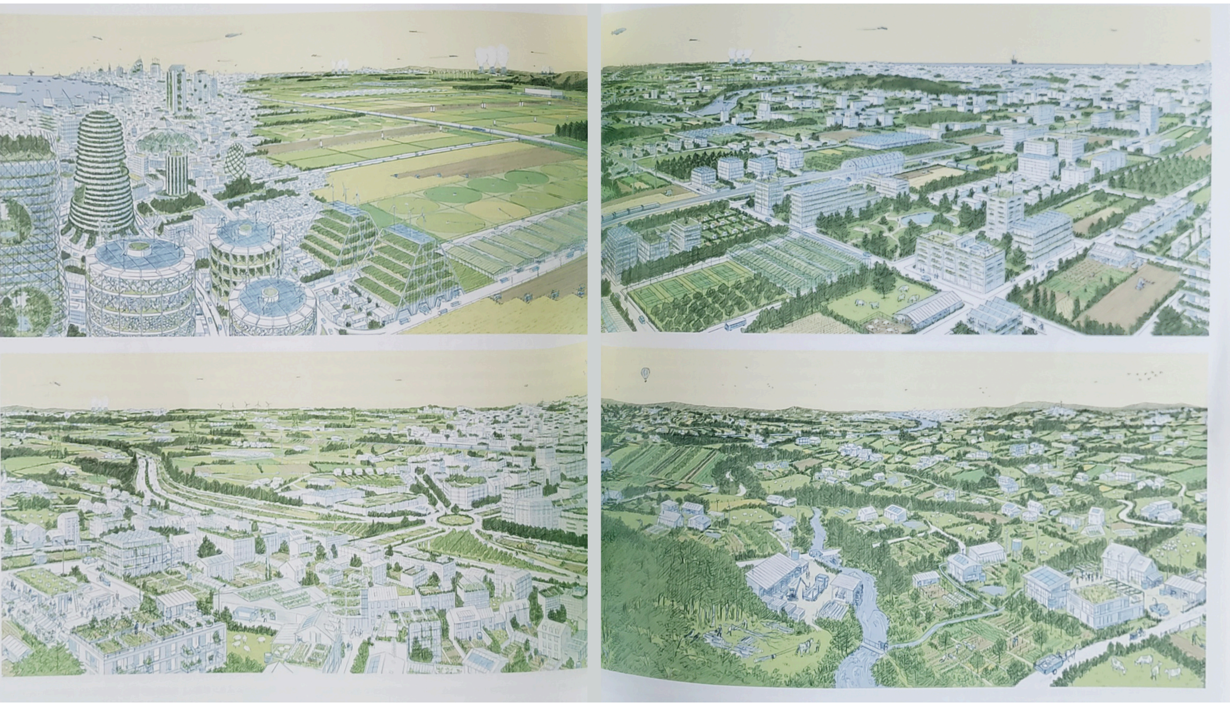


Figure 2.5: Four narratives for architecture and agriculture. Sébastien Marot & Martin Étienne

This task can take advantage of speculative design methods, such as imagining scenarios. For example, Sébastien Marot (2022) formulated four competing *'narratives'* that explore possible futures for integrating the agricultural and urban tissues. The four different paths, incorporation, negotiation, infiltration and secession, inquire into possible models of hybridisation that guide several design paths. Although the text lacks a specific design proposal, four images by Martin Étienne illustrate it, serving as a visual guideline for the proposal.

This kind of speculation was profusely used during the seventies, when metabolist methodologies required new techniques to approach them. For example, "The Limits to Growth" (1972) investigates urbanisation and natural resources through computational methods. The complexity of the variables, the number of stakeholders, and the convoluted process invited the use of digital computation to incorporate them. Since then, many scholars and designers have investigated using computation to imagine future scenarios. Konstantinos Chatzis' *"Forecasting Travel in Urban America: a deep dive"* (2023) is a good example of recent speculative work that examines the interplay between engineering models, social factors and technological advancements. In it, the evolution of travel forecasting models is discussed, particularly about the social aspects of the voyagers. Examining the impact of technological advancement, such as GPS-tracking of smartphones on travel behaviour, he discusses the opportunities and challenges presented by these innovations. The precise but open formulation of futures unveils organisational possibilities.

The speculative work of *"The?Factory"* at TU Delft is also a good example of the use of computation for urban scenario-building. The development of computational tools has shaped disciplines like industrial design or architecture. For instance, they have suffered a radical shift through data analysis and parametric design. Nevertheless, it seems that the influence of the digital turn has revealed a minor impact on the disciplines that deal with urban nature, such as landscape architecture (Fricker 2021). Why is that? Are the tools not adapted? How could the technical shift of the digital help formulate speculative scenarios that deal with urban nature? What are the characteristics and qualities of that shift?

2.5 Transformative research and speculative design

The value of speculation in urban design highlighted up to this point also counts with certain limitations and critiques, starting with the risk of imposing the subjectivity of the designers and their own biases. Besides, scenarios perceived as too radical and unrealistic lose their connection with the present and the possible stakeholders involved. Or, even when perceived as motivating, it can be challenging to translate them into action, bridging the gap between speculative ideas and implementable actions. Finally, these practices are often perceived as time-consuming, and their experimental nature does not assure a successful result. However, the capacity of speculation to originate change and innovation is related to one of the most relevant forms of research nowadays: transformative research.

2.5.1 Defining transformative research

The methods of speculative design echo a form of research that has been increasingly relevant since the turn of the millennium: transformative research. The U.S. National Science Foundation (NSF) defines it in its Board's report: *"Transformative research challenges current understanding or provides pathways to new frontiers in science and engineering. It involves ideas, discoveries or tools that do one or both of the following: 1) Radically change understanding of an important existing concept in science, engineering or education; 2) Lead to the creation of a new paradigm or field of science, engineering or education"*. There are many types of research, almost all of which can lead to transformative change in science. In this sense, it is reportedly manifested that it is only possible to identify transformative change retroactively and then investigate if the research that led to it was transformative. How can this kind of research be identified, and why is it valuable?

Although the NSF admits that there is no precise definition, it considers that several characteristics are consistently present in transformative research. The first one is the development of new approaches, methodologies and tools. This explorative character differs from innovative design, which usually builds up from previous research, with similar methods and perspective. Therefore, transformative research is often perceived as a high-risk path that can potentially bring a high pay off. This is the example of many discoveries, like those called scientific revolutions, by Thomas Kuhn, the American philosopher from whose work the basis of transformative research is based on. The work on the DNA structure of Watson and Crick is one example.

2.5.2 Synergies between transformative research and speculative urban design

Another characteristic of transformative research is its capacity to challenge conventional knowledge. This makes its results difficult to interpret or unsuitable for more established theories. This characteristic makes transformative research valuable, as it can bring new perspectives to a specific area. Speculative practices, which question the agreed-upon status quo by imagining possible futures, can achieve this goal.

Of course, these characteristics are not necessarily met by all projects that present transformative results, and other research forms may also arrive at them. Nevertheless, many research institutions support the most innovative and potentially transformative research, looking for high-impact ideas. The reason is that, in many cases, the novel methodologies and longer time lapses to perform the *'out-of-the-box'* experiments require extra support to overcome the *'high risk'* they imply, as the results are not assured. The impact of this kind of research is of high value for institutions and even countries, being identified as a key factor for competitiveness in the report of the NSF Board (2007).

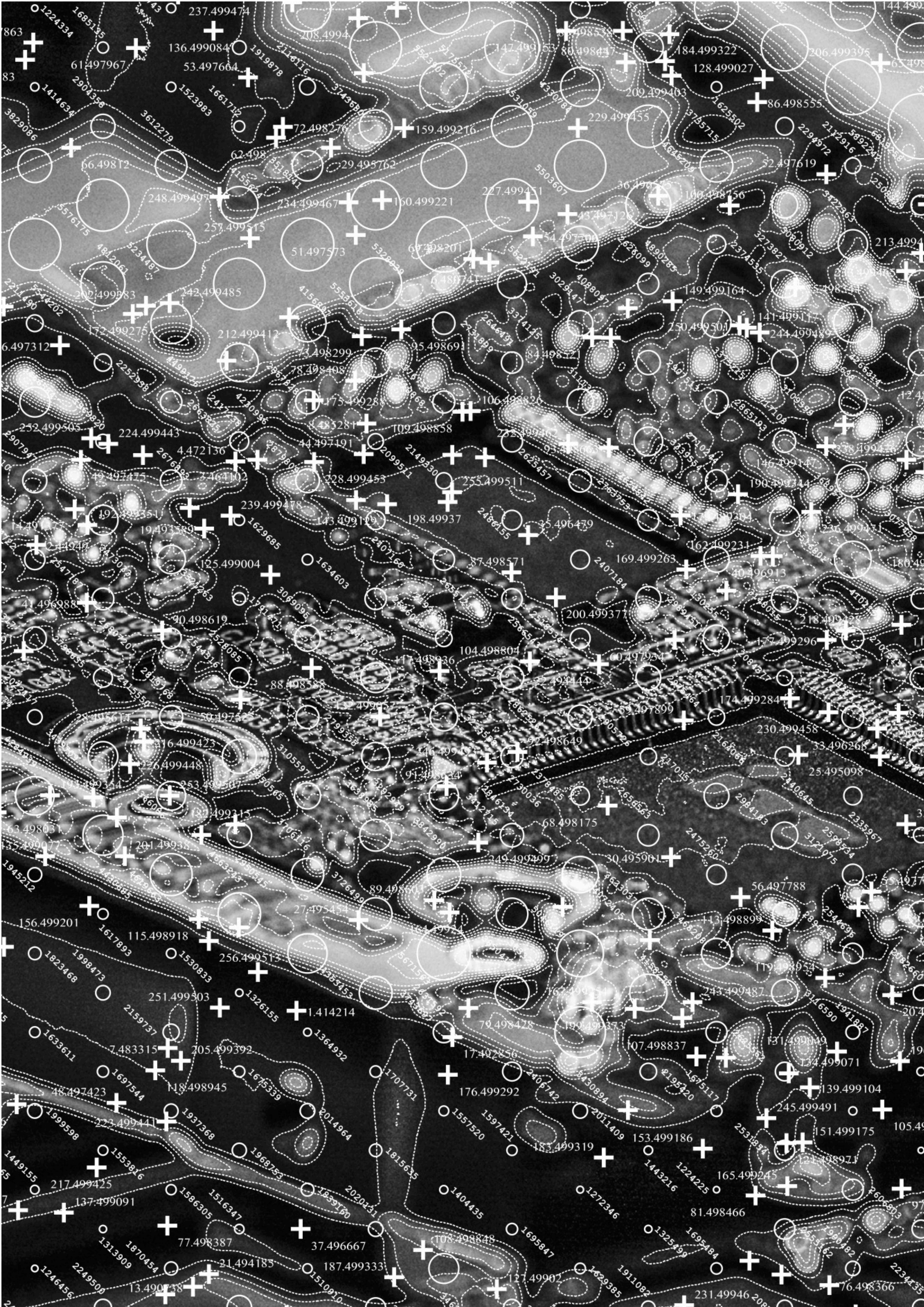
Transformative research shares a common goal with speculative design: both explore alternative possibilities; challenge established norms and envision radical futures. Although one opens up imaginative possibilities, the other pursues tangible, groundbreaking discoveries. They are, though, in a complementary dialog, as speculative design can inspire transformative research. The work of Terry Irwin shapes what is known as transition design. It offers a compelling framework for finding the methods that bring speculative futures into action and towards societal change. This transition design model seeks to create pathways to profound, systemic change by connecting disciplines and fostering collaboration.

There are countless themes to develop. For instance, the U.S. NSF considers developing an instrument or tool a potential project to be funded as transformative research. Could a speculative method to inquire about new visions of nature in cities be a form of transformative research? Could the technological development of a tool contribute to this sustainable goal? The confluence of new digital tools and environmental justice has been identified as a twin transition.

2.5.3 Twin transition

The European Union policy writing identifies this kind of mindset as part of the European Green Deal (Muench et al. 2022), naming it *"Twin transition"*: the simultaneous pursuit of both digital and the green transition towards a sustainable future. While it emphasises the integration of digital technologies to drive environmental sustainability, enhancing efficiency and reducing resource use across industries, it is even more relevant to contribute to setting the framework where future actions will take place. Elevating the twin transition beyond pure technocratic solutionism and embracing its speculative capacity to propose eco-technological environments that foster planetary stewardship should be on the agenda of every designer working towards Ecocene, regardless of scale and location.

The required technological advancement is far from exclusive to an elite of designers with access to last-generation computers, software, and digital knowledge. It can be extended to almost every designer. Certain data literacy and digital training can effectively unleash a cultural change. The next chapter discusses this democratised technological shift.



3 Computational mapping

Umberto Eco challenged the fascination for computing: *"A computer is not an intelligent machine which helps stupid people, it is rather a stupid machine that only works in the hands of intelligent people"*. This statement contests the widespread delusion that computers can solve problems without any human input. An ambiguous relationship between humankind and technique has historically oscillated between two poles: *"recognition of all what humankind owes to techniques on one side, and the will to relativise them, on the other one"* (Picon 1998). The following section seeks an understanding of the impact of digital mapping technology on speculative design practice, particularly for the planning of nature in cities, while neither demonising computational thinking, nor kowtowing to technological promises supposed to instantly solve contemporary problems.

First, the evolution of digital mapping is explored, following its trajectory from analogic tools managing statistical data in the 19th century to sophisticated and still-in-development AI tools in the 21st century. This is followed by a look at the way in which technological advancements in mapping have transformed how we understand, represent, and ultimately design urban environments, particularly in relation to the integration of nature. This shift starts with deterministic, nature-centric approaches and finishes with a more design-oriented perspective, embracing the agency of mapping as a tool for speculation.

Then, a detailed examination of Nicholas de Monchaux's *"Local Code"* provides an example that epitomises a data-informed, speculative approach to urban design with Nature-Based Solutions. Using mapping to inform and parametrically generate thousands of proposals, it serves as a platform for thought about how design processes can be imagined to merge nature speculation and critical mapping effectively. Finally, weaving the conceptual threads of these first three chapters, a precise form of practice is outlined.

3.1 Technologies of revelation: meaning making through assemblage and layering

Technology as creativity to unveil reality

Technology in this thesis refers to the apparatuses and tools that contribute to elaborating a design proposal with urban nature. The ancient Greek word *'techne'* refers to a learned craft or skill, in the sense of making and doing. In *"The question about technology"* (1954), Martin Heidegger explored how *'techne'*, that is, technique, can be related to *'poiesis'*, which is the act of creation beyond pure production. For Heidegger, technique is an act of discovery and revelation, a path to uncover possibilities. When the Four Aristotelian Causes, *"causa materialis", "causa formalis", "causa finalis"* and *"causa efficiens"* work together to create something, this process is called *"bringing-forth"* (Waddington 1975). This process is considered a creative unfolding where things are allowed to emerge naturally, reshaping how humans perceive and engage with reality. However, he considered contemporary technology as a process *"challenging-forth"*, a form of revealing that rather *'frames'* –*"Gestell"* in original German– reality as a mere resource to be optimised, controlled and used. He uses the example of the canalisation of the river Rhine: human technological thinking transforms the river from a natural phenomenon to an instrument of economic and industrial productivity. The river is no longer perceived as a natural entity in its own right, but as a system to be engineered. This process reduces the parameters of inquiry about reality to immediate practical functionality. It does not reveal, but instead conceals more profound forms of understanding; more layered, interconnected and meaningful. For Heidegger, technology could be considered a threat if used as *"challenging-forth"*, totalising perspectives and hindering the gain of richer, more meaningful insights into reality.

However, Heidegger did not consider the technique threatening; it could be positive and help discover new possibilities. It is then necessary to inquire into the interaction between human beings and technologies, so that their revealing forces flourish. Gilbert Simondon (1958) explores how technology interacts with users and the environment, becoming complex systems operating within a spectrum that encompasses utility, aesthetic experience and social meaning. Antoine Picon (2015) aligns with Simondon here: technical systems carry a creative potential that influences not only how things are made, but also how they are imagined and understood. This dynamic relationship of the user and the tool contributes to engaging with a broader understanding of the world beyond functionality. Technical apparatuses become cultural mediators, and their users undertake a significant, active role creating and shaping new meanings.

The relationship between creativity and technique has been investigated in the field of Generative Artificial Intelligence, identifying three types of creativity: combinational, exploratory and transformational (Furtado et al. 2024). Combinational creativity generates novel ideas by combining familiar ones. Poetic imagination works like this, with metaphors and unexpected juxtapositions creating new meanings. Exploratory creativity explores new ideas within a structured conceptual space: it iterates in loops, identifying potential and describing the boundaries of its conceptual space. Finally, transformational creativity involves a disruptive modification of the conceptual space, creating new structures within which the new ideas may fit. This last type is the most powerful, and probably the one that fits best for the goals of Ecocene and speculative design methods.

Creating new frameworks –or conceptual spaces– through technology is not linear only, and many philosophers have inquired into how it takes place. Deleuze and Guattari (2002) introduced the idea of '*assemblage*', or *"agencement"* in original French, a form of understanding how diverse elements come together to form complex systems and produce meaning. Technologies operate as cultural assemblages: they are not merely a means to achieve a function, but rather composites of social, material and symbolic dimensions that interact, producing cultural meaning. Technologies immersed in a particular context interact with it, reflecting and shaping cultural meaning.

While the idea of '*assemblage'* highlights the heterogeneity of the components and their non-linear interactions and influences, Manuel de Landa tries to find a structure for these complex relationships with the idea of '*layering'* (de Landa 1997). For him, assemblages are organised into structured yet interconnected layers that contribute to the stability and adaptability of the system. Layers may have material and expressive components. The former involves physical form, such as cities, buildings, or trees, while the latter involves symbols, regulations or behaviours governing interactions within and between layers. Even if layers have their own properties, they do not function independently; they exchange resources, information or energy. The complex behaviour of the whole arises from the interplay of its layers.

3.2 Mapping, a technological, layered, cultural assemblage

Considered together, '*assemblage'* and '*layering'* provide a robust framework for understanding complex systems, as well as the structure and relationship between these systems. Designers working with urban nature are then encouraged to consider multi-scale and multi temporal interactions, to embrace complexity and emergence. Digital mapping is a technology that brings together technical, social, material, and symbolic components. Maps interact beyond displaying geographic information; they become cultural assemblages that produce knowledge that was not necessarily evident at first glance. Maps convey particular visions of the world and are profoundly political. *“Maps cease to be understood primarily as inert records of morphological landscapes or passive reflections of the world of objects, but are regarded as refracted images contributing to dialogue in a socially constructed world”* (Harley 1988). Harley questions that maps are *“value-free”*: they are not neutral, purely scientific, objective representations of reality. He advocates overcoming traditional cartographical criticism binarisms as *“‘true and false’, ‘accurate and inaccurate’, ‘objective and subjective’, ‘literal and symbolic’, or that are based on ‘scientific integrity’ as opposed to ‘ideological distortion’”* (ibid.). He invites reflection with maps about the assembled and layered assumptions, cultural values and intentions of the map-makers. The suitability of maps to convey images and ideas of the world makes them a definitive tool for groups in society aiming to generate a considerable impact for transformation.

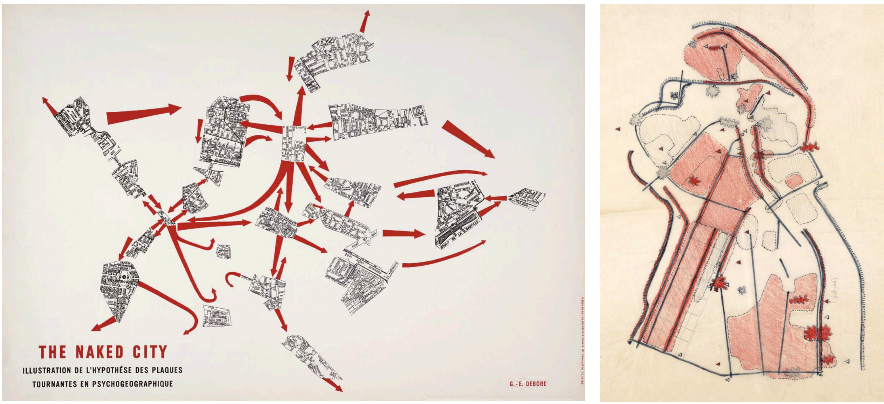


Figure 3.1: Left: The naked City, Guy Debord. Right: cognitive map of Boston, Kevin Lynch.

In *“Operative mapping”*, Roger Paez (2020) states that *“neither map [cognitive map of Boston by Kevin Lynch, and psychogeographic map of Paris by Guy Debord, Figure 3.1] claims absolute objectivity, because they both understand that maps are not simply representations, but rather systems of propositions concerning reality. They do not represent reality in a neutral way, they construct it”*. This kind of understanding of mapping, that Paez calls *“operative mapping”* implies its capacity to construct reality and shares two vectors of affinity with design, spatiality and proposition: for Paez, both propose realities within a spatial framework. *“In the context of design, operative mapping implies the use of maps as an active part of the design process”* (ibid.). While Paez demonstrates the suitability of operative mapping only for architecture, he acknowledges the possibility of expanding it to urban design and landscape architecture. This thesis takes that path further.

According to Paez , and this is the cornerstone of his reflection, operative maps create meaning, which is a key factor in imagining possible futures: *“Maps are not the same as plans. While the latter’s capacity to anticipate would seem to have been exhausted, the map remains rich with all manner of possibilities”* (Picon 2016). Using operative mapping within a speculative practice becomes a powerful asset in imagining novel forms of design—for instance, novel naturecultures in urban environments.

French geographer Henri Desbois has investigated the role of maps as a form of gaining precision and measurement, as well as their use as symbols of power from the Renaissance onward. His work on *“Cartographic imaginaries”* (Desbois 2015) brings to the table the cultural entanglement of maps and literature: how maps have been used in imaginative literature and how literary works have shaped perceptions of maps. This bidirectional interaction between the technology –mapping– and the expression of the imaginary is at the core of this chapter. Shannon Mattern (2017) also highlights the historical and contemporary relationships between urban environments and the various media that shape them, emphasising the importance of critical mapping methodologies in revealing the layer of urban information and power dynamics. The capacity of maps to create cultural visions is investigated hereafter, inquiring into how this process occurs.

3.3 Maps, agents of territorialisation and deterritorialisation

In mapping, two simultaneous and opposite processes take place. Lending Deleuze and Guattari's (2002) formulation, they are *'territorialisation'* and *'deterritorialisation'*. The first refers to how something is stabilised, organised or structured within a given context; establishing boundaries, norms and functions. The structuring forces can be physical, such as architectural forms, or country borders. They can also be abstract, such as social norms, laws and code. In urban planning, roads or parks define clear function zones with distinct boundaries. But social norms or traditions contribute to the stability of behaviour and identity. Territorialisation fosters coherence within an assemblage and promotes predictability of the element's behaviour.

Maps organise data into different layers, such as infrastructures, green spaces, and population density. All of them have boundaries, functions and social rules. Categorising and organising this information becomes a territorialising process. This is even more evident when maps define boundaries –visible or invisible– using a form of standardisation of the symbols and interfaces to interpret complex data. These processes have remarkable social and cultural value, enabling communication and providing a game board and a ruleset.

However, parallel to this stabilisation dynamic, the opposite also occurs: deterritorialisation is the counter-process that breaks down the established structures. It disrupts, enabling changes, reconfiguration or liberation from established forms. This can involve removing elements from their usual contexts, transforming their functions, and creating new meanings or forms of use. Mapping becomes a fascinating case where both processes can be observed simultaneously, especially given the fluid and multi-layered nature of digital spaces. For instance, Debord's and Lynch's maps in fig. 3.1 are examples of psychogeography, mapping a subjective or emotional space. They break the rigid, functionalist view of urban space, showing how different cultural or personal perspectives shape geography. Similarly, data activism and counter-mapping practices can unveil marginalised realties ignored by official maps and consolidated mapping techniques.

A flexible urban design emerging from mapping may merge successfully both processes. This blending of territorialised and deterritorialised elements can empower minorities to integrate their individual perspectives in the urban realm. Decentralising traditional forms of territorial control allows users to map their own experiences onto spaces. In parallel, such a practice can be a powerful tool to initiate novel narratives about urban nature, which do not correspond to hegemonic, established visions of nature. Such mapping exercises mobilise the three kinds of knowledge discussed in the previous chapter, as seen in table 2.1. Scientific knowledge, such as data analysis, can profoundly impact territorialisation. With it, defined contours of different aspects of reality can be outlined. However, humanistic knowledge is key to understanding the context, motivations, consequences, and cultural embedment of the numeric and spatial results of scientific analysis. Deterritorialising processes are profoundly linked with speculative knowledge production and *'designerly'* forms of knowing: tacit knowledge acquired by designers after years of practice helps to envision alternative spatial configurations, challenge existing preconceptions, and propose imaginative interventions that transcend conventional planning constraints. By integrating intuitive, experience-based insights with scientific and humanistic knowledge, designers can create mapping practices that reveal hidden structures, amplify marginalised voices, and foster new cultural perspectives on urban nature's spaces. This dynamic interplay between territorialisation and deterritorialisation enables urban design to remain adaptable and responsive to evolving social and environmental conditions.

It is important to note that mapping enables cultural deterritorialisation by allowing alternative narratives and histories to be mapped. This echoes the ideas of Dunne and Raby about speculative design, which was discussed in the previous chapter: challenge existing norms and conceptions and provoke alternative imaginaries in the intersection of technology, society and design. Speculative design can deliberately deterritorialise common perceptions of urban nature, revealing hidden assumptions and opening up a space for creative and critical engagement. Speculative digital mapping actively deterritorialises the traditional role of design by displacing it from a merely functional operability towards a critical function; one that questions, imagines and unsettles established assumptions.

Deterritorialisation and speculative design are valuable methodologies to envision alternative realities, exploring new possibilities liberated from entrenched categories. They can both operate to displace the function or meaning of elements of systems, encouraging designers to reflect on the assumptions embedded in everyday objects and systems. In this sense, they operate as tools for cultural critique, dismantling dominant structures and creating platforms for dialogue about possible futures. The power of reterritorialisation lies in its ability to present alternatives that challenge users to reassemble their understanding of technology, ethics and design. In this process, new meanings and identities are assembled. These forces have been key along digital mapping history, shaping new imaginaries that allowed designers to propose novel visions for urban nature.

Visual theorist Johanna Drucker states that *"data visualisations like maps, charts and graphs are intellectual trojan horses from the empirical sciences"* (Drucker 2014), criticising how visual representations of data carry implicit epistemological and ideological assumptions. They have indeed advanced thinking throughout history, shaping ideas, societies and technologies. The crisis of maps, operating manuals and guides (Picon 1998) can be understood as the impossibility of reducing the anarchic development of cities to any discursive structure. Even admitting the impossibility of making a completely ordered sense of the urban realm, is it possible to represent its essential coherence? Information design is a discipline that focuses on presenting complex data in a clear, engaging and easily understandable manner. Merging principles of graphic design, psychology and communication, it guides users through information. Edward Tufte introduced the main principles and provides solid theoretical grounding to achieve clarity, precision and efficiency in his seminal work, *"The Visual Display of Quantitative Information"* (1983). Tufte's ideas (1990, 1997, 2001) have influenced today's data visualisation structure and hierarchy, and have shaped contemporary visual storytelling to support decision-making.

3.4 Seven key moments in the evolution of digital mapping

The following sections give a brief overview of the historical construction of vision, cognition and representation in the last decades. The historian of sciences Orit Halpern (2014) states that *"the ways we are trained, and train ourselves, to observe, document, record, and analyse the world are deeply historical in character"*. It is therefore important to understand how each period influenced the technologies of cartographical representation. She defines *"communicative objectivity"* as the "*new forms of observation, rationality, and economy based on the management and analysis of data"* after World War II, thanks to the introduction of computation. Seven key moments in the development of digital mapping are presented chronologically, in relation to the different paradigms that each technology contributed to shaping. Rather than an exhaustive description of each stage of technical innovation, it looks for pivotal situations where a technical or a theoretical shift delivered –or promised to deliver– radical changes in the form that urban design produced. From each moment, relevant aspects of mapping are critically extracted, compiling in section 3.4.9 the lessons drawn from this succinct digital mapping history. Together, these insights facilitate the articulation of a mapping framework that is both critical and generative, serving as a methodological foundation for formulating speculative scenarios with urban nature.

3.4.1 Pioneers before digitalization

In 1832, Paris suffered the consequences of cholera epidemics, particularly in the unhealthy slums. A process of rationalisation, technification and normalisation of the notion of *"insalubrité"* –unhealthiness– took place in the second half of the century (Fijalkov 2000). Every building had a *"fiche immeuble",* a paper card with information regarding address, number of rooms, occupants' ages and occupations, and health status, with records of illnesses. Finally, information about the sanitation of the building was recorded, including details about water supply, sewage system and water quality. These cards were crucial to understand the correlation between infrastructure and health, and became a powerful tool for making urban decisions such as building renovation or demolition. Armed with rudimentary maps and mortality statistics, a grand, top-down, urban redesign started. This event and its central theme, hygienism, planted the seeds for spatial analysis: a form of urban design informed by significant amounts of data. While the representation of the map of Paris was more traditional, John Snow documented the London cases of cholera in a more advanced form that demonstrates the power of spatial analysis. He put a line for every detected case over each address, identifying the hotspots of the city to be treated. The effective lesson of Snow's cartography echoes contemporary forms of data visualisation.

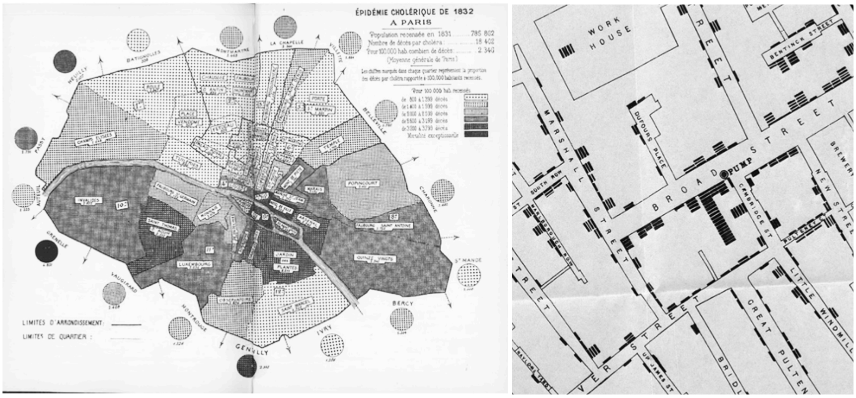


Figure 3.2: Left: Paris cholera epidemic statistic map, 1884. Pulic domain; Right: London Cholera map, John Snow, 1853. Public domain

The seminal work of Ildefonso Cerdà, *"Teoría general de la urbanización"*, General theory of urbanisation, was published in 1867. In its first volume, he described the principles he imagined guiding urban design. It was the theoretical ground for one of the most iconic urbanisations in the world, Barcelona's *'Eixample'*. The second volume, much less cited and referenced, started like this: *“convinced more and more each day, as I have been deepening my studies and research, that urbanisation is a true science, and therefore understanding the need to investigate, establish and fix the bases and principles on which this science must be built”* (Cerdá 1867). He clearly states that there is no place for *“el capricho de la imaginación”*, the caprice of imagination: the work of an urbanist has to be deeply rooted in science, more precisely, in statistic, *“ese arsenal inagotable de razones contundentes e irresistibles, a que han acudido con féliz éxito todas las ciencias sociales”*, that inexhaustible arsenal of compelling and irresistible reasons, to which all the social sciences have successfully turned with confidence. This second volume compiles a copious amount of statistical data he had access to, which he considers incomplete. He identified data gaps in the census and carried out his own surveys, gathering information about the physical form of the city as well as the social tissue that inhabits it. A pioneer in statistical analysis techniques, he identified patterns and trends, such as the relationship between population density and disease rates or the impact of street width on air quality (Magrinyà & Marzá 2017).

Figure 3.3: Hollerith’s Sorting and Tabullating Machine. Public domain

Like hygenism, the development of statistics became a new public policy foundation. Moreover, statistics allowed the development of the first ideas that laid the groundwork for the digital analysis of urban environments. The 1880 US Census took eight years to be completed, and gave rise to questions about how the process could be streamlined. In 1890, Herman Hollerith introduced a punch card system that allowed machines to gather the data in less than three years, dramatically reducing the processing time (de Monchaux 2014). These artifacts became mechanical precursors to computers as an endeavour to assume greater complexity, while systematising it to make it more comprehensible and manageable. The machines and the punch cards lacked the capabilities to make connections between data: the human brain's associative ability looked for patterns, analogies, interferences and generated knowledge from the raw data.

Military technology was a key driver in the development of digital cartographies. A radar system developed during World War II became SAGE –Semi-Autonomous Ground Environment (ibid.)– a program that combined computation, mapping and visual display. In the 1950s, Walter Christaller used statistical analysis to understand settlement patterns, but the term *'Geographic information system'* –GIS– was only coined in 1963 by Roger Tomlinson. He developed the world’s first true operational GIS console for the Federal Department of Forestry and Rural development. Remarkably, the first crystallised GIS tool had nature as object of study.

Two key aspects are then relevant from this period. First, the spatialisation of statistics to understand complex phenomena. Spatialised scientific data analyses reveal behaviours and indicate the direction of the first actions to react to a situation. These maps are not mere representations of the reality, but *“operative mappings”* (Paez, 2020) that construct reality and propose paths pointing towards possible transformations. Secondly, systematising and automatising considerable amounts of data becomes an opportunity to reduce processing time while augmenting the complexity of the considered parameters. However, this advancement risks operating only with *'datafied'* aspects of reality, ignoring qualitative, historical or other elements that are carefully converted into data. Furthermore, the *'black box effect'* increases, as data processing occurs unseen and uncontrolled by human eyes.

3.4.2 Analogic data-layering

Between 1957 and 1959, the landscape architect Ian McHarg directed *“Metropolitan Open Space”*, an ecological planning investigation for the Urban Renewal Administration. It inquired into the Philadelphia metropolitan region, which is considered his first foray into examining environmental factors at a metropolitan scale. Working within a transdisciplinary team, Nohad Toulon *"digitized the natural resources data with punch cards and computed areas for each parameter and their combinations. His calculations were employed by Bill Grigsby and Anthony Tomazinis. This was the origin of what would become computerized ecological planning: Geographic Information Systems, or GIS"* (McHarg 1996). The team used a similar system to the US Census, taking it to a spatial analysis level.

This connection between space and information launched the path that followed with the foundational publication of *"Design with nature"* (McHarg 1969), describing a series of methodological mapping techniques that built upon Christaller's principles. His approach to map overlays shaped the intellectual framework for Geographic Information System, GIS. His principles to study nature, landscape, geological processes or ecology are the decisive forces that should guide a design proposal. The structural consideration of several overlaying studies has been considered as ***'data-layering'*** in landscape architecture (Fricker 2021). Deleuze and Guattari's idea of *"assemblage"* and de Landa's concept of *"layering"* are more than metaphors that can be represented graphically as a series of interconnected layers of meaning, they are epistemological foundations of map making.

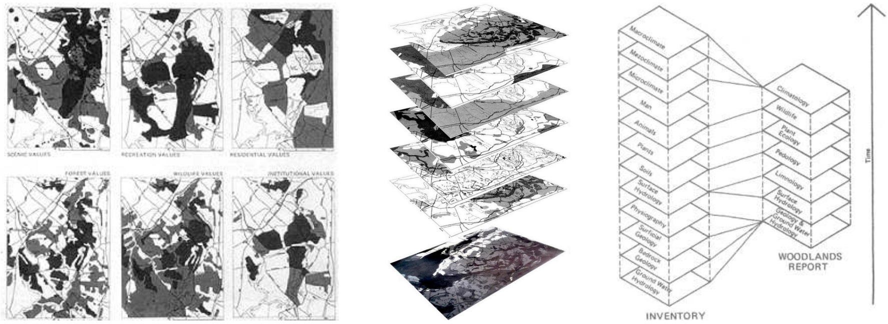


Figure 3.4: Design with nature. Ian McHarg, 1969.

No digital methods were used in this case, but transparent plastic sheets were utilised to draw maps. McHarg identified geological, climatological, biological and ecological factors drawn separately in successive maps interpreting value, danger, protection or evolution. Their superposition should guide urbanisation, avoiding damaging the surroundings and the environment. The approach was innovative because of its emphasis on the use of scientific data to inform planning and design decisions, as he explains in a highway assessment from 1960: *"This method's distinction from traditional engineering lay in its dependence on natural science factors, arrayed as a layer cake, and their evaluation. It was, I believe, the first environmental impact analysis"* (McHarg 1996). The designer's practice evolved and was shaped thanks to the methodological approach proposed by McHarg. Despite the fully manual execution of this method, it was the seed of the current understanding of digital GIS. Borrowing the terminology from Merleau-Ponty: in this case, it is a new perspective towards nature –the emergence of ecological responsibility– that triggered the technological advancement, and not the other way around. *Methodology*

McHarg's overlay enquiry included a hierarchical analysis to prioritise different factors and identify trade-offs between competing land uses. This approach embodies a methodology to assess the environmental impacts of development projects. *"For McHarg, site design was not simply a matter of spatial shape, form and experiential impression but more the adaptation of various ecological forces in time to shape a more dynamic and complete whole"* (Corner 2014). In this sense, he promoted the idea of planning urban evolution from the information that landscape and ecosystems provided. For him, landscape –not other built infrastructures, such as mobility or services networks– should be the key organisational force in urban design. He also considered simultaneously all environmental processes in close relationship to sociocultural comprehension of the territory. For him, urbanisation is an extractive practice, which could be done with less harm to the environment. This protectionist approach does not yet fully recognise non-human agency.

Despite the continued influence of McHarg's methodology today, many consider it too deterministic and rigid. If all information is within the context and the indicators to interpret them are set, it seems like only one solution is possible. This could be understood as a form of sacralisation of data from nature and the landscape. James Corner questioned in particular the lack of agency of human beings and society in McHarg's approach.

McHarg's analogic data-layering becomes a perfect example of operative mapping, illustrating its three essential characteristics (Paez 2020): first, mapping becomes a cultural construct, profoundly different from a neutral representation of reality. Beyond the pure facts it compiles, it operates as an assemblage that has moulded what has been understood as ecological stewardship for many decades. Besides, mapping becomes a tool that reveals and recognises existing opportunities and threats, and, finally, *"mapping [operates] as a technique for expanding reality and transforming the human living environment"* (ibid.). McHarg's maps can be interpreted as guiding frameworks for fostering a more ecologically literate approach to both urbanisation and its associated planning methodologies.

3.4.3 First digital layering cartographies

While McHarg's approach set the core theoretical fundaments of contemporary computational mapping, he worked only with transparent sheets to superpose his cartographies. It was Howard Fischer who, through his experience in design, architectural education and practice, was able to develop GIS software (de Monchaux 2016). One of the first uses of IBM's computers at the beginning of 1950 was for mapping census data. When Fischer, who was already retired from his architectural practice, found out about this semi-computational application, he decided to improve it. He looked for man-machine interaction where the computer deals with quantitative information, and where the role of the human is to control the design process and perform a final evaluation *"which is not readily quantifiable"* (ibid.). The resulting program was called

SYMAP

SYMAP: Synagraphic Mapping. Beyond simple overlapping of layers, the program aimed for total encoding and manipulation of multiple variables simultaneously: *"its goal was, literally, to draw together– visually, strategically and creative. In this, SYMAP emphasized the map less as a method of optimally acting on the world and more as a method of seeing it anew"* (ibid.). In this sense, de Monchaux considers SYMAP to be the first attempt to use digital mapping as a visual tool, not just an administrative technique. In a precedent form of open-source software, not being dependent on a particular administrative purpose, its features were developed to respond to its own internal logic.

The development of architecture through computation was much faster at that time, which Fischer blamed on a move *"toward the traditional academic disciplines of economics, sociology, statistics, etc, and away from more 'design-oriented' thinking"* (ibid.). McHarg and Fischer understood the tool as an operative device for both thinking and designing: two actions they did not separate from each another and whose improvement was part of their primary goals. De Monchaux summarises Fischer's most important lessons like this: *"First, maps remain at their most powerful when used not as instruments of unattended action or procedure, but rather as devices to change our perception of the world, and understanding of its possibilities. And second, that architecture matters –inside and outside of the computer, and in particular the connection between the two. Particularly as the distinction between the space of information and the space of our own* *cities is subject to its own, evermore complex shades of gray, we need to be mindful in a new way. We need to remember that the way in which we would seek to operate in the city –carefully, transparently, collaboratively, and creatively–must hold true in the irreversibly interlinked space of city and data as well."* (ibid.).

This vision of Fischer's work acknowledges that the device's construction to help designers think cities anew is a project in itself. Moreover, this device is imagined as a tool for speculation, to explore unforeseen possibilities, to formulate new imaginaries, to collaborate, and, of course, create. However, GIS is rooted in a positivist and scientific approach, which assumes that spatial phenomena can be objectively measured and represented through data. This has generated criticism, since it lacks tools to integrate more qualitative and nuanced data (Desbois 2015). Critics of GIS argue that the focus on technical aspects and quantitative data can obscure the social and political dimensions of space. This can potentially perpetuate existing power structures, such as those that support the Capitalocene. Moreover, integrating non-human perspectives and agencies in GIS remains a difficult task to solve at this stage.

Fischer pioneered computation at a time when its mastery was limited to a significantly reduced number of professionals. However, nowadays, democratising access to coding languages, software, and devices empowers designers with some digital literacy to become the creators of their own mapping methods and customise them as needed. The challenges and criticisms of Fischer's tool are to be acknowledged and integrated into the process of designing new mapping tools.

3.4.4 Control, the paradigm of Cybersyn

Different paradigms have been imagined, formulated and developed since the early implementation of computing in urban design. They constitute frameworks within which different actors operate, such as governments, urban planners, companies and citizens. They all strongly believe in data analysis as a powerful tool to face contemporary challenges. Media and technology theorist Sun-ha Hong (2020) defines *'honeymoon objectivity'* as *"the recurring hope that with this generation of technological marvels, we shall establish a universal grounding for our knowledge, a bedrock of certainty, a genuine route to the raw objective layer of the world around us"*. This has been the force that has advanced many of these paradigms.

If McHarg's goal was urbanisation in harmony with nature –or with the least harm to it– the technical advancement of digitalisation during the 1970s introduced the idea of information feedback to feed decentralised decision-making. Cybersyn, the Chilean project led by the economist Fernando Flores, explored the potential of digital technology revolutionising urban governance. Although it never functioned entirely as it was planned, it fed two powerful imaginaries. One, superficial but extended: the image of the control room, with screens and data running in real time, an icon of the upcoming digital city science. Another one is a decentralised planning system that uses computers to understand networks better. The project aimed to distribute control across different sectors and industries, rather than concentrating all decisions in a single central authority.

This precursor of *'Internet of Things'* had the goal of helping the recently elected government of Salvador Allende manage a significant number of nationalised companies. Informed real-time by telex machines, it was considered a decision support system for national economy stability. The paradigmatical symbol of this project is its Operations room, a retrofuturistic lounge with revolving plastic chairs and screens on the surrounding walls. In it, real-time feedback from the companies was received and subjected to scrutiny. There was even economic simulation software that would inform decisions. These were voted on and approved, and data analysis and prediction modelling informed them. The etymology of the program's name comes from *'cybernetics'* and 'synergy' and refers to the idea of a digital world steering decisions in close cooperation. Nevertheless, the image of this all-knowing *'brain-room'* has become the image of control. Similar rooms have been built in many cities worldwide, with suitable technologies for every moment. The advantages of using real-time data and the simulation of its effects are obvious and were brand new at the time. However, a problem was also quickly perceived: *"The technology trajectory, however, is clear; more and more data will be generated by individuals and will persist under the control of others"* (Zuboff 2015, p75). The suspicion of overexerting control over society and centralising power appears from the earliest stages of digital urban science. The project stopped during its early stages due to the military coup of Pinochet in 1973, and was never fully operational (Medina 2006). Its true potential and effectiveness remain speculative. The second wave of cybernetics, developed from the 70s onwards, incorporated theories of chaos and complexity, but most important, considered the observer a fundamental actor included in the observed system. Paradoxically, this search for complexity, contingency and unpredictability has declined into instruments of control (Krivy 2016).

At the same time, further GIS technology was developed but did not reach the capacity to fulfil the imaginary of Cybersyn. MIDAS, *"Mapping Display and Analysis System"*, was launched in the mid-1960s by the US Census Bureau to automate the process of drawing maps and displaying census data. A crucial moment was the foundation of ESRI, *"Environmental Systems Research Institute"* in 1972. While it started out as a land-use consulting firm, ESRI quickly became a key player and GIS-software developer. In the 1980s, it released the first desktop GIS Product, *"Mapinfo"*, making this kind of technology available to the public. Others followed, such as *"Arc View"* or *"ArcGIS",* until user-friendly GIS expanded in the 1990s. These allowed simple functions such as storing, managing and manipulating geographic data, performing simple spatial analysis, displaying maps –like layers, as McHarg did analogically thirty years before– and importing and exporting data. The spread of this technology fostered collaboration across disciplines. However, the forward-looking imaginary of Cybersyn has not yet been incorporated into designers' technical equipment.

Cybersyn and the first desktop GIS software contribute to a methodology for working with digital mapping. They both rely on Systems Thinking, holistically approaching the comprehension of complex systems, focusing on their relationships, interactions and interdependencies with each component. The system's behaviour, structure and dynamics arise from the interplay between its parts and their environment, rather than just the sum of its individual elements. This may become a powerful tool for inquiry into urban nature's interconnectedness, cohabitation, and hybridation. However, using systems thinking as a form of control is a considerable risk that must be addressed appropriately.

3.4.5 From tracing towards mapping

During the 1990s, former students of McHarg at the University of Pennsylvania questioned whether all the information needed to produce an urban design comes from studying nature. Professionals such as Charles Waldheim or Chris Reed started investigations beyond McHarg's intention to bring people closer to nature. For example, Chris Reed's studio, *'Stoss Landscape Urbanism'*, showed interest in functional hybridation, where different uses can coexist simultaneously and in space. This helps to create new social and ecological synergies that influence one another. But it was James Corner who, from the same chair in the University of Pennsylvania as McHarg, and his practice *'Field operations'*, shifted the focus from nature towards design: *"his [McHarg's] deterministic approach to ecological and land-use planning fuelled Corner's rebellious insistence on the role of imagination in landscape architecture. Importantly, however,* *Corner has continuously sought a balance between poetic imagination and McHarg's sense of instrumentality and purpose"* (Corner 2014). For Corner, nature together with the act of designing has power to shape possible futures.

From tracing towards mapping

Another key distinction Corner introduced beyond McHarg's ideas is the consideration of time and long-term evolution in urban design. The result is a flexible developmental framework emerging from the deep understanding of McHarg's overlayed mappings. This vision and the methods listed above illustrate the shift from McHarg's theories towards a conscious design approach that integrates time and process. Corner considers the tools and the assemblage of the mappings as important, if not more, as the data extracted from the natural environment. They are not passive elements of representation, but active agents that have the power to shape our understanding of the world. With this vision, Corner confronts Cybersyn's paradigm of control, trying to work with the unexpected, the evolutionary, and the agency of design proposals.

Agency of mapping for James Corner	Operational structure	Fields	The graphical limits of the flat surface of study. With scale, units, orientation, projection.
		Extracts	The object of the study, observed within a given milieu. Selected, isolated, de-territorialised.
		Plottings	The drawing out of new, latent relationships that can be seen amongst the various extracts within the field
	Essential operations	Creation of a field	The setting of rules and the establishment of a system.
		Extraction	The extraction, the isolation of parts and data de-territoralisation.
		Plotting	The setting out of relationships, the re-territoralisation of the parts.
	Thematic paths of contemporary emerging mapping	Drift	Situationist "derive", as a form of cognitive mapping rather than descriptive. The contingent, the ephemeral, the vague, the phenomenological becomes foreground. Maps alternative realities and subvert dominant readings. A sense of bottom-up.
		Layering	Superimposition of differentiated layers, producing a thick complex composite surface. The layers are not descriptions.
		Game-board	Shared working surfaces upon which various competing agents are invited to confront their differences. A tool to enable discussion, find common grounds and play out several scenarios
		Rhizome	The rhizome has no beginning or end, just middle (milieu), from which it grows linear multiplicities. It is acentric, non-hierarchical, and continually expanding across multiples terrains. Maps that construct 'planes of consistency'.

Table 3.1: The agency of mapping for James Corner (Corner 1999).

Corner goes beyond the disctinction proposed by Deleuze and Guattari between *'maps'* and *'tracings'*. The latter operates as a description of hierarchical systems that are known and do not allow any kind of innovation. On the other hand, maps or mappings are open, connectable, *"experimentations with the real"*; rhizomatic. For Corner, interpreting Deleuze and Guattari, the map has no object. It has only itself as an assemblage, and what counts is its relations and connections with other assemblages. The power of this perspective is its focus towards actions and effects, rather than representation and meaning. While this concept is still in connection with McHarg, Corner considers *"mapping as an active agent of cultural intervention"* and *"perhaps the most formative and creative act of any design process"* (Corner 2011). He believes that *"new and speculative techniques of mapping may generate new practices of creativity practices that are expressed not in the invention of novel form but in the productive reformulation of* *what is already given."* In this sense, the focus relies on the creative design process instead of disseminated hints from nature. James Corner describes the operational structure and the essential operations in the article *"The agency of mapping"* (2011). In it, he also envisions four different thematic paths (Table 3.1) of contemporary emerging mapping. These correspond with some of the methods described in this research.

Although Corner did not contribute to the technical development of mapping software or technology, the conceptual development described above finds an interesting echo in the GIS-software development of the early 2000s. *"QGIS"*, the first GIS-FOSS, free open-source software for GIS, was released in 2002, providing a free alternative to private options such as ESRI's ArcGIS, while naturally allowing for continuous community-driven development. The characteristics of open-source software connect with Corner's explorative approach, which looks for ways to explore the agency of mapping beyond the representation of reality. If ESRI embodied the technical refinement of established methods, QGIS opened the field to experimental approaches. Designers with some experience in programming could potentially create their own design tools. This technology, shared and developed in open form, combined with the spread of open-source parametric software such as *'Grasshopper'*, reached a more significant number of designers to use their technology and adopt new design processes.

James Corner's taxonomy of mapping operations provides a non-comprehensive set of precise mechanisms that operative mapping can deploy to thrive. Corner's encouragement to imagine further tools for mapping that are operative –that have agency– finds in open-source software a perfect ally. This particular moment in the history of digital mapping embodies the technical empowerment of the designer in parallel to promoting a form of practice that extracts as much as possible from the available mapping tools. The lack of standardisation in mapping techniques speaks for a quest to discover all the possibilities that they may offer. Designers have the freedom and the responsibility to explore this open field.

3.4.6 Optimisation and civic hacking, two parallel paradigms of Smart Cities

During the first decades of the 2000s, the emergence and pervasive use of smartphones boosted data generation and collection, and data became the new oil. In 1999 the architectural office MVRDV launched *"METACITY – DATATOWN"*, a form of data speculation for urban design, which preceded the Smart Cities that were to come: landscape becoming indistinguishable from *'datascape'* (Picon 2013). MVRDV's book tells the story of a hypothetical city based only on data. It completely corresponds to Dunne and Raby's definition of a speculative design that starts with the question *"what if…"*. In this case, what if a city knows no topography, no ideology, no representation, no context? Only huge, pure data (MVRDV 1999).

While MVRDV used the datafication of reality to speculate about possible futures, the hegemonic approach to the use of data in the same period, Smart Cities, had an entirely different perspective. The development of technology facilitated the incorporation of sensors and computing devices in many everyday objects, converting them into what we can understand to be a new networked skin to *'feel'* reality. The so-called *'third wave in computing'* relies on ubiquitous technology, converting the world into a network of interconnected *'intelligent'* objects, called *'Internet of Things'*.

Smart Cities, enabled by this technological revolution, hold immense promise for urban development: cities could optimise resource management, improve their infrastructures, and improve citizens' lives through data-driven decision-making. This paradigms of performance and optimisation stem from a *'fordist'* vision: a closed environment –the factory– with the single goal of reduced cost –or time, which is also cost– and a limited number of factors and indicators. The extrapolation of this model to the city environment, considered a wicked problem with an infinite number of parameters, leads to an illusion fuelled by modelling optimism (Picon 2015). This idea of performance and its improvement is widely questioned (Greenfield, 2017).

Efficiency and optimization

The idea of efficiency is not univocal and has evolved over time. During the industrial revolution, it was interpreted as good functioning of machines and production. Nowadays, it is rather applied to systems and networks (Picon 2001). This understanding lies on the foundation of the Smart Cities framework, which is widespread and almost monolithically imposed to all urban digital practices. It has become hegemonic, transforming and even partially supplanting urban planning practices (Krivy,2016), and presenting itself as the sole dispositive to enhance the performance of cities. However, while the implications for urban management are numerous, the impact on urban design is more challenging to identify because of its infiltrated nature: the claim of optimisation is easily attributed to management, but not as straightforward to apply to the design process.

Big corporations like IBM or Cisco are heavily involved in developing and implementing these technologies. Critical voices have been raised, arguing the danger of an *'overtechnocratic'* management of the urban realm that leaves decisions to algorithms rather than citizens. However, or even for this reason, another parallel trend emerged from the same technologies. Contrasting with the top-down operability of optimisation, data-literate citizens and communities empowered by digital technologies react with bottom-up counter-practices to shape their environments themselves. Projects such as *"Open Street Maps"*, a community-driven initiative for collaborative mapping the Earth, show a path emerging from collaboration and autoregulation. These practices contrast with other Smart Cities initiatives stemming from corporate power and supported by technologies that only certain big companies can access. It is common to confront these two extremes of the Smart City paradigm. The distinction between them is clear but does not consider that *"a whole array of intermediaries exists between technocratically inspired control and freely consented cooperation"* (Picon 2015). What Townsend (2013) considers *"civic hackers"* are independent or organised software developers, artists and entrepreneurs who ideate Smart City technology, embodying an alternative approach to neo cybernetic decision-making.

What both extremes share is profound data literacy, being able to use these ever-evolving technologies to fulfil their goals. Big corporations have the know-how and even develop their own tools. Independent city-hackers act as a form of Pro-Am (Leadbeater & Miller 2004), amateur in a field such as urban planning, but with professional skills for data analysis (Flichy 2010), for instance. However, different forms of practice have emerged between the two poles. Searching for forms of practice that reclaim design agency while working with these technologies, Miguel Paredes Maldonado (2020) states: *"an immense array of opportunities opens up to collectively reframe data-based urban discourses through critical practices of data collection and representation. We could therefore wonder: Is it possible to articulate an infrastructural, data-based counter-project that subverts the prevalent urban narratives of optimisation, efficiency, and top-down "smartness"? Can we steer the representation of data flows towards the emergence of multiple, distinct individual subjectivities (as opposed to the emergence of an 'assembled whole')? Could we resituate this milieu of human subjectivities as the locus of design agency?"* These *"practices of dissent"* are linked to critical making (Ratto et al. 2014; Wylie et al. 2014; Offenhuber 2017), a term first coined by Matt Ratto. This emphasises the intersection of theory and practice and focuses on fostering a deeper reflection on the ethical and societal dimensions of technology. These practices may use the digital as a motor of the emergence of new forms of subjectivities: *"modes of collective intervention [...] that predate the technical overlay of the Smart City to leverage both individual and shared human subjectivities in the urban public domain through a DIY technological ethos"* (Paredes Maldonado (2020).

Practices like these may contribute to the goal of imagining future naturecultures through speculative scenarios. Independent designers could perform them, but their limited data literacy would need to improve to extract the best results from such an approach. The exact professional profiles –situated between civic hacking and corporate use of big data, while willingly seeking to improve their digital competences to incorporate them into their workflows– are who this thesis could be most of use to. In **Part two**, the key competences to develop are investigated in depth, leading to a proposal for the possible evolution of design practice in **Part three**.

Frugal innovators are those creative people making the most of very limited resources, such as Pedro Yirogen's Mexican phone-based primary healthcare system for people who lacked comprehensive health insurance. In the same way, *'data-aficionados'* professional designers should be both *"cosmopolitan in their ideas and outlook, and yet also deeply rooted"* (Leadbeater 2004), avoiding cutting-edge technology and instead making radical use of established and available tools, often twisting their most extended applications. Innovation in this case does not lie in technological development, but in the *'detournement'* of the use of established GIS algorithmic procedures. This approach goes hand in hand with todays' student generation: young professionals without coding expertise but profoundly rooted in digital practices. In their leisure time, they are immersed in technologies such as Snapchat map, where they can check in real-time the geolocation of their friends, helping them to decide how, where and with whom they wish to spend the afternoon. It is therefore important to understand the challenges involved in extending this to more experienced professionals, who are less aware of such applications. This group of professionals are less keen to engage in self-learning with online tutorials, data repositories and expert forums. Creating tailor-made learning environments for these professionals is a key challenge that will be discussed in the outlook section.

3.4.7 Prediction, the paradigm of digital twins

In the early 19th century, Augusto Comte originally coined the term *'social physics'*: *"Social physics is that science which occupies itself with social phenomena, considered in the same light as astronomical, physical, chemical, and physiological phenomena, that is to say as being subject to natural and invariable laws, the discovery of which is the special object of its researches".* In this sense, human beings are considered as atoms in flow, whose trajectories, attractions and reactions can be understood, classified and predicted. The possibilities of computation changed the scale of the samples and the mathematical formulation of these social laws. Scholars like Alex Pentland at MIT mobilise novel strategies and approaches to predict –quantitative– human behaviour. However, he acknowledges the lack of qualitative information about the reasons and motives that steer people's decisions (Pentland 2015).

To better understand this new *'physics'*, models and simulations have become an increasingly prevalent tool to work with. While modelling is a way to create a virtual representation of a real-world system, simulation is used to let the model run and test different design options. The conditions that the model reproduces help to evaluate a system –usually, a closed system– through mathematical formulation of physical conditions.

The opportunities offered by big data analysis and AI integration (Batty 2018) are oriented to improve maintenance and transparency, while offering many different options for decision-making (Clemen 2021). Nevertheless, working with one simulation or mathematical model jeopardises results that may be impacted by other parameters, which are external to the model. Even considering the prediction to be very accurate, it may severely affect other parameters or areas external to the model. To avoid this, the current trend is to create the most precise digital environment by reproducing all the existing parameters. Digital twins are virtual models that accurately reflect a physical object or environment, and the development of digital twins of cities is a growing trend in urban design.

Because the use of digital twins is relatively new and the technology is still being developed, there is no standardisation in the parameters or the models. This makes it extremely difficult to compare results between different digital twins. The simulations rely on historical data, which is often too limited to be considered adequate for the model to run (Tzachor et al. 2022). Moreover, the availability of data differs considerably between cities and countries. Insufficient data quality that lacks granularity can lead not only to false results, but also to exclusion and inequality. The digital divide (Negroponte 1995) implies that only certain big technology firms have access to the data, and the required technology to analyse it is being fought with transparency portals, data literacy, and the democratisation of open-source software tools.

Carlo Ratti and Matthew Claudel pose the question: *"Does the act of considering the future – in this case, the future of the city – have inherent and productive value?"* (Ratti & Claudel 2016). The impression given by many past predictions, which articulates a future that somehow seems old or dated already, generates what Ratti and Claudel call *'paleofutures'*. To escape this fate of predicting the future, they inscribe themselves in the current of speculative design, as defined by Dunne and Raby at the Royal College of Art in London. Within this framework, they establish their own methodology, named *'futurecraft'*: *"we posit future scenarios (typically phrased as What if questions), entertain their consequences and exigencies, and share the resulting ideas widely, to enable public conversation and debate. In other terms, we propose to extrapolate from the present condition and to place ourselves, as designers, in a fictive but possible future context with the intent of realising or precluding that future through public discourse"*. In the words of Dunne and Raby, *"to achieve change, it is necessary to unlock people's imaginations and apply it to all areas of life at a microscale. By generating alternatives, critical design can help people construct compasses rather than maps for navigating new values."* Ratti and Caludel conclude: *"Our work is meaningless unless it ignites imaginations and provokes debate: design by mutation is intrinsically collective".* In this sense, Ratti and Claudel open up the possibility of generating hybrid speculative devices where top-bottom design is critically confronted with bottom-up discourses. These alliances speak for innovative formats where design finds a space beyond the upside-down and downside-up paradigm. In this sense, modelling becomes more than a tool for prediction; it is a methodology to rethink design processes.

Which lessons can independent designers learn from digital twins and incorporate them into their workflows? Starting with pertinent data collection, analysis, and synthesis with systems thinking in mind, the first idea is to use scenario planning purposefully. The feedback from simple simulations from data-rich models contributes to refining the imagined scenario. Through simulation-outcome evaluation, the proposed scenario is successively adapted, generating multiple possible scenarios. This could mean that the end product is not a design proposal, but the imagined evolution of a specific scenario.

In this sense, mapping becomes a propositive rather than analytical tool. Even if it does not produce a result, it is a powerful asset for imagining, describing and critiquing possible future processes. This idea of designing a process is particularly valuable for imagining urban naturecultures. As Corner states, a project with urban nature is not *'finished'*, as some architecture could pretend to be. It is in continuous evolution, and it is the designer's task to define a path for its alteration through time.

Beyond the mirage of precise future prediction, modelling becomes a powerful method for testing speculative scenarios. It avoids the pitfall of conceiving speculative scenarios as fortuitous ideas, allowing one to explore the effects and impacts of a possible future evolution in detail. Today, these modelling methodologies are only available for professionals with access to powerful computing and complex modelling knowledge. Still, it is not unrealistic to imagine that access to such technical means and expertise will soon be democratised.

3.4.8 Upcoming mapping techniques

The technical evolution described in this chapter, from cholera maps up to today's generative AI and Machine Learning, describe a kind of quest. The pursuit of proposals and scenarios guided by a new concept of measure: definitively abandoning capricious compositional methods and embracing data-informed design strategies and processes. Georg Vrachliotis, Professor of Theory of Architecture and Digital Culture at TU Delft, asks himself: *"what does it mean to design in a society that seeks its balance between Artificial Intelligence and the datafication of all areas of life, increasingly rapid global migration, and urgent environmental and societal issues?"* (Fricker 2021). The term *"Twin transition"*, first used in 2019 in the context of policy writing by the European Union, describes the fusion of two parallel transitions: digital and green. It aims to integrate the necessary change towards a future understood as Ecocene, as well as the digital tools that can be used to reach that goal. What are the forthcoming techniques that can help designers in this quest?

LiDAR and 3D photogrammetry will provide dense point clouds that can be enriched with additional information through deep learning. Virtual, augmented and mixed reality are slowly becoming more accessible, helping to create immersive experiences and present urban scenarios. Semantic segmentation or urban elements will be analysed through knowledge graphs, representing relationships between urban elements and other human and non-human entities. Participatory mapping, citizen science and digital storytelling will search for novel means of governance.

In the near future, the rapid development of AI may overtake many design functions but, today at least, the designer's work is still required to steer the process. In a fast-evolving technological world, data literacy will be the basis of many tasks. The role of the users –designers, for instance– is pivotal to developing the techniques that correspond to their aspirations. As the technology philosopher James Bridle (2018) states, technology should not be considered as a separate thing that 'happens to us'; designers can raise their voices to shape the future of the technology they are actively using. The making of digital mapping will not differ from many of these design tasks. To advocate for positive changes in these technologies, we have to ask ourselves the right questions that connect technological achievements to a broader context: 'Who benefits from this technology?', 'Who may be harmed by it?', 'What could its unattended consequences be?'.

These upcoming techniques are, in many cases, still being tested, and their capacities are being proved. At the same time, their accessibility is being accelerated. It is already possible to download a point cloud scan of the whole city of Tokyo, which effectively changes the representation and even the conceptualisation of existing contexts: urban trees are no longer symbolically represented by a circle; instead, their exact 3d geometry is public and available. Many of these technical advancements will definitely impact designers' practice in the coming years.

3.4.9 Lessons from the evolution of digital mapping: toward an operative practice

The previous pages capture a journey through several phases of the evolution of digital mapping. History is here understood beyond a mere reservoir of information about the past. Instead, it encompasses analytical knowledge about conceptual and technical developments. More precisely, about the complex relationship between technical instrumentation and digital cartography, between data and graphic representation, between analysis and proposal, between the making of design and the making of the tools to imagine such design. This enables a position to be taken on the mapping practices to be investigated by this thesis. The historical journey contributes through a series of characteristics, which the mapping exercises studied in Chapter 5 will help to discuss in depth. The following list summarises the key aspects revealed in the last seven sections:

– Spatial character of statistics and automation of data processing

– Maps; a cultural construct revealing potentials, expanding reality, transforming environments

– Development of the designer’s own digital techniques for mapping

– Computational systems thinking

– Development of the designer’s own design methodologies for mapping

– Designer counter-hegemonic practices within Smart Cities

– Test of speculative scenarios through future modelling

– Use of novel technologies such as Artificial Intelligence

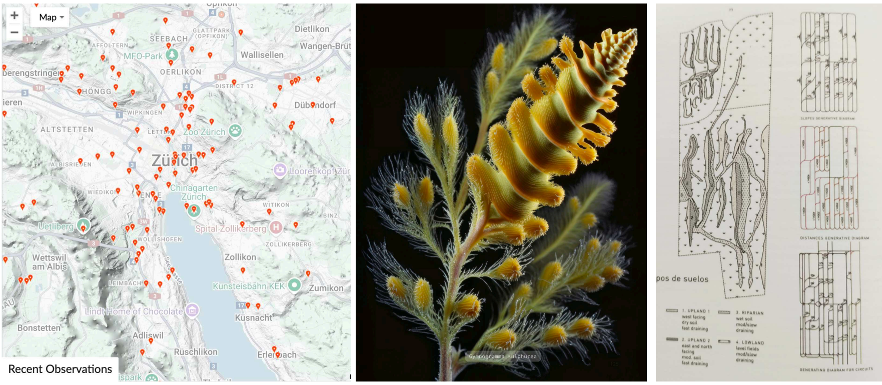


Figure 3.5: Left: Observations of western bees in Zürich, iNaturalist. Centre: Gymnogramma sulphurea, Craig Ames. Right: Plan for Downsview Park, FOA.

These characteristics encompass some of the goals of a form of mapping practice, a tool at the service of designers who –within the framework of this thesis– mobilise speculative design methodologies to produce novel forms of naturecultures. This precise combination of tool, method and theme –digital mapping, speculative design and new forms of urban nature– is not new or original. Any combination of two of the three notions can be illustrated by a multitude of examples: iNaturalist’s fauna and flora observations, Craig Ames’ speculative AI-generated fern species (Ames 2024), or propositive maps such as those for Downsview Park by Foreign Office Architects –see Figure 3.7. However, it is not easy to find examples that embody all three notions. The following section unfolds a paradigmatic case of this kind of mapping exercise that plays with speculative design and has nature in focus. Understanding its mechanisms contributes to outlining, in the next chapter, the parameters used to assess the mapping exercises of the KIT students.

3.5 *"Local Code"*, an exemplary approach

While Fischer's SYMAP mapping software was released before any Computer Aided Design –CAD– software, the impact of digital tools on cities and landscapes has not been as remarkable as on architecture (Picon 2013). Nevertheless, digital tools may be about to profoundly transform the design practice of professionals working with urban nature. Which operational framework and design methods shape this new paradigm?

From the evolution of digital mapping over the last sixty years, a series of notions are extracted and combined to describe a particular form of design practice. This section presents a pertinent example of this kind of practice, which can serve as a path for designers willing to speculate about urban nature through data analysis. *"Nature is indifferent to human geometry"*, explains Antoine Picon (2024), when introducing the work of Nicholas de Monchaux in *"Local code"*: an approach that avoids classic axial composition towards a distributed agency, similar to nature's pollination or propagation. It is not only its geometry that makes it a singular example, but its conception of an operative workflow that effectively merges data analysis, iterative design and speculations about nature and its relationship with the social tissue. The following section describes de Monchaux's ideas in detail, embodying a professional, open approach that inspires forms of practice to come in the future. The method to be presented expands on many of the previously presented paradigms and methodologies. It:

– builds spatial knowledge from statistical data,

– reveals possibilities to construct a cultural understanding of the sites, transforming their reality and proposing a development of their environments,

– creates a tailor-made workflow through digital mapping techniques,

– mobilises principles of computational systems thinking,

– puts in place a speculative and generative design methodology,

– takes position as an empowered counter-actor of Smart Cities,

– creates models to evaluate scenario development,

– mobilises its own set of technologies, adapted to the specific needs.

In *"Local Code: 3,659 Proposals About Data, Design, and the Nature of Cities"*, Nicholas de Monchaux (2016) articulates a design proposal –one of a total of 3,659 proposals– that comes not only from the careful lecture and superposition of the indicators of the context, but also from a series of mapping methods that he develops for several cities. The book contains three biographical essays –Jane Jacobs, Gordon Matta-Clark and Howard T. Fisher– which feed its thematic interests. It also counts from mapping inquiries into four case studies –San Francisco, Los Angeles, Venice and New York– and finally, 3'659 design projects. Monchaux borrows the ideas of social justice and the measure of urban planning from Jacobs, the interest in abandoned urban plots from Matta Clark, and the ethos of the first GIS software and computers from Fischer.

"Local code" is a series of multi-stage design methodologies and a set of self-developed software tools. It identifies abandoned, underutilised sites and applies a city-wide analysis parallel to a site-specific analysis. Then, a series of parametric site designs take place in each of the sites, generating a series of encounters with the inhabitants that foster community

engagement. The strength of de Monchaux's approach in *"Local code"* is that it formulates a territorial analysis parallel to a wide range of simultaneous speculative projects to enhance urban distributed robustness.

3.5.1 *Local Code*'s use of mapping

The book focuses on vacant and underutilised urban spaces in different case-study cities worldwide. Thousands of publicly owned or abandoned sites in major cities are identified using GIS mapping techniques. These maps enable lectures of the cities that highlight spatial patterns and relationships not evident through traditional observation methods. Mapping the distribution of these lots and analysing their relationship –with topography, infrastructure, health and socio-economic conditions– demonstrates how these spaces are often concentrated in areas of need, particularly those lacking access to parks and green spaces. These overlooked spaces are treated as key elements in facing ecological challenges, which can contribute simultaneously to economic and social revitalisation.

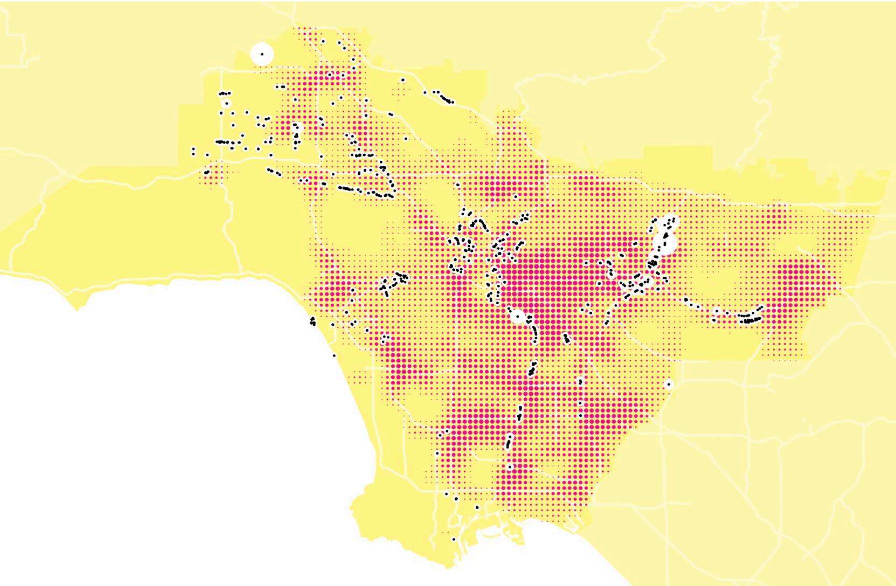


Figure 3.6: Respiratory illness incidence in Los Angeles. Nicholas de Monchaux

The resulting maps embody perfectly the three characteristics that Paez confers to operative mappings:

– their non-neutral representation of reality serves as a cultural construct: the purposeful selection of data avoids pretended objectivity, and its analysis becomes a new lecture of these territories from the perspective of the entanglement of social and ecological challenges

– they become a mechanism to reveal existing development potentials: the maps connect issues such as respiratory illnesses and water run-off issues with the presence of underutilised potential lots; the opportunities to react to these problems are spatially identified, and the associated topics they could react to are formulated

– they embody a path for expanding reality and transforming the human living environment: the superposition of the mappings provides hints towards possible evolution of the sites, triggering design actions.

To perform this task, software was developed at MIT by working with open-source databases of site information. The datasets generated a series of iterations between different tools: site selection and analysis, geometry creation, thermodynamic modelling and visualisation. However, many of the mapping techniques employed by MIT are well known and do not require sophisticated computing equipment to perform them. The tool itself is not powerful or new, but its use makes it exceptional, particularly in terms of how the maps represent a *'fire-starter'* for an unprecedented form of speculative design.

3.5.2 *Local Code*'s speculative approach to design

The work of Nicholas de Monchaux in *"Local Code"* is analytic and propositive at the same time: there is no contradiction in exploring latent possibilities defining conceivable –but not very probable– futures through data analysis with the production of thousands of design proposals. Such pioneer work opens up a path towards graphic, technical and intellectual mediation in design practice. The book does not explicitly articuate a *"what if…?"* question, but the proposals seem to react to this inquiry: What if vacant and neglected urban spaces could be transformed into a decentralised ecological infrastructure network, rather than being seen as wasted land? Already the idea of concentrating on underutilised urban states invites speculation. The produced maps are not blueprints for implementing specific solutions. Instead, they operate as critical thinking provocations to reflect about the future of cities. The maps are used as a guide to acupuncturally implement an interconnected network of active landscapes with ecological and social functions. From an environmental perspective, they contribute to local rainwater infiltration, avoiding water run-off and generating vegetation that withstands the heat island effect while improving air quality. At the same time, these spaces become social hubs in open-air environments.

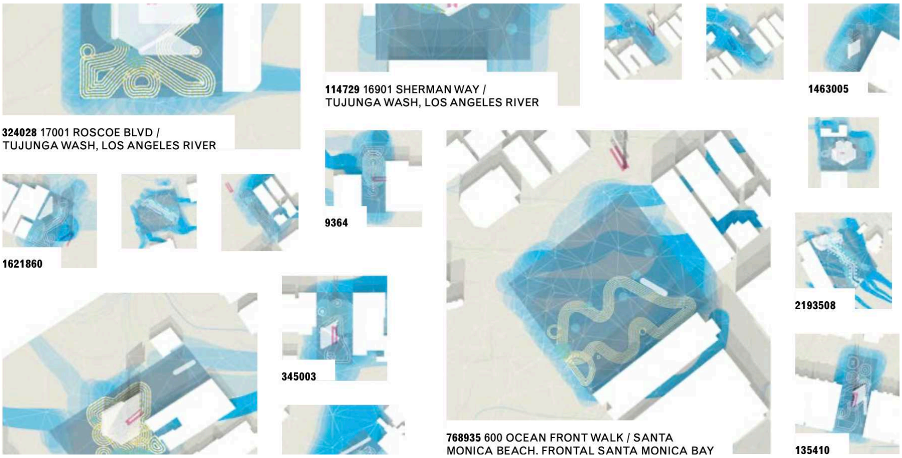


Figure 3.7: Proposals for Los Angeles. Nicholas de Monchaux, 2016

The proposals are parametrically configured and all respond to the same generative laws. While they present a geometry and precise distribution of zones, they are intentionally open-ended. Instead of prescribing specific solutions, a range of possibilities is outlined, which invites readers and neighbours to engage in their own speculations about potential outcomes. Such an approach emphasises the process over a final product. Maps and design proposals are used as critical reflection and imaginative exploration prompts. The designer, the reader, and any other urban stakeholder that may want to be involved in the design process, are encouraged to think about the complex interrelations between social, ecological and technological systems in cities. Practising a networked design approach, it seems that the absence of entirely rational, premeditated design can generate distributed robustness. Following this idea, de Monchaux clearly expresses that *"It is hard, yet essential to divorce the practice of design from certainty"*. His position is clearly defined in a science and data-rich informed speculative practice, which is the path to open design practices dealing with uncertainty.

On the whole, it is possible to state that *"Local Code"* is much more than a design proposal. Beyond imagining an idealised or utopian design outcome, it critically questions the implications of that possible future, profoundly rooting this work in the tradition of speculative design of Dunne and Raby. This work challenges assumptions about the present by exploring alternative possibilities that reveal hidden structures, biases and consequences of current systems. First, it rethinks abandoned spaces as a systemic condition: rather than trying to solve a design problem, it speculates what their existence reveals about urban ecological and health failure. The book's goal is not to propose a design solution, but to provoke reflection on why these conditions exist in the first place. To this end, de Monchaux uses a myriad of mappings and design proposals that serve as basis for a broader discussion.

In addition, his work explores the limits of urban autonomy and self-organisation. It suggests that small, decentralised interventions shape cities organically, but highlights the need to clarify who controls this process and how it should be coordinated. The overall redundant robustness of the systemic proposal is dependent upon the addition of all interventions, which gives rise to an open question about how to implement governance instruments and models that foster complementary actions, both super-local and metropolitan. Finally, de Monchaux questions the role of computation in urbanism. Instead of imposing a single future vision, he speculates on the implications of relying on data-driven urbanism, delving into hybrid models that incorporate the input of empowered communities to the computational analysis and proposal. This work aligns with the best tradition of speculative design by questioning many prevalent power structures in urban planning.

3.5.3 *Local Code*'s notion of nature

The choice to work on marginal spaces –frequently characterised by ecological features that emerge without human influence– is connected to Matthew Gandy's interest in places such as Berlin's *'Brachen'*. These spaces have become a *laboratory* for synanthropic species and social resistance in cities, acting as the perfect breeding ground for novel naturecultures. They *"accumulate in parts of the city - downhill, downstream, down-at-heel - where ecological interventions are most transformative"* (de Monchaux 2016), transforming them into a networked natural infrastructure that provides ecosystem services such as stormwater management, air purification and temperature regulation. The performance of both individual sites and the city as a whole is clearly enhanced through redundancy and robustness, learned from observing natural systems. Moreover, this new natural infrastructure is connected to larger ecological systems, enhancing territorial resilience on a larger scale.

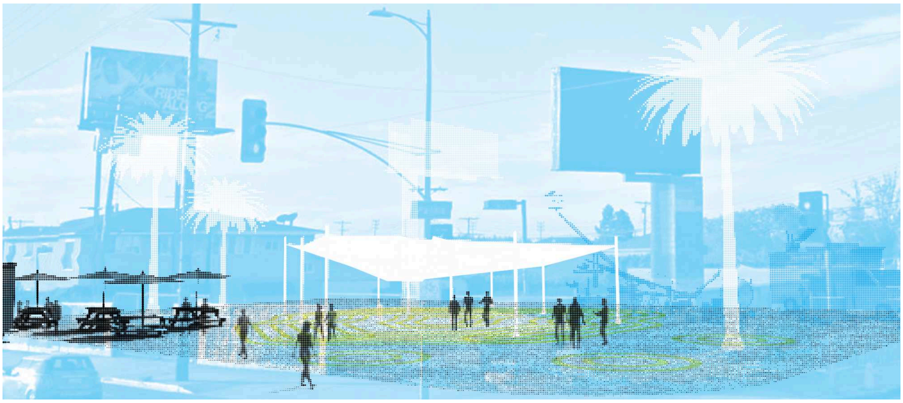


Figure 3.8: Visualization of a proposal for a site in Los Angeles. Nicholas de Monchaux, 2016

The book's approach stems from the ideas of Nature-Based Solutions, a group of sustainable actions leveraging natural ecosystems to address societal changes. They face climate change, biodiversity loss and water security while providing environmental, social and economic benefits. However, de Monchaux's application could be enriched by less anthropocentric ideas of nature, as put forward in Chapter 1 with the ideas of Donna Haraway or Timothy Morton. Although a positive impact on urban ecosystems is identified, *"Local Code's"* vision of nature is primarily a resource to be managed and utilised for human benefit. Moreover, the book's focus lies on evidence of ecosystem services. Acknowledging non-human agency would be a first step towards rethinking the notion of ecosystem services in the Ecocene. Collaboration and symbiosis are essential in de Monchaux's work, but it would first be necessary to extend it to non-human entities. Collaborating with nature instead of instrumentalising it could foster spaces that encourage co-evolution and mutual adaption between human and non-human communities.

3.5.4 Limitations and design after *"Local Code"*

The method proposed by de Monchaux provides a compelling and systemic approach. It is not intended to replace all forms of urban design practice, but to work collaboratively with them or inspire the creation of other data-rich speculative design workflows. Its limitations include difficulty in scaling up the method and identification of more transformative and large-scale infrastructure needs. Data quality and availability are also issues, although the work was exclusively done with open data.

A note in the book's introduction summarises a critical point concerning participation: *"A final note concerns this work's future. At the time of writing, several projects are underway, involving myself and others, to address the enormous policy challenges that lie in front of this effort to radically reimagine urban infrastructure alongside social and environmental welfare. These efforts involve local instrumentation, community collaborations, and policy studies. And such unglamorous work is, of course, the real effort of building cities and communities—and will continue long after this book is put to bed. In the story of this project, then, the text you hold is (qua Churchill) not so much the end as it is the end of the beginning"*. This demonstrates Monchaux's approach to breaking the binary paradigm of bottom-up / top-down, generating new co-creation formats. However, very little information on these efforts is well documented.

Published in 2016, De Monchaux's book considerably impacted design methods and urban planning research. It was considered a pertinent path to be further explored in planning urban natures (Picon 2024), and inspired many explorative investigations into data, nature and cities. Nevertheless, de Monchaux's own career took a different direction afterwards. Few professionals in design and academia have pursued this example, integrating these ideas and procedures in their practice, teaching or research.

Despite its tailor-made programming, the technique behind *"Local Code"* is much more straightforward than Digital Twins or many Smart Cities initiatives. Using these methods in an independent design practice would require certain data literacy, along with use of specific software. However, with today's open-source tools and available open data, many design professionals could start similar works or even take them further. Why, then, is this not happening on a bigger scale? It is likely to be a combination of multiple factors, such as data availability or economic viability, as these projects require a high investment for a return that lacks sufficient clarity. Regulatory and policy constraints, along with plot property, must also be considered. Finally, of course, technical capacity and data literacy are key to bringing this scheme forward.

3.5.5 Learning from *"Local Code"*

James Bridle (2018) insists on the empowering experience of a deeper understanding of technological advancements. He uses the example of Uber employees, who were very familiar with the app they worked with. They used it to place a mass pizza order to be delivered to Uber's headquarters, where they had organised a demonstration with all their colleagues who arrived to deliver to the same point. There, the union could inform colleagues in person about critical issues. Technical literacy goes beyond the know-how of the tools; it looks for understanding the governance of systems, bending it to one's favour, and using it to achieve one's particular goals. With technical –or, in this case, data– literacy, it is possible to regain control and reclaim agency.

Similarly, the value of Nicholas de Monchaux's *"Local Code"* for this dissertation lies beyond the technical accomplishments with mappings and the proposals it brings together. It is beyond previously unknown or unavailable technologies. Instead, it is the *'detourned'* use and particular combination of them that make them a valuable asset in transforming the design process. In *"Local Code"*, external science does not inform design decisions. However, it seamlessly integrates data analysis in its design process, enabling an open, flexible and science-rooted form of speculative design with urban nature. *"Local Code"* is not relevant here as an exemplary design practice to be systematically repeated. It is rather perceived as an invitation to follow its example and stimulate the conception of other design paths; integrating mapping analysis, nature and speculation. It embodies a form of *'research for design'* in an exemplary way as it profoundly reflects on the mobilised technologies, proposing a new *modus operandi* –a form of practice that did not previously exist as such– that will be outlined in Chapter 8.

Klaus Krippendorff (2006) identifies five outstanding features that science for design needs to acknowledge and address. First, *"designers essentially are concerned with artifacts, products, and practices that do not yet exist"*, implying that science can provide certainty of the past and must have the agency to make changes happen and innovate. The particular use of well-known forms of mapping in *"Local Code"* leverages a multitude of possible futures and gives the proposals a sense of which futures constitute improvements. With this, de Monchaux is not only imagining a future that does not yet exist but actually generating it through a form of practice that was not used before. At the core of this thesis –particularly the following three chapters– is how to stimulate such an attitude towards the design process.

The last of the five points identified by Krippendorff concerns the self-examination of design discourses, highlighting the need to correct its misconceptions and continuously expand its vocabulary. *"In other words, a science for design, while investigating design from inside its boundary and supplying the design community with reliable concepts, methods, and knowledge,* *has to sustain the viability of its own discourse"* (ibid.). This attitude fosters healthy design practices that are assessed adequately by science. These pages aim to invite designers to question their design practice and incorporate science, not as a form of validation that externally audits design decisions, but as an endemic source to redefine design questions and stimulate new scenarios.

3.6 Taking a position on mapping practices towards urban nature's speculative futures in the Ecocene

This point in the thesis –the end of its theoretical framework– is a critical moment to look back and better understand the path travelled so far. The first three chapters explore the territories of the initial hypothesis presented in the Introduction. Based on years of teaching experience, it can now be reformulated as follows: computational mapping can be a powerful tool to leverage and explore Ecocene-oriented speculative scenarios with urban nature. This hypothesis is progressively confirmed and developed across the three chapters; each contributing with different theoretical and methodological support layers, moving from a foundational inquiry into urban nature planning and speculative design towards a concrete exploration of computational mapping as a key tool for designers working with urban nature.

Chapter 1 establishes ontological and theoretical foundations for urban nature, positioning it within the paradigm of the Ecocene (Haraway 2015; Boehnert 2018). Posthuman ecological thought (Morton 2007; Latour 2004, 2020; Descola 2013) proposes visions of nature beyond conservationism, advocating for evolving, co-produced ecosystems in intertwined interaction with socio-technical systems. Urban ecological processes are not neutral but politically constructed; new methods and tools to reorient futures of cities towards Ecocene are needed.

Chapter 2 finds a key methodological framework for navigating uncertainty, complexity, and future-oriented ecological imaginaries in speculative design. Designers can integrate three forms of knowledge and knowledge production: scientific, humanistic and 'designerly'. Drawing from Dunne and Raby (2013), the goal of speculative design is not prediction but provocation, in a movement towards better exploring and understanding the intricate forces that weave possible futures. Integrating mapping into the speculative design process acts as an exploratory mechanism, revealing unexpected futures and making them contingently debatable.

Finally, Chapter 3 directly engages with the purposeful potential of GIS-based computational mapping, demonstrating how it can be used beyond mere analytical tool. It can become operative mapping (Paez 2000): an active, interventionist device shaping and transforming people's perception of urban nature. Computational mapping is not only about data representation but about leveraging speculative design thinking (de Monchaux 2016). The reappropriation of the tools of Smart Cities serving independent *'data-aficionados'* professional designers can function as a practice of dissent (Paredes Maldonado 2020), or counter-mapping practices towards Ecocene. The democratisation of these tools and their increasing accessibility engenders a form of practice, which is a key aspect that this thesis contributes to academic discussion: the identification of a new form of practice, *Mappings Exploring Speculative Scenarios with Urban Nature*, MESSUN.

3.6.1 Mappings Exploring Speculative Scenarios with Urban Nature

MESSUN, Mappings Exploring Speculative Scenarios with Urban Nature, is a methodological framework that reclaims mapping as a critical, speculative, data-informed and dissenting form of practice. Rooted in the Ecocene paradigm, it moves beyond anthropocentric urban optimisation and instead fosters new forms of multispecies cohabitation. It repurposes Smart City technologies for counter-hegemonic urban design, advocating for democratised access to simple but effective digital tools. The key features of this practice are presented below.

3.6.1.1 First pillar: mapping as counter-practice

Mapping, the tool that will be further inquired, is nurtured by digital data, mathematical and statistical sciences. The position towards mapping lies beyond sterile representations of reality, or allegedly neutral analysis of the urban realm. The mappings that this thesis inquires into are complex, layered assemblages, which construct meaning and provide novel lectures on the relationship of nature with cityscapes. Such mapping practices build upon historical forms of digital cartographies and can operate by combining several of the previous paradigms: they incorporate mathematical datafication of reality; they apply systems thinking and predictive model methodologies; and, above all, they inscribe themselves in a form of practice of dissent to Smart Cities. They mobilise similar technologies but differ in their optimisation and design agency approaches. Here, technology is key to activating the designers' imaginations. They *'fold-the-box-differently'*, subverting and hijacking GIS-based approaches, which are easily accessible for designers without advanced computational expertise. These amateur-friendly technologies empower designers to engage in interdisciplinary discussions and bottom-up urban design processes. The resulting cartographies are genuine reflection-in-action instruments that seek questioning and provoking thought, intervening actively in shaping futures with urban nature.

3.6.1.2 Second pillar: speculation as method

Mappings Exploring Speculative Scenarios with Urban Nature employs speculative mapping not to anticipate fixed futures but as a tool to destabilise assumptions, understand contexts contingently, and dynamically manage uncertainty. This form of speculative practice is collaborative: maps become a comprehensible and shareable knowledge production that serve as a basis for interdisciplinary discussion. Moreover, speculative scenarios can be integrated into collaborative workflows such as Geodesign or become a mechanism for bottom-up urban strategies. Carl Steinitz (2012) states that *"designing for change cannot be a solitary activity"* and geospatial data analyst and theorist Michael Batty (2013) considers that *"design is increasingly regarded as a bottom-up activity [...] and GIS is increasingly being used in this way"*, paving the way to use speculative mapping in this direction.

3.6.1.3 Third pillar: naturecultures towards Ecocene

Mappings Exploring Speculative Scenarios with Urban Nature recommends working with urban data, reclaiming design agency to propose counter-hegemonic map visions. Generating alternative readings of spatial data and mappings can reveal hidden urban-ecological processes and challenge anthropocentric narratives. MESSUN highlights interdependencies, vulnerabilities and opportunities for multispecies cohabitation, fostering nature-city hybridation and acknowledging non-human agency. As James Bridle says, new imaginaries, or *"new metaphors"* must be formulated at the intersection of nature, city, and technique. Those will be true naturecultures towards Ecocene.

3.6.2 From ideas to action: the *laboratory*

The proposal of *Mappings Exploring Speculative Scenarios with Urban Nature* concludes the state of the art and theoretical framework that are the foundation for this thesis. Beginning on the next page, **Part two** investigates this particular form of practice by setting up a *laboratory* to test the data-informed mappings for speculative design towards Ecocene. The proposed approach is not a static methodology, but an evolving practice that responds to the shifting realities of urban nature and the technologies of mapping for design. The next phase of this research delves further into the reformulated hypothesis and engages with experimental applications of this approach, testing its potential within an academic setting. By situating this thesis's original methodological mapping approach within the broader trajectory of digital cartography –speculative design and posthuman ecological thought– this thesis aims to demonstrate that alternative mapping approaches are not only possible but necessary. Through critical engagement with digital tools, designers can reclaim mapping as a space for dissent, imagination and transformative ecological futures.

Part two

The *laboratory*

Having surveyed the extensive theoretical analysis of the preceding chapters, where nature, design, and technique were analyzed in systematic distinction but still clearly separate conceptual spheres, **Part Two** investigates their entwinement on an empirical plane. The laboratory is presented here as a working area, an active but controlled sphere where abstract principles developed in previous chapters crystallize into definite methods and uses for experiments. The lab is not to be read in purely material terms, however, but as an epistemological instrument—a place where the triad of nature, design, and technology meet, and their interconnected effects are examined through a pedagogical setting.

The laboratory's position as epistemological device bridging theory and practice

The previous chapters worked out a multi-stratal narrative around the thesis of the city's nature as a hybrid formation—a at once manufactured and living object, perpetually reshifting within temporal, social, and ecological contexts. This emergent Ecocene paradigm of urban nature calls for new modes of engagement, both theoretically and in practice. The *laboratory* is thus a testing ground for the articulation and actualization of the speculative design practices beyond narratives of sustainability. Instead, it embraces the multiscalar metabolic entanglements of human and non-human actors in the urban realm. Emphasized in this section is the recognition of the design process as a reflexive and iterative activity that is inextricably intertwined with conceptual speculation and technical mediation. The *laboratory* is an engaged site wherein these activities are enacted, questioned, and iteratively constructed. It is a pedagogical space situated within the broader educational context of the Karlsruhe Institute of Technology, more specifically within Bachelor and Master-level architectural education. But the laboratory trascends the institution: it becomes a microcosm of broader questions about the cultivation of design competences in the data-driven practice of space.

The core question driving this research is one of competence—here not conceived as a repository of fixed skills but as an adaptive, dynamic ability for critical spatial thinking. Competence development, as researched in the lab, cannot be separated from the adoption of computational practices, and more specifically Geographic Information Systems, into the nascent designer's practice. GIS, far from functioning as a technical tool of neutral agency, is leveraged as a reterritorialising complex: not only enhancing the designer's capacity to handle spatial data but also modifing the cognitive and performative dimensions of design practice.

Competency development as dynamic interplay between data literacy and spatial thinking

The laboratory's methodological framework is twofold, integrating *research by design* and qualitative research. Research by design, which is taken up in this work, positions the process of designing not merely as goal-directed activity but as a systematic form of knowledge production. It enables close observation of students' emerging design processes, offering rich insights into the ways GIS tools permeate and transform every stage of their speculative work—everything from initial data sensing, through analytic synthesis, to the crafting of speculative urban futures. This approach aligns with the critical positions interrogating the hegemony of rigid academic approaches in evaluating creative disciplines, and instead asserting the legitimacy of design as an intellectual inquiry practice. Paralelly, a qualitative approach is established to understand nuances in student experience beyond the GIS courses. Using focus groups and semi-structured interviews, the research chartes the long-term trajectories of competency development and critically assessing how the integration of computational tools influences the professional mindset of the students as they transition into the broader design profession. This two-pronged approach ensures that the analysis is maintained both situated and expansive, sensitive to the students' ordinary lives and yet remaining vigilant about broader epistemological shifts.

Tracing long-term impacts of pedagogical strategies beyond the academic setting

Most importantly, the *laboratory* neither merely replicates familiar teaching conventions nor reinforces them but subverts them with the introduction of a speculative logic into its conceptualization. It urges students to ask questions regarding the ontological and epistemological foundations of their practice of design, and to have a reflexive sense of how their interventions can contribute to the construction of post-anthropocentric urban futures. Digital mapping is therefore not envisioned as a passive representational medium but rather as an active, critical one that can deconstruct prevailing narratives and enable other imaginaries. Thus, the laboratory positions itself in relation to the three conceptual pillars established in **Part One**: naturecultures, speculative design, and digital mapping.

The triad naturecultures, speculative design, digital mapping becomes operational

These pillars meet in the laboratory as an embodied pedagogical and methodological apparatus. Naturecultures, as theorized in this thesis, dismantle the binarism of the natural and the artificial, positioning the urban landscape as a landscape of perpetual hybridisation. Speculative design provides the methodological context in which to interpret this hybrid terrain, inviting students to envision and fabricate various futures. Digital cartography, employed in significant part through GIS, is both instrument and critical form, enabling capture, analysis, and reprogramming of spatial information in ways attuned to the Ecocene's imperatives.

In addition, the laboratory is actively situated as an intermediary between theory and practice. It is a liminal space where abstract theoretical abstractions—be they the posthumanist redefinition of urban nature, the deconstruction of anthropocentric design epistemologies, or the promises of computational cartography—are operationalized through experience-based interaction. To this end, the laboratory is an actualization of the thesis's overarching objective to transgress disciplinary walls, establishing transversality across architecture, landscape, urban planning, and spatial sciences. It challenges students to inhabit a hybrid professional self: at once a designer, a researcher, and a data-driven agent capable of traversing the complex topographies of contemporary urbanisation.

The laboratory, empirical backbone of the thesis' contributions

Above all, the laboratory is not conceived as a static or dogmatic model but as an evolving dispositif. Its pedagogic strategy, methodological techniques, and assessment procedures are subject to continuing scrutiny and development, both in response to the outcomes of individual design exercises and through the feedback loops generated by qualitative engagement with students. This iterative cycle ensures that the laboratory is attuned to the changing socio-technical environments within which it is situated, and attuned to the challenges and possibilities of the twin transition towards digitalisation and ecological justice. Overall, **Part Two** constructs the laboratory as a speculative, reflexive, and experimental space. In this context, the theoretical insights established in the initial chapters are not simply tested but retranslated by way of empirical practice. The lab is focused on the mutually dependent development of competencies, instruments, and practices and situates them in the broader endeavor of imagining and making new naturecultures for the urban century. This frames the subsequent critical examination of student exercises and critical attention to future implications for professional practice –a consideration that will ultimately feed into the broader epistemological and methodological contributions of this thesis.

4 Methodology

This chapter sets out the methodological framework for the *laboratory* investigated in these pages: an inquiry into competency development in designers –in this case, architecture students– when incorporating computational data interpretation. Specifically, it explores the impact of GIS tools on the skills of designers planning and speculating with urban nature, which is core to the first Research Question: *"In which ways does the incorporation of GIS-based methods influence professional competences necessary for merging computational analysis with design practice?"*

It is crucial to note that this investigation is situated within an academic setting, which provides opportunities for close observation of design processes, and also presents certain limitations. This research aims to move beyond traditional academic research frameworks and focus on the design process itself.

The study employs a mixed-methods approach, combining *'research by design'* techniques with qualitative methodologies. Both complementary approaches are outlined, presenting how their integration is envisaged. Then, a series of core competences are identified, following James Corner's key subjects in his text *"Terra Fluxus"* (2006), with a detailed grading to be applied in studying the students' exercises. Finally, the limitations and concerns with this methodology are addressed.

4.1 A *laboratory* with two complementary methodological approaches

The setting for exploring the first research question is a *laboratory* within an academic environment. Architecture students learned basic GIS skills in this *laboratory*, which they mobilised in design courses. Analysis of their design process with *'research by design'* techniques, is combined with qualitative methodologies. This double approach offers a holistic understanding by capturing both the tangible skills and competences developed through GIS exercises and students' lived experiences applying this knowledge. The strengths of both methods are complementary, providing a comprehensive view of GIS's influence in design workflows. Research by design excels at generating new knowledge through enquiring produced designs, allowing for a close and critical observation of skills while they are being developed (Roggema 2017, Hauberg 2011). However, such an approach alone might lack the depth of understanding regarding an individual's experience and the applicability of the learned skills beyond the immediate exercise (Roggema 2017). The long-term impacts of the learning, as well as nuanced personal perspectives, experiences and challenges, are best captured by qualitative methods. Both methods are used together to reinforce each other, by providing insights and highlighting aspects that were not visible by one methodology only. This combination was successfully implemented in different research studies assessing the impact of spatial thinking skills on secondary school students (Hickman 2023).

4.1.1 Research by design

The analysis of GIS competency development through examining the design process in a series of exercises is possible thanks to the academic setting. The ability to see the weekly advancement and incorporation of GIS tools and methods allows close observation and evaluation of each step of the design process. Moreover, this approach focuses on practical application, which is a core aspect of the investigation in this thesis. Observing weekly how students use GIS in their design workflow offers a singular perspective to understand how the learned methods are integrated in their design thinking (Paradis et al. 2013).

This particular form of research by design aligns with voices criticising the dominance of traditional academic research frameworks in evaluating design work (Frayling 1993). Creative processes can also be rigorous forms of inquiry. For that reason, the focus here does not lie on design results. Instead, it explores the design process itself, observing and evaluating the impact of GIS at every stage, from initial conceptual ideas to final mappings, which construct speculative scenarios in different degrees of detail and development. The notion of professional competences as a key measure of GIS's impact on spatial thinking has been a widely adopted approach in GIS research (Lee & Bednarz 2019). They allow a comprehensive assessment of the level of spatial reasoning and design thinking abilities acquired through GIS learning. The analysed exercises offer direct, observable evidence of skill development, from which correlations between the design practices and the competences the students gain and develop. A detailed description of this methodology follows in this chapter, better explaining the academic setting, the investigated competences, and the data and geographical environment of the exercises. The analysis of the exercises is captured in Chapter 5.

4.1.2 Qualitative research

Aiming to understand student experiences and long-term impact better, a semi-structured focus group was undertaken with former students of the GIS courses. This allowed an assessment of how students' competences improved during the months and/or years after the courses, and how the proposed learning activities helped develop these skills. With the results from the focus group, it was possible to organise a series of semi-structured interviews with other students. This format was used as there was limited time to conduct the interviews. At the same time, semi-structured interviews allowed students to express their experiences with GIS, revealing their challenges, the insights they gained, and how this affected their critical and spatial design thinking (Hickman 2023). These insights provided context and depth to the quantitative findings from the exercises.

The discussions with the students provided new perspectives to understand how they perceive the learning process and its effect in the long term. Moreover, the students could express clearly which benefits they consider important. Lee and Bednarz (2019) analysed numerous studies and proposed a questionnaire method: the students' perceptions were monitored through *'traffic light coding'* in structured questionnaires (ibid.), useful to reflect development of spatial thinking but does not capture design competences. However, for this thesis, it is key to explore how the students transferred the value of GIS knowledge into their design practice. The proposed qualitative approach is more nuanced, contextual and open to unexpected outcomes, providing insights to tailor future curricula and methodologies better (Roggema 2017). The methodological details of the qualitative analysis and its results, are detailed in Chapter 6.

4.1.3 Merging both approaches: research for design

The integration of both methodologies –the qualitative study and the analysis of the exercises' design processes –converge towards critical knowledge to enhance design practice: rather than focusing on outcomes of design practice, the focus lies on design processes, methods and their effects. They become research for design (Herriot 2019, Roggema 2017), aiming to improve how design is done. The synergic combination of both methodologies allows a deep understanding of the design process. The analysis of the exercises involves actively engaging in design activities to generate knowledge (Herriot 2019), observing the continuous learning curve of the students and their application in their practice. This builds the basis of the inquiry, which is nuanced by the insights extracted from the qualitative interviews and focus group.

The extracted insights from both methodologies provide outcomes that benefit design practice. With these, it is possible to identify and improve design methods and tools supporting critical spatial thinking, promoting collaboration and creative thinking. A better understanding of decision-making processes means it can be shaped towards an evidence-based process, closing the gap between theory and practice. Testing spatial thinking competences and design approaches in real-world applications contributes to bridging the gap between computational analysis tools and their effective and flawless integration in design processes. Finally, the *laboratory* becomes at the same time a piece of research for the pedagogy of GIS tools, exploring experimental approaches and evaluating their impact. This knowledge is of remarkable value when imagining new pedagogical approaches and advanced curricula integrating GIS technologies.

4.2 Towards a pedagogy for critical spatial thinking

The presented methodologies are applied within an academic context, taking advantage of the regular monitoring of the design processes. This setting requires a brief reflection on the particularities of the academic landscape in the first place. The Bologna Declaration was signed by 29 European countries in 1999, aiming to increase mobility of students and faculties, to set a comparable framework for curricula and degrees, and to enhance the quality and competitiveness of the European higher education. The proposed system of credits, ECTS, is based on workload and learning outcomes, which are key. It means a shift from the previous *"teaching centred education"* based on the input or the content – what is taught – towards a *"learning centred education"*, which focuses on the learning experience: from lecturers teaching inputs towards students learning outcomes. In this sense, lecturers are no longer knowledge transferors but facilitators who enable the learning process. Lecturers guide students in making fresh interpretations of the material to be learned. Their job is to imagine meaningful learning experiences where learning is not a spectator sport; where the proof of the learning is not a check on the memorisation of inputs, but the mobilisation of different abilities to achieve a solution to a proposed task. However, lecturing has a key role in introducing, giving context and examining concepts and ideas that are not easily learned on their own. This is the initial position taken in the courses whose exercises are examined in the following chapters.

Schulze (2013) defines the Bologna Process through two key terms: competence and employability. The latter places considerable emphasis on the training of the students to join the labour market. Thus, the applicability of the learned expertise is crucial. Concerning competence, there are countless definitions, but the following one by Weinert settles where the discussion is currently in the German debate: *"cognitive abilities and skills possessed by or able to be learned by individuals that enable them to solve particular problems, as well as the motivational, volitional and social readiness and capacity to utilise the solutions successfully and responsibly in variable situations"* (Weinert 2001).

Spotlighting competency development for professionals working in Geodesign, Schulze (2013) claims an acute urge to model competences in higher education. By thoroughly studying several GIS curricula, he identified three key dimensions of GIS core competences: GIS knowledge and skills, spatial thinking and problem solving. The first deals with the *"acquisition, management, analysis and communication of geodata"* and basically trains the student to interact with different software and programming tools that allow them to work with this kind of geographical information. The second, spatial thinking, is particularly relevant for architects and urban planners, as they are professionals in charge of spaces. Other scholars consider it pivotal to look instead at *"critical spatial thinking"*, as a *"reflective evaluation of reasoning processes while using spatial concepts and spatial representation"* (Kim & Bednarz 2013). This skill may empower students to undertake tasks such as evaluating data reliability, assessing a process and change, or evaluating the produced mappings. The last dimension, problem solving, considers the framework within which the students should work is a *"real world context"*. They would have to mobilise *"critical and analytical thinking, creative thinking, and decision-making, to generate, evaluate, and implement solutions as parts of the problem-solving process"*. The education is, then, situated in a specific context and it is characterised by being hands-on, applied, and skills based. It is operative, but not monolithically solution-driven: *"implement solutions as parts of the problem-solving process"* indicates how each design proposal can only contribute towards a shared goal. This is where speculative methods can become robust to elaborate situated, data-informed but critical, innovative and creative scenarios.

The above-described competences concern professional competences and include specific knowledge and particular skills. Nevertheless, students should also train in soft skills or personal competences, as described by the German Qualifications Framework (2011). These include social competence to cooperate with other professionals and disciplines –one of the central features for Geodesign–and autonomy. This last idea is key in the courses that are to be analysed. The students are asked to make their own decisions, not only about the task, but also about the design of the path, methods and tools to be deployed to achieve their deliverables. They become co-creators of the learning process, deciding which specific tools should be learned, and why they are relevant for their demonstration. They are even encouraged to articulate their learning goals, enhancing motivation and implication (Huba et al.,2000). This is considered the first of multiple similar situations in their future professional career as designers, where they will have to face the learning of new tools, methods or processes. Providing the students with a learning situation that they will live in the future prepares them to shape their career as they imagine it.

Pedagogy for Geodesign

Geodesign education is considered as an outstanding platform for promoting learning-centred education (Paradis et al. 2013). The basis of geodesign is not new, and architects, such as Frank Lloyd Wright, are nowadays considered to have contributed to geodesign, on the grounds of having performed designs that come up after a new understanding of the geographic, natural and social context. The Waterfall house is a good example. However, challenges and emerging opportunities for education in geodesign have recently been discussed more broadly, as at the Geodesign Summits between 2010 and 2013.

The profound reflection that geodesign students must perform results in two critical skills: metacognition and synthesis (Paradis et al. 2013). For a detailed discussion about synthesis, see section 4.3.4. Geodesign is a relatively new field, immersed in a quickly evolving technological society and market, and students must gain self-reliance to decide what they will have to learn during their careers. Metacognition is learning how to learn and how to manage that learning by reflecting on how you learn best, thereby preparing for a lifetime of learning. The first drafting machines appeared in the early 20th century, and combined rulers and protractors for more accurate and efficient manual drafting. During the 1980s, CAD changed again how design schemes were drawn, and BIM arrived less than 25 years later. It took even less time for the arrival of generative artificial intelligence. The technological evolution that today's students must navigate will be faster and more challenging than ever before. They must be armed with soft skills such as metacognition to avoid drowning in technical ignorance or misinformation.

4.2.1 Previous courses without a GIS focus

Although GIS is considered valuable for architecture, it *"is yet to be conceived as an important content in the global trends of architecture education"* (Monsur & Islam 2014). The literature discussing geodesign education reflects the author's academic experiences with architecture students at KIT and ENSAS. These experiences occurred before the courses and exercises analysed in Chapter 5. The courses –not documented in these pages due to space limitations– relied on somewhat traditional design methods and had no specific GIS or digital science focus. They highlighted many of the issues that challenged the learning of architecture students working with urban nature. There was a clear need for better tools to capture the scale of an entire city, particularly tools capable of incorporating higher levels of complexity. In addition, understanding the connections between scales required improvement, particularly in grasping the close relationships and interdependences between them.

Moreover, tools to better identify and analyse urban elements and actors were required, particularly those regarding natural infrastructures and ecological occurrences of cities. Fully integrating the biosphere –*'le vivant'*– into their design schemes would empower students to plan beyond conventional forms sustainability, which too often veer towards greenwashing.

Regarding the design processes and techniques employed, students worked with very limited data. While this could be considered acceptable for learning purposes, their frequent perception of these –very scarce– datasets as exhaustive or complete was, at best, naïve. They notably lacked awareness of the bias introduced in their decisions.

4.2.2 Integration of digital tools into design education

Concerning the specific digital paths most relevant for designing with nature in urban environments, the following four have gained importance over the last decades: GIS, BIM, parametric design, and artificial intelligence. GIS was already presented in **Part one**. The following chapters discuss GIS software, such as freeware and open-source QGIS. BIM –Building Information Modelling– applied to landscape is an approach that is still not widely used. It brings forward CAD principles, integrating 3D modelling with data management and building a strong collaboration and lifecycle management platform. It is primarily used for construction documents and work on-site, and less to generate speculative designs. Parametric software such as Grasshopper, which is applied to Rhino, allows designers to create sophisticated scripts with a visual interface. The result of the programming is easily displayed in 3D, and the high level of customisation and flexibility fosters creativity and iterative work, refining solutions on the go. It is a powerful tool and a good example of the learning outcomes to reach: it can provide the designer with methods and tools to speculate based on relevant datasets. Nevertheless, its processing capacity for large amounts of data, such as those for whole cities of up to 500,000 inhabitants, is very limited compared to GIS software, such as QGIS. Furthermore, the latter nowadays has Python consoles similar to Grasshopper, which allow designers to program with visual blocks. These factors and the limited time for the courses that will be examined oriented the learning experiences to QGIS exclusively. However, merging QGIS with other methods is highly beneficial for a more robust design process.

From the early days of GIS, where trainings tended to be software-centric, the extended use of GIS led to a form of Problem-Based Learning: integrating spatial thinking. The rise of Web-Based GIS and cloud computing democratised access to technologies and databases, and the focus turned towards education for data-driven decision making. Future pedagogical trends point towards artificial intelligence and systems thinking, and their closer integration with the design process.

The mathematician John McCarthy created the concept of Artificial Intelligence *"using the human brain as a model for machine logic"* (Chaillou 2010). However, the use of AI was not extensive enough when the courses examined in the next chapter started. Large Language Models –LLM– such as Chat GPT were first launched to the public one year after the first course. However, they have radically changed several aspects of the work with any software. In many cases, AI functions are already embedded in the latest versions of many design apps. However, the main change has occurred in self-learning: it is possible to interactively discuss with the LLM to solve problems of use and find rapid solutions. Moreover, being that QGIS is software that not only offers standard functions but also allows full programming in a language called Python, LLMs have been revolutionary. People with very rudimentary knowledge of Python programming use LLMs to write, debug, and refine the programming code from orders, which they explain in plain language. This has radically extended the field of experimentation to novice programmers. The use of LLM in combination with GIS Software will be discussed in the specific cases that made use of it.

4.3 Identifying foundational core competences

As discussed in **Part one**, the design practice of professionals working with urban nature evolves with the interaction of nature, technique and design. Schulze et al. (2013) describe three dimensions of key competences when working with GIS: GIS-related knowledge, spatial thinking, and problem-solving skills. This classification and the related competences corresponding to each dimension are technology-oriented rather than design-explorative. Besides, the central theme investigated in this thesis, nature, is unrelated to the competences. Landscape urbanism – the design and planning approach presented in section 1.2.3 – challenges the separation of city and nature by treating ecosystems as the primary framework for urbanisations, emphasising flexibility, infrastructure-based solutions and ecological performance over static, object-oriented designs (Waldheim 2016); urban nature, not buildings, serves as the organising medium of urban growth. Charles Waldheim argues that landscape urbanism is not limited to vast territorial interventions; it can influence smaller-scale projects integrating ecological stewardship and their connection to their non-human context as the guiding principles. Understanding landscape urbanism as an operative approach through scales makes it a valuable paradigm for the activity of those professionals named in this thesis as *'designers'*. James Corner proposes in *"Terra fluxus"* (2006) four crucial notions for the professional working within the paradigm of landscape urbanism: process, field, operation and imaginary.

Landscape urbanism

The first one, *"process"*, implies fluid, dynamic and systemic interrelations: a process-driven practice. He argues that urban form is not as relevant for establishing city relationships as the process of urbanisation. The notion of time is here essential, since landscape urbanism proposals should provide a form of *"space-time ecologies"* in interrelation: *"The promise of landscape urbanism is the development of a space-time ecology that treats all forces and agents working in the urban field and considers them as continuous networks of inter-relationships"*. These ideas certainly resonate with Morton's concept of *"mesh"* or Descola's *"continuities"*. Not only because of their implications for interconnectedness, but also because of the acknowledgement of evolution and dynamic balance over time. Corner insists on looking for new forms of representing this earth in movement, the *"Terra fluxus"* of the title. This approach highlights the systemic nature of the different elements in interrelation: how systems influence the distribution and density of the urban form is more relevant than the urban form itself. This leads to the conclusion that the task of designers is not the formal description of a finalised object. Instead, they must ideate transformation processes, and this is closer to speculative scenarios than solution-oriented design schemes.

"Field" looks at the idea of surface from a multi-scalar and infrastructural approach that negotiates and anticipates change. This understanding of a hypothetical *'surface'* as continuous –again, Descola– merges sidewalks, facades and roofs, blurring the limits of landscape, building or public space. Imagining this continuous surface as the host for urban nature unleashes potentialities and design opportunities. In opposition to architecture, this surface becomes a form of infrastructure. While the former exhausts all possibilities, infrastructure becomes a platform enabling possible futures between uncertainty and promise. This understanding of urban surfaces as catalysts for the unknown is closely related to the principles of Dunn and Raby for speculative design, even giving it a spatiality: the field.

"Operation" stands for revising conceptual, representational and operative techniques. Corner looks for novel working methods that help to conceptualise urban proposals corresponding to the previous concepts, process and field. Proposals that are in dynamic motion, (eco-)systemic, multi-scalar and infrastructural. Advocating the simultaneous use of digital, poetical and innovative techniques, he admits this area requires most development and research. Indeed, it encompasses the methods and tools of each design team.

Lastly, *"imaginary"* advocates for speculative design, a form of practice that stimulates desirable but unlikely futures: *"Public space in the city must surely be more than mere token compensation or vessels for this generic activity called 'recreation'"*. Aiming to recover the vibrant urban and natural complexity that the last century's urbanism has flattened, he argues that *"landscape urbanism is first and last an imaginative project, a speculative thickening of the world of possibilities"*, echoing Dunn and Raby visions, as well as discourse on speculative design.

The interaction of the triad upon which this thesis focuses –nature, technique and design– is also present in Corner's words *"Materiality, representation, and imagination are not separate worlds"*. With imagination, as discussed above, he refers to the capacity to imagine new futures, which is synthesised in these pages through speculative design. Corner's idea of representation relates to the capacity of mapping to create meaning, and the materiality of landscape urbanism dovetails with what has been described as urban naturecultures in Chapter 1.

James Corner's "Terra Fluxus" as framework to identify core competences for designers

Based on the above, James Corner's four notions provide a comprehensive and structured framework for the work of designers producing speculations with urban nature. The next step involves identifying the core competencies corresponding to each of the four categories proposed by Corner. With these competences –research question 1–, designers would be able to transform the design profession –research question 2. How do Terra Fluxus's four categories relate to the theme, method and tool presented in the previous three chapters? Operation encompasses the technological digital tools to be deployed, while imaginary relates to the methods of speculation described in Chapter 2. Field and process are related to characteristics that should be considered in projects involving landscape urbanism. Lastly, nature is the thematic axis that each competence should work with.

Corner explicitly points out that operation seems to him the area that deserves the greatest attention and research: *"the techniques to address the sheer scope of issues here are desperately lacking"*. Moreover, considering that this thesis focuses on design processes, it is pertinent to deploy enough competences – up to seven – within the category of operation. In contrast, the other three categories require two or three competences. However, the identified competences are not considered comprehensive or closed sets. Instead, they aim to provide a game board from which further competences can be identified and inquired into. The following sections interrogate these identified competences, their role, and how they can be helpful in evaluating processes within the students' exercises.

A comprehensive review of the latest trends and digital tools is beyond the scope of this thesis. This *laboratory* is limited to the competences corresponding to those key for designers willing to start working with computational data analysis. It explores how some simple GIS tools can impact design practice profoundly. Further, more elaborate competences, methods, and tools may follow once these are implemented. The ability to work with real-time data, create detailed models and simulations of complex systems, and establish collaborative digital models can be a powerful asset. It may be the logical target for learning. However, all require mastery of the following described skills, which are considered as foundational core competences.

4.3.1 Operation

Of all the possible operation competences that match Corner's definition, the focus lies here on digital tools and GIS approaches. As Corner suggests, these should be used together with other traditional or poetic methods. This is emphasised by other scholars, who call for a combination of computational analysis with hand sketches, collages or other quick methods (Brechtold 2016). Active engagement of designers is required here, not only in terms of customising their toolkit, but also in understanding design as a form of *"reflection-in-action"* (Schön 1983). These competences should not be understood as pure technical mastery of a theoretical approach, but as the exercise of a profession bridging technical and experimental approaches.

The seven competences identified are presented in the following sections. They are: sensing, augmenting, analysing, synthesising, GIS proficiency as design thinking tool, integration in the design workflow, and capacity to create human-nature-technology alliances. The first ones are chronologically ordered along what could be considered a common design process. Nevertheless, several iterations may happen in a different order, and are even expected, for instance when following Steinitz's method for Geodesign.

4.3.1.1 Sensing

While data gathering was made by site visit in the past, digital technologies now allow different forms of *'remote sensing'*: the acquisition of characteristics of a place from a distance. Satellite images, digital cartography, the pervasive emplacement of sensors, and live transmission of multiple captures make it possible to assemble considerable amounts of information from every computer. As discussed previously, data is not objective (Sun Ha Hong 2020), nor is data gathering. The sole act of selecting one dataset or the other already compromises the neutrality of the process.

Types of raw information

There are different types of senseable data: it may be *'descriptive'* –where it provides a vision of a specific time and space–, *'predictive'* –where it builds up on historical statistic values that indicate what future values will be– or *'prescriptive'* information –where data is sensed to make decisions, such as monitoring a grid system to optimise its distribution. Moreover, datasets about nature are inherently conflictual. The interconnectedness of ecosystems is influenced by numerous factors, making it difficult to isolate individual variables. Since these relationships are often non-linear or complex, it is very challenging to model and predict behaviours. The statistical treatment of the biosphere reduces complex organisms and ecosystems to numerical values. An exclusive focus on data contributes to a dissociation between the data and the living being it represents. Searching for datasets beyond human experience enables incorporation of the perspectives of non-human actors, which can play a pivotal role in a nuanced design scheme's capacity for inclusion. Incorporating diverse data sources and perspectives from non-human entities fosters Haraway's idea of *"situated knowledge"*, which emphasises the importance of embodied perspectives and the situatedness of knowledge production. These ethical considerations must be critically addressed if the principles of the Ecocene are to be met.

Data quality

Big data provides four main features (Hashem et al. 2015): volume –larger amount–, variety –diversity of data structures and forms–, velocity –speed of generation and processing efficiency– and value –the methods enable hidden value to be revealed. While these characteristics are commonly accepted, the assessment of the quality of the data is essential to ensure its reliability and accuracy. Several factors affect quality, such as completeness or timeliness: certain datasets may lack information for a specific parameter during a particular period, or the time period that the dataset reflects is not suitable for the project. In addition, it is crucial to understand where insufficient quality can lead to potential biases. For example, with walkability, street view data may be skewed towards certain times of the year (ibid.) when the images are more appealing, but do not represent all-year use. Moreover, the level of detail captured in a dataset may be enough to assess overall greenness of a city. Still, data may require a finer granularity when working on micro-climate conditions (ibid.).

Data availability

However, data sensing is highly dependent on the limitations of the currently available data. How does data availability influence project direction and how is it initially integrated? Designers must assess the data's reliability, and act accordingly. Bad practice may lead to questionable data opportunism, one of the limitations discussed in section 4.5. In official data scarcity cases, designers can also generate their own datasets with sensors or mobile phones or combine them with open-source repositories (Fricker et al. 2020). These repositories, such as iNaturalist, where observations of plants and animals are registered and publicly shared, are a form of citizen science. This term describes communities or groups of citizens who become observers in a particular domain of science (Godchild 2007). These platforms have become a powerful source of non-official information that can be valuable for designers.

During the beginning of the 19th Century, the bird population in Cornwall was declining. Concerned about this trend, local naturalists and landowners started collecting data on bird sightings, and involved individuals of all backgrounds to follow nesting habits and track movements. This collective effort to gather environmental information is considered the birth of the citizen science we know today. Involving regional inhabitants in registering different local aspects has become a new form of remote sensing. Nowadays, complete datasets are available as the sum of all users' contributions worldwide. This is the case, for instance, with iNaturalist. It has taken advantage of smartphones to contribute to its expansion, easing the process to a simple series of clicks.

This leads to the question of the sources of data: they can be institutional and structured, or unofficial and unstructured, or just appropriable and choral, such as social media data. Non-official sources often imply scraping, where automated processes look for information on the internet or a specific website to connect data that was not compiled this way before. An example would be looking for specific tags in pictures posted on social media, and gathering the geolocations of the images that share a particular tag.

Citizen science

Citizen sensing (Gabrys 2014) happens when people participate in the collection of data through mobile devices, social media –Flickr or Komoot, for instance– or crowdsourced platforms such as iNaturalist. Citizen sensing aims to capture subjective qualitative information about the urban realm, such as perception of enjoyment or suitability for social encounters. The difficulty in converting subjective experience into computable data is one key criticism of using social media datasets (Madsen et al. 2022). On the other hand, many scholars involved in digital humanities research advocate using data from social media networks for urban planning (Serrano et al. 2022). Lacking robust and widely accepted methodologies, many designers simply use their inquiries to test the validity of the methods. For example, Erica Fisher did spectacular work in classifying images of cities taken by locals or foreigners. The obtained granularity representing touristification is outstanding, and the spatial consequences that emerge from the sensed data could well serve to guide urban policies to protect the life of neighbourhoods. The work of such Pro-Ams –*'professional-amateurs'*– pushes research and design forward.

The ability to responsibly collect data and to insightfully integrate it into the design process highlights a significant shift towards a more proactive and critical approach to data (Fricker 2021). The curatorial role of the designer in assuring that the collected data is tightly tailored to the spirit and needs of the project is crucial to positively informing the design process.

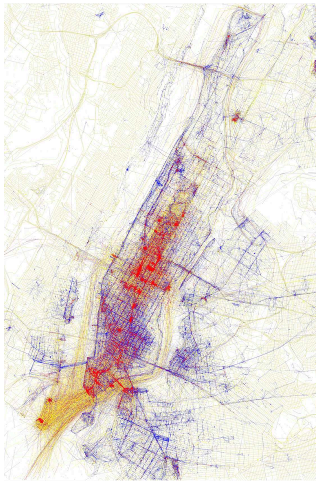


Figure 4.1: Map of New York with Flickr data. Erika Fischer. Creative Commons Share-Alike 2.0

4.3.1.2 Augmenting

The augmenting phase encompasses more than merely preparing data for the following design process. Once the datasets are collected, they are cleaned, reformatted, completed, enhanced and combined. Crossing them with other datasets enables augmentation of the level of information they cover. For instance, a tree cadastre can be completed by adding allergy reactions to each species from botanical bibliography, identifying areas in the city that may be harmful for the vulnerable population or other species. Visualising the spatial distribution of potentially allergenic species brings the initial information to a different level.

Taking datasets to a next level

Data filtering and preparation is always required, regardless of the specific processing method. The datasets can also be investigated through tools that foster the transformation of the acquired dataset into a more sophisticated one, eventually unveiling information that was not previously evident. Carlo Ratti has extensively researched this procedure in *"Senseable cities"* (Ratti & Picon 2013) where digital technologies are used to enhance existing datasets. For example, raw data about the position of mobile phones in cities may be crossed with environmental or social data, which would reveal patterns about exposure to extreme climate conditions or mobility of social groups.

Augmenting techniques

Multiple techniques exist to combine and work with existing GIS datasets, such as overlaying datasets, proximity analysis, or spatial join operations. The data augmentation process may reveal new insights or relationships relevant to the project theme, such as previously unknown ecological corridors. It is important to assess how the design development process is informed or even altered by the augmentation of one or more datasets.

Augmenting non-human perspectives

At this stage, looking outside the box is key to unleashing possible future connections. Transdisciplinary collaboration becomes the trigger that enriches this process: interpreting causality and explaining the laws of cause and effect (MVRDV 1999). By infecting the designers' preparation methods with those of other disciplines, it is possible to avoid always using the same process, which tends to produce a similar approach. Critical thinking is crucial here, avoiding exclusively human-centred perspectives and considering non-human actors' agency in the urban realm. This perspective shift fosters novel visions and approaches, and the augmenting phase is suitable for incorporating them. Discussing the datasets with other disciplines may help to reveal patterns, behaviours and trends of non-human beings that were not evident. For example, aerial imagery can be treated through colour filters to highlight specific features that botanists and geographers interpret as the health of plants, or the imperviousness degree.

Considering the current data overload, designers must take an active role when preparing datasets to avoid simplistic, direct representation of data. Instead, they must move towards a fully functioning form of augmentation tools, which substantially inform and shape design processes (Wallis & Rahmnann 2016). This requires developing certain degrees of data literacy and critical understanding of data processing, contributing to an ethical and responsible data treatment.

4.3.1.3 Analysing

The first two competences belong to the expanding movement of the first diamond of the British Design Council –Figure 2.1.–, a phase in design when options are explored, to achieve a broader understanding of the situation in question. The analysis competence is also deployed during this explorative phase, but belongs to the convergent stage of design where ideas are refined, aiming for a conclusion.

Analysis techniques

Once digital datasets are prepared and augmented, they are inquired to understand the information's hierarchy better. One of the first techniques still used today comes from McHarg's idea of layering. A simple superposition of datasets can start revealing hidden information. The practice of designers cannot only rely on what is considered old ways of overlay mapping (Batty 2013), but is clearly a first step to be learned by designers without further experience. Statistical and mathematical techniques can be used to identify correlations, trends, patterns or clues hidden in raw data. Spatial correlations are particularly complex but, even in today's global world, Tobler's (1970) first law of geography is still generally accepted: *"everything is related to everything else, but near things are more related than distant things".* In such a setting, graphical representation of data serves as a tool for reflection beyond mere visual output. The goals can be various, from understanding site potentials revealed through the study, to informing possible futures. Where several design iterations are planned, it is also possible to introduce a design scenario as initial data, evaluating the proposal's appropriateness.

Critical thinking with maps

The exercises covered in the next chapter must be investigated by looking at the type of analysis carried out and how this relates to the dataset quality. What techniques were used to analyse the GIS datasets? The data analysis process may have uncovered new insights or relationships relevant to the project theme, altering and/or informing its development. Letting excessive data guide spatial inquiries is dangerous: the power of information and communication technologies has led to a form of data hegemony where it is more important than ever to carefully design the questions being investigated, as well as the research method. This helps to avoid the risk of anecdote, disinformation and loss of focus (Buhigas & Solá-Morales 2022).

It has become common practice to incorporate machine learning processes into this step. Here, computational methods are used to go through the collected samples and let the model learn from them, often analysing hundreds of thousands of samples in minutes. As demonstrated by the 1890's US Census, analysis at this scale would take far longer using human supervision. Moreover, whereas Hollerith's machine was an exclusive product, the access to these new digital tools has been progressively democratised. The arrival of free Large Language Models such as ChatGPT or Deepseek has allowed many inexperienced professionals to start using programming language to perform specific tasks. This has the capacity to shape new forms of practice, where each designer does not have to rely on existing tools, but will be able to easily develop their own ones. What are then the competences that designers require to face this new horizon?

Imagining new tools

The ever-evolving forms of datasets give rise to novel data analysis techniques and methods that require continuous adaption. Data scientists advocate for a holistic approach, which integrates data from different sources, evaluates its limitations, and leverages technology that generates innovation. Using open-source software such as QGIS or Grasshopper allows collective contribution (Fricker et al. 2020) and alternative methodologies that foster creativity and innovation.

4.3.1.4 Synthetising

The synthesis competence is crucial for designers. Beyond a mere superposition of data layers, it requires a critical interpretation of complex –and often contradictory– forces between various urban systems and actors. It represents a pivotal moment of design, where the insights gathered from data sensing, augmentation and analysis converge towards a holistic understanding of the site, its contextual condition, its causes and consequences. In the double diamond of British Design Council –Figure 2.1–, it corresponds to the last part of the first diamond, where the problem is finally identified. Meaningful insights are portrayed in easy-to-digest graphical representations, which are not the end product but a robust communication tool, unleashing further conversations about the next steps.

In this phase, synthesis competences facilitate the identification of crucial design parameters, constraints and boundary conditions that will shape the following critical design strategy. For example, synthesising datasets about biodiversity, soil degradation and environmental protection of a series of meanders, could reveal not only the areas where actions are unavoidable, but also the characteristics of the interventions. A solid mastery of digital GIS tools and techniques can further enhance this synthesising process into problem definition. Correct interpretation of patterns, relationships, and behaviours that may not be evident in independent datasets is key at this stage. Furthermore, this step serves as a crucial bridge between analysis and a critical design proposal.

Computational Design Thinking

The relevance of computational design thinking in landscape architecture –as well as its pedagogical implementation– has been discussed in depth by Pia Fricker (2021). Design thinking is an approach that begins by deploying empathy to understand better the –natural, human, built– context, and then defines the problem and sets the objectives. Next, a series of creative solutions are ideated, prototyped, tested, and iterated until a satisfactory implementation is chosen. This thesis explores the opportunities originated using digital mapping as a powerful tool for the first two phases, where the problem is identified. Further use of technologies described by Fricker, such as computational design –with tools such as Grasshopper– or augmented reality and virtual reality, are compatible with digital mapping. However, they are out of the scope of this research.

The profound understanding of the context and its conditions allows the formulation of situated knowledge (Haraway 1988) and the exploration of speculative scenarios deeply rooted in a specific location. These can be more operative than generic speculations that are not site-dependent, such as Sebastian Marot's four scenarios described in subsection 2.4.5. While powerful in their formulation, these lack imbrication in a territory. No specific city is named, not even a continent or a constructive culture, so they could be considered proposals without a place—*a-topos*.

These four steps to produce sense and knowledge are valuable, but not enough on their own. A quantitative analysis of reality requires pairing it with other forms of study, *"a more subjective study"*, as Ronald van Tienhoven (MVRDV 1999) calls it, which can generate *"signals"* to help interpret the numbers. In the process of the students' exercises, it is key to enquire if the data synthesis led to the identification of critical design parameters or constraints that unleashed design proposals. A holistic understanding of the site and its urban nature context may follow the students' synthesis of the various data layers. The relationship between the synthesised data and the overall design strategy will be investigated.

4.3.1.5 GIS proficiency as design thinking tool

The use of GIS data is extended in spatial planning. It is used less in landscape architecture (Fricker 2021), even less in architecture, and almost ignored in architectural education.

Nevertheless, its pertinence is well documented (Monsur & Islam 2014, Santos et al. 2021). Merging the first two competences described by Schulze et al. (2013), it is key to understanding how the use of GIS enhances design thinking. It provides designers with spatial insights that inform their path towards a specific project. As discussed in chapter 3, GIS is particularly valuable for fostering innovative design. Mapping complex spatial relationships can fuel creativity and experimentation (Freitas et al. 2021). The lack of more established GIS learning at design universities is attributed to insufficient digital infrastructure and the need for interdisciplinary teaching (Schulze et al. 2013). Moreover, the limited emphasis in design curricula and a steep learning curve for many of these technologies often deter students from deepening this form of knowledge (Blišťan et al. 2015).

It is key to understand this proficiency not as a technical goal per se but as an enabler of design thinking (Terzidis 2006). The learned digital tools and methods are in service of forms of reflection and not as a mechanistic form of automizing parts of the design process. In cases where traditional problem-solving methods are not sufficient to work with complex and uncertain situations, design thinking thrives. GIS can complement this by providing spatial data and insights to explore alternative pathways (Liedtka 2018).

This mastery should avoid a certain form of inevitable determinism, which was a recurrent criticism of the work of Ian McHarg as an initiator of GIS technology. Rather than using GIS to, step by step, reduce the number of possibilities for a project, designers can use it to start up novel paths. Mansilla y Tuñón (2003) use the metaphor of funnels and showers to describe these processes. Instead of using boundary conditions as a kind of funnel to limit possible design proposals, they use boundary conditions to combine possibilities creatively, opening a new path after each combination, like water spreading in different directions from a shower head.

Data literacy and competences for spatial data analysis are key for collaboration across disciplines. Understanding, incorporating and questioning the work carried out by colleagues or cooperation partners, such as engineering consultants –'*bureaux d'études*', '*Fachpläner*'– allows the designer to react to those inputs critically. Projects incorporating urban nature are never an isolated piece of work, and co-design processes benefit significantly when participants from different fields bring their expertise together. This is only possible when all stakeholders have a solid grasp of data interpretation. Moreover, it strengthens the iterative cycles of testing that are key to design thinking.

Since GIS is a technology in constant evolution, it requires practitioners to engage in continuous self-learning –this idea will be developed in detail in the following competence. This means that no specific level must be reached, but rather an involvement with a series of technologies that foster critical and design thinking. Every designer, regardless of their proficiency stage, can use GIS as an explorative tool.

Different GIS skills and knowledge are essential for effective data analysis and design. But how do students ensure proficiency in using key GIS software and tools? And how do they stay abreast of the latest advancements in GIS technology and methodologies, as they evolve rapidly? General GIS principles are used to enhance the overall design process, and proficiency in GIS enables improved quality and accuracy of data analysis. In what ways does general GIS knowledge facilitate the synthesis of data into actionable design insights? It is interesting to inquire into the resources –tutorials, workshops, online courses– that are most effective in developing and maintaining GIS proficiency.

4.3.1.6 Integration in the design workflow

The distinction between analysis and projection vanishes in contemporary design. In social innovation, to analyse is to imagine alternatives, and to project is to generate knowledge. These two aspects are not separate but coexist throughout the entire design process (Manzini 2015). This vision illustrates how several scholars (Paez 2020, Viganò 2012, Dunne & Raby 2013) consider that the border between analysis and projection is, at least, blurred. Moreover, design thinking does not follow a linear process of analysis first, then projection (Schön 1983). Making a design proposal rather involves a reflective engagement with the situation, inputs, constraints, and involved stakeholder's aspirations.... During this process, the designer is analysing and projecting simultaneously.

In this sense, the previously described competences do not necessarily correspond to distinct steps to follow in such order, but rather a series of skills to be combined and assembled in the process. This fluid, non-linear approach, combining methods and techniques that even clash with one another, encourages designers to explore alternative futures (Dunne & Raby 2013). This iterative approach fosters creativity, helping the designers to look at the design subject from unexpected perspectives.

Thus, ensuring that GIS methodologies are seamlessly integrated into the overall design process goes beyond starting with site analysis or informing decision-making, and aims to allow for iterative feedback loops between data analysis and design development. Enabling mechanisms for symbiotic integration of data interpretation in the design process requires leaving some traditional design paths and assuming that not all iterations are equally successful. On the other hand, continuous testing and refinement of the ideas that emerge from data interpretation lead to a more robust design solution, avoiding the pitfalls of linear thinking. This approach also contributes to the responsiveness of the proposed scenarios to evolving situations and insights. Nevertheless, there are challenges to face. These include technical barriers regarding the need for specialised expertise and, in the case of the students, the lack of solid and established design skills. The latter may require additional maturity and control to hierarchise the datasets and extracted insights.

When examining the exercises, it is key to examine how GIS is incorporated throughout the design process, as well as to identify the strategies employed to ensure that GIS effectively generates novel insights. The role of iterative feedback loops between data and analysis and design development is investigated to understand how these loops influence the evolution of the design process, particularly in comparison to traditional methods. How was the workflow altered, particularly the aspects that guide towards a critical or speculative design? Did the use of GIS present any limitations or challenges in that process?

4.3.1.7 Capacity to create human-nature-technology alliances

Measuring the urban biosphere is not a neutral activity (Fricker et al. 2023). The techniques we use to understand it present particular processes for translating and transforming information. The scenarios that emerge from these techniques and their representations are a collection of measurement codes, technological conventions and mathematical formulation. Thus, these speculative scenarios depend on the technologies used to create them. Designers were long dependent on software –BIM, CAD, 3D– developed by private firms, and were not keen on programming their own methods. This trend has changed in recent decades through the introduction of open-source software such as Grasshopper or QGIS, which even incorporate graphic consoles for block-programming, making code-writing accessible for people without previous experience. This graphic interface leads to accurate and manageable result representation. Furthermore, the expanded use of Large Language Models makes possible to program in different languages such as Python without really having programming knowledge (Österlund 2024).

A quick look at the current applied use of AI for planning purposes reveals that a significant quantity is oriented towards commercial property (ibid.), such as apps to optimise land use for maximal profit. However, the combination of both technologies, LLM and open-source software, could represent a new asset for the designer in the form of man-machine alliances that foster creativity. It is not necessary to rely on pre-configured tools. Each individual can develop those that correspond to the new methods they desire. These tailor-made tools can contribute to formulating new forms of urban naturecultures, as will be demonstrated in chapter 5. Conversely, novel understandings of the hybrid of nature and city cause unseen techniques to emerge. Most importantly, these new tools belong to a form of collective intelligence that is not as dependent on pre-configured software. Fricker and Kotnik (2023, 2024) acknowledge the current availability of AI-related tools but emphasise the relevance of designers to *"embrace technological innovation and push the field towards being an active agent, not merely applying existing tools"*. This approach speaks for the re-professionalisation of spatial media, where free and open source software plays a key role (Crompton,2009).

After the initial enchantment and fascination with the speed and apparent appeal of the results of generative AI, it is now clear that *"to receive a high-quality answer, you must first ask a high-quality question"* (Österlund 2024). Fostering collaborations between human, natural, and technological systems to create synergistic urban environments that promote sustainability and resilience speaks for the goals of Ecocene. These alliances make design proposals possible that would not be imagined using conventional methods (Bohnacker et al.2012). As Haraway does in her *"Cyborg manifesto"*, the possibilities of blurring the line between humans and machines are celebrated and appreciated.

Ultimately, this competence does not refer to each of the three key notions of this thesis, but to their interplay: how did the students manage to merge them? The design exercises sought to identify and leverage human-nature-technology. How were they used? Did they automate routine tasks or were they key to triggering new design ideas? It is important to ascertain how technological innovations may be integrated to support human well-being within ecological balance. What strategies are used to promote synergy between these systems? Chapter 5 explores how design proposals enhance sustainability, resilience and redundancy –values of the Ecocene– through these alliances.

4.3.2 Imaginary

For Corner (2006), the mobilised competences to achieve new forms of fields, operation and process make sense only if they are in service of reinventing a world of possibilities for the urban and the natural. He asserts the total impoverishment of imagination behind the failure of twentieth century planning. Can nature in cities be something else than the place for a blurred concept of '*recreation*'? Is it possible to imagine novel forms of representing nature in cities that unleash fresh visions of nature? Three competences are identified here to contribute to this task: speculative potential, enunciation of naturecultures, and representational skills.

4.3.2.1 Speculative Potential

GIS can not only be used for deterministic analysis, but also to envision and create speculative scenarios that challenge existing urban nature paradigms and propose innovative insights. Commonly used for quantitative surveys of existing conditions, designers can utilise mapping as a tool for critique, speculation and invention: mapping unfolds potential (Corner 2011, Paez 2020).

Spatial datasets include information about the biosphere, the built environment, and granular aspects of society and population. GIS offers the possibility to cross them and investigate their topological relationships. For example, understanding the interrelations of ecological restoration, population growth and urban green infrastructure. Hybridising these realities through digital critical mapping allows the articulation of complex proposals studied through the prism of the primary competence of a designer: space. Being able to comprehend better the forces that shape the co-evolution of urbanisation, social dynamics, and natural processes allows the designer to formulate possible futures: GIS offers the capability to merge datasets across environmental, infrastructural, and demographic domains, providing a platform to speculate on the hybrid futures of cities where human and non-human systems combine.

The idea of *"undisciplined cartography"* (Crampton & Krygier 2005) advocates for freeing mapping practice from academic and elite control, opening it to the people. Such a shift makes mapping practices accessible through GIS technology, and is the perfect catalyst to bring a broader range of voices and perspectives to the surface, with the imagination of new worlds and possibilities. New visions for new naturecultures can emerge unexpectedly, as the results from an opaque process may force the designer to confront their own assumptions (Mattern 2017). This approach invites designers who use mapping to critically engage with the technical processes and the representations they generate. At the junction of both lies a fertile land for speculative mapping. Moreover, the specific form of reflection by the designer is particularly useful to produce speculative scenarios: *"Essentially, we can say that designerly ways of knowing rest on the manipulation of non-verbal codes in the material culture; these codes translate 'messages' either way between concrete objects and abstract requirements; they facilitate the constructive, solution-focused thinking of the designer [...]; they are probably the most effective means of tackling the characteristically ill-defined problems of planning, designing and inventing new things."* (Cross 2006).

The students' exercises are investigated to discover how they challenge the status quo by creating speculative scenarios that emerge from GIS data. The speculative scenarios can be formulated in different ways and not necessarily drawn in detail – they can take the form of a text or discussion during the courses. How do these speculative scenarios address current urban challenges and anticipate future needs? Innovative solutions not only emerge from GIS but may also be evaluated with the same technology. Inquiring into the design flow generating forward-thinking urban nature designs may reveal using fresh speculative methodologies.

4.3.2.2 Naturecultures

As discussed in chapter 1, it would be almost naive to intervene in the public space without acknowledging that the result is a natureculture. Nevertheless, nature often appears as somewhat of an afterthought, in predictable forms of lawn, planters and missed opportunities to truly incorporate ecological processes into the design of a city (Spirn 1984). James Corner encourages landscape designers to speculatively broaden the world of possibilities: imagining urban nature requires a boost to encompass the design precepts of the Ecocene. GIS technology promotes an inclusive perspective where society, nature and built spaces form a complex assemblage: GIS enables the integration of human and ecological data, allowing for the design of hybrid urban spaces where human and non-human life can thrive together, breaking down the binary between the built environment and nature (Pickles 1995). This integration of human and non-human is key, and digital tools may contribute to understanding, for example, how an ecological corridor may restore an ecosystem while promoting social and interspecies encounters.

The capacity of better integrating the biosphere –*"le vivant"*– into speculative scenarios is also enhanced using datasets that embody non-human agency. This way, it is easier to avoid the anthropocentric perspective of traditional urban planning and imagine cities as interspecies shared spaces. Projects become a platform for recognising non-human agency, for example, by using colour classification of aerial pictures, where the health of vegetation through time can be studied. A form of inclusive urbanism should also consider the well-being of all non-human entities. GIS can be a valuable tool to reveal how marginalised human populations and non-human environments are negatively affected by urbanisation. These forms of environmental injustice are becoming a key aspect of contemporary planning, encompassing the design values of the Ecocene.

When working with naturecultures, if the task of the designer –regardless of the scale– is to imagine spaces, then these would be spaces of cohabitation and hybridization: the facilities where interspecies encounters and exchanges can be possible. Design, traditionally anthropocentric, must reimagine how to create spatial prototypes that not only promote biodiversity, but also enable sustainable forms of cohabitation. Combining datasets from human and non-human behavioural patterns empowers designers with detailed and thorough knowledge to accomplish this task.

It is also key to consider the environment the biosphere inhabits: the atmosphere, water and climatic aspects –such as temperature or pressure – shape the forms of urban natural life. Water quality, heat island effects or air pollution are easily parametrisable factors captured by urban sensors and added to the palette of the designers' datasets. These spatial datasets often come with long historic values, describing their evolution through seasons and years. With this, it is possible to imagine proposals that enhance the environments in which the suggested naturecultures will evolve. This will not only promote biodiversity and ecosystem services but will also have a substantial impact on human health. However, the risk of objectivising nature through its datafication is considerable. Designers must find new forms of incorporating non-human subjectivities, not only non-human data, in their proposals.

4.3.2.3 Capacity of representation and communication

While graphic representation is often viewed as a basic or a technical competence, it is considered here as a tool for the imagination; that is, it is closer to propositional character than sheer information rendering. For the visual artist Ronald van Tienhoven, *"the result [of data representation] is more than a graphic interface; it is also a social interface" (*MVRDV 1999). In order to imagine new hybrid forms of nature, society and infrastructure, novel forms of representing and communicating them are valuable tools to shape this new construct. This competence implies effectively conveying complex GIS data, analysis, and design proposals to diverse audiences, including other disciplines and professionals, stakeholders and the public. It acknowledges the power of storytelling and the role of representation in shaping a particular understanding of the world.

Ian McHarg's superposition of transparent layers inspired GIS and remains a powerful capacity within it. Multilayered visualisation enables designers to speculate on the dynamic relationships between social, environmental, and infrastructural systems (Kitchin et al. 2014). When introducing the dimension of time, these layers may even express more than their spatial relationships. This will be discussed in depth in section 4.3.3.1.

Corner pleads for the agency of mapping beyond passive representation. Mapping can become performative cartographies; real and active agents in the design process. Then, GIS becomes a formidable tool that illustrates conditions and enacts change and transformation: *"Performative cartographies challenge us to see maps as enactments, opening new speculative possibilities for urban design"* (Wood et al 2008). Representations of cities can shape our understanding of urban spaces, and even influence our experiences of them (Picon 2015). This applies in particular to digital representations of cities.

Speculative scenarios can be complicated to formulate beyond textual narrative. Breaking them up into a series of simple graphic documents can help us better understand and explain them. GIS can achieve remarkable clarity by incorporating high complexity. The simple readability of the produced cartographies allows fluent transdisciplinary discussion and fosters communication beyond urban science professionals: anyone can potentially understand a well-designed mapping (Goodchild 2007).

The possibilities of moving from classic top-down cartographic practices towards participative processes incorporating citizen participation are fascinating. It is covered in the outlook chapter but is out of the scope of this analysis and methodology. Similar practices, such as critical cartographies and counter-mapping, are nevertheless considered and inquired into. They capture the voices of marginalised minorities often overlooked in traditional urban planning. Introducing their narratives allows the production of mappings that challenge existing power structures while proposing more equitable futures (Crampton & Krygier 2010). The path to developing such documents is not fixed, and the open and integrative character of GIS enables tools and methods that can be useful for the production of counter-mappings.

The exercises will be then examined to understand how complex GIS analyses and designs are communicated, even to non-expert audiences. What tools and techniques are used to visualise and present GIS data and findings? The methods and techniques mobilised to ensure clear, concise, and impactful communication are crucial.

4.3.3 Process over time

James Corner considers that the contemporary landscape architect should work on formulating new *"possibilities"* –echoing speculative scenarios– emerging from process, rather than from form. This does not imply a rejection of spatiality, and the specific form that a proposal adopts, but instead considers the evolution of those forms over time. Considering nature as a key element of urban design implies that evolution through time has to be considered: urbanism made not only with inert materials, but also with a myriad of living species. This dimension encompasses the idea of the term *"Terra Fluxus"* –an earth in flow, a dynamic and evolving urbanism– for which the idea of ecology is an operative perspective. Trying to understand the dynamic interactions of ecosystems, it is helpful to imagine the built realm as one system, dynamically interacting with all others. These two ideas, time and systemic, are explored as two further competences for designers in the Ecocene.

4.3.3.1 Unfolding temporal dimensions

The spatial fragmentation of contemporary cityscapes finds a reflection in its temporal fragmentation. Like in electronic games, the notion of *'event'* is key (Picon 1998). Just like in a video game, a constant emergence of events without any transition occurs in the urban space. *'Microevents'* such as the pollination of a flower, the overflowing of a trash can, a viral contamination or autumn harvest of urban gardening take place as autonomous sequences. Moreover, urban sensors or databases often capture them as single actions in a time and space. How to make sense of all this given such a fragmented perception of time? How to incorporate a temporal dimension to digital mapping? How to incorporate other experiences of time, which are more continuous and fluid?

While traditional maps represent static snapshots of space, novel forms of mapping fully enable the incorporation of temporal dynamics. From the digitalisation and georeferencing of historic cartographies, to modelling behaviour for future proposals. The continuous feed of real-time information dynamically captures the present. Time becomes a key element in the speculative re-imagining of the co-evolution of nature and cities.

Similar to spatial superposition, GIS also fosters inquiries with multilayered temporalities. It allows visualisation and interpretation of several temporal lines. The idea of speculation is tightly embedded in practices working with the future, making GIS tools powerful assets in formulating scenarios. Such scenarios can be future or past. They allow designers to speculate on alternative pasts and their plausible evolution. This can help with critical understanding of our present, challenging conventional thinking: how current decisions might shape future outcomes. This overlapping of past, present and future becomes a sophisticated tool for understanding how these temporalities intersect. The rewriting of critical urban histories fosters creativity while anchoring these visions in past and present insights.

The processes that induce change in society, ecosystems, and urbanisation operate on various rhythms, which can be captured with mapping technology, such as day/night, yearly seasons, or climate evolution. The cycles of growth, reorganisation, collapse and renewal of ecosystems and urbanisation can be considered for formulating scenarios that incorporate the friction between their different tempos. Manuel Castells (2002) calls this *"heterocronia"*. How to capture such distinct rhythms? The accelerationist impulse of urbanisation radically contrasts with the slow changes of ecosystems. The opportunity to visualise processes –such as tree growth, soil recovery or decline of biodiversity– that happen very gradually, allows the designer to imagine naturecultures that are not static, but rather evolve with parallel, simultaneous, syncopated rhythms.

In the students' exercises, how they manage to incorporate these temporal dimensions will be examined, including which GIS tools allow them to perform dynamic studies of different phenomena. Nowadays, real-time information has become pervasive, being the keystone of smart cities. Its influence in city management is undeniable, with dynamic signs on streets –depending on the real-time use of the transport infrastructure– allowing more fluid traffic, for example. Despite the remarkable responsiveness that can be gained, this aspect will not be considered in the following chapter, since the lack of real-time information and technical resources available to manage them meant that no student could follow this path of inquiry.

4.3.3.2 Systemic approach

Corner states that *"cities and infrastructures are just as 'ecological' as forests and rivers".* This vision aims for a holistic approach to landscape urbanism, acknowledging the interconnectedness of several simultaneous systems: ecological, social, economic, cultural... The understanding of the urban realm as an environmental network, to Duvigneaud's vision, encourages the designer to inquire into how these systems interact with and influence each other. Instead of planning an isolated green space, GIS enables visualisation of these interconnections and incorporates them into the scenario. The result can promote resilience and adaptability, as designs are not considered as a finished, isolated piece of architecture or urban planning. However, they can incorporate how they can react to stress, absorb disturbances, and reorganise themselves to overcome impacts such as drought or high pollution. Understanding thresholds within systems (Walker & Salt 2006) is key for resilience, and digital mapping can help designers propose schemes that take this into account, contributing to ecological justice.

The various urban systems are studied in depth by different disciplines –sociology, anthropology and economic sciences, as well as forest engineers, urban ecologists, biologists or climatologists. GIS has become the platform for cross-disciplinary collaboration, where datasets and visions of these diverse fields can be compared, overlaid and interpreted. The capacity to display high degrees of complexity in manageable mappings encourages designers to incorporate visions, inputs and reflections from other relevant disciplines. While the students could not access multidisciplinary teams, their capacity to utilise GIS to understand urban metabolism is studied and evaluated in chapter 5.

4.3.4 Field

In *"Terra Fluxus"*, the theme of field is described by James Corner as the ground plane; a series of surfaces considered across different scales, from paths to the complex web of the contemporary megalopolis. It spans across countryside territories, urban anthropised soils, facades, roofs and waterbodies. All of them are susceptible to hosting novel forms of naturecultures. These surfaces are not understood as a finished and closed architectural or urban project, but rather as a platform: an infrastructure for future possibility, operating simultaneously at several scales. Emerging from this understanding of field, the two competences described below are multiscalarity and infrastructurality.

4.3.4.1 Multiscalarity

Mies van der Rohe understood the practice of the architect through scales, from the door handle to the city –*"del tirador a la ciudad"*, a non-officially confirmed quote of the German Architect. This vision makes even more sense when talking about nature in cities, where every life form has an impact on the overall ecosystem. It is said to designers to act local, and think global: actions and decisions at one scale –from microbiological to regional or global– have impact across scales. Acknowledging this fact motivates the search for tools and methods that can operate simultaneously at different scales. GIS contributes to this task by allowing the combination of datasets of various sizes, quality, and granularity. The challenge of making the data from different scales compatible can be considerable. Nevertheless, the opportunities to integrate information originated through social sensing –see 4.3.1.1.– such as iNaturalist offer fine-grained information that emerges outside official sources. For example, using bird observations from this platform, it is easier to understand seasonal migrations and their spatiality: from the paths followed to the bird density every year in a particular part of a city.

Design thinking, critical thinking, and systems thinking profit from working in a multiscalar arrangement. The proposals gain in depth, holistic approach and systemic understanding. Spatial complexity and contextual sensitivity are key to understanding the multifaceted condition of Corner's idea of *"field"*. Visualising the multilayer nature of urban ecosystems with digital mappings accounts for unique conditions and dynamics for each scale. In the students' exercises, the multiscalar aspect of their mappings is relevant, particularly between small and localised ecological occurrences and urban biotopes.

4.3.4.2 Infrastructurality

This competence involves rethinking projects with urban nature as a dynamic infrastructure: a foundation for ecological, social, and cultural life that evolves, adapts, and generates new opportunities. It is crucial for urban resilience and adaptability, hosting, and managing the unexpected. A certain sense of incompleteness may foster creativity and lateral thinking. Such understanding is helpful for imagining speculative scenarios, which could evolve differently from the initial, infrastructural starting point.

In a hybrid natureculture, nature and the built environment may serve as infrastructure for one another. Symbiotic systems can be imagined, where each supports the other's prosperity: urban nature sustains social and ecological processes, and the built environment simultaneously creates spaces for nature to unfold (Gandy 2014). In this sense, roofs may become the infrastructure for the nature growing on them, providing temperature regulation or humidity.

The mapping exercise may turn into an infrastructure in itself. *As "Terra Fluxus"* describes it, *"Mapping is a fantastic cultural project, creating and building the world as much as measuring and describing it"*. Digital cartographies, when created with this in mind, can become a platform of possibilities; an infrastructure for speculative ideas. They may provide the discussion environment where further futures can be imagined, for example through the means of participation and co-creation.

4.3.5 Weighting and grading

Different competences may be deployed at various levels. The following table captures three levels of utilisation and proficiency for each competence. They are valued 1, 2 and 3, from lower to highest. Value zero would mean no use of the competence. These values are used in radar diagrams –fig. 4.2– evaluating each exercise throughout chapter 5. The grading was adapted to best capture the different studied approaches and corresponds with the highest and the lowest capacities of students who have pursued the courses. These competences are not independent but interconnected. The connections between them will also be inquired in the analysis of the exercises and represented in a chord diagram –fig. 4.3.

Operation	Sensing	**1** Identification of basic data sources, lacking diversity in data sources and formats
		2 Acquisition of multiple datasets from several sources. Limited evaluation of data quality and its pertinence
		3 Comprehensive collection of diverse and information-rich datasets. Critical evaluation of data selection, quality, granularity and relevance
	Augmenting	**1** Basic preparation of datasets. Little augmentation or combination. Data remains largely unchanged
		2 Moderate augmentation of datasets. Use of some GIS techniques to gain new insights
		3 Significant augmentation through advanced GIS tools or creative cross-dataset analysis
	Analysing	**1** Superficial analysis through basic GIS techniques. Difficulty to fully inform the design process with the analysis
		2 Moderate use of GIS tools to conduct analysis that reveals certain relationships, patterns or relationships that were not visible
		3 Advanced analysis through sophisticated GIS techniques. Profound understanding gained about spatial relationships, trends and patterns.
	Synthesising	**1** Simple superposition of datasets. Limited connection between the design parameters and the synthesis
		2 Certain critical synthesis of data. Identification of constraints and boundary conditions that inform design
		3 Profound synthesis that integrates datasets into a holistic approach. Key constraints are revealed and foster innovation in design
	GIS proficiency	**1** Basic GIS knowledge: map creation, simple spatial data analysis, identification of relationships and interdependencies. Supports early-stage exploration
		2 Intermediate skills with complex data analysis, iterative testing and scenario exploration
		3 Advanced proficiency fostering creative experimentation, innovative approaches, and critical engagement in complex challenges
	Integrat. In workflow	**1** Analysis and proposal aligned, emergent from simple spatial data analysis and layering
		2 GIS integration fostering feedback loops between data analysis and design, promoting design processes beyond traditional linear approaches
		3 Iterative testing with speculative exploration. GIS enriches design proposal, only possible thanks to the workflow
	H-N-T Alliances	**1** Use of open-source tools with possibility to customise methods for creative exploration
		2 Synergistic alliances surpassing conventional methods by alteration and customisation of tools and standard approaches
		3 Tailor-made tools in collaboration with AI transforming design routines into idea-generating systems with strong links with urban nature

Table 4.1: competences to evaluate the student's exercises.

Imaginary	Speculative pot.	**1** GIS use transcending deterministic analysis and enabling simple speculative scenarios
		2 Mapping on the service of articulated speculative proposals exploring dynamic relationships between urban and natural realms
		3 Critical reflection prompt from speculative scenarios, anticipating future impacts and challenges
	Naturecultures	**1** Merging of human and biosphere data, fostering explorative site analysis and integrated proposal
		2 Mapping non-human agency, addressing environmental conditions for sustainable cohabitation
		3 Complete integration of urban and natural datasets, generating speculative naturecultures promoting cohabitation and non-human agency
	Representation	**1** Simple but effective forms of representation bridging data, nature and urban space
		2 Multilayered visualisations revealing spatial and environmental relationships, fostering fresh visions with transformative power
		3 Critical mappings unfolding complex GIS outputs, presenting them with clarity, enabling discussion and co-creation
Process over time	Temporal	**1** Punctual representations, missing opportunities to explore or communicate further temporal dimensions in urban or natural processes
		2 Basic use of temporal mapping, acknowledging dynamic patterns and cadences
		3 Effective integration of multilayered temporalities, fostering speculative interplay of nature and urban rhythms
	Systemic	**1** Focus on isolated elements and occurrences, with limited systemic understanding, and capturing limited relationships and interactions
		2 Acknowledgement of system organisational patterns and connections, addressing opportunities and challenges emerging from systems thinking
		3 Holistic integration of multiparametric and dynamic vectors of organisation, revealing non evident systemic behaviour and fostering speculation
Field	Mulitscalarity	**1** Basic references to different scales, with focus on one exclusively. Lack of discussion of impacts on other scales
		2 Incorporation of multiscalar perspectives, but with limited depth or effective integration of broad-scale data
		3 Full integration of diverse datasets across multiple scales, demonstrating contextual and systemic sensitivity about the impacts between scales
	Infrastructurality	**1** Limited comprehension of natural and built environments as platform for possible futures, showing systemic functionality rather static
		2 Exploration of the infrastructural character of the mapping and the proposal, allowing forms of transformation and adaptability
		3 Innovative understanding of mapping and naturecultures as dynamic infrastructures, fostering adaptation for possible futures in cohabitation

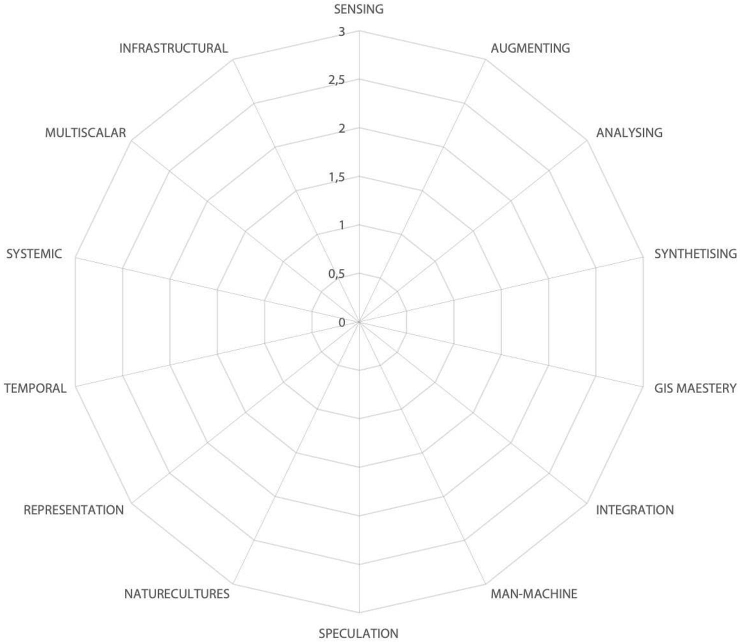


Figure 4.2: grading of competences. ARC

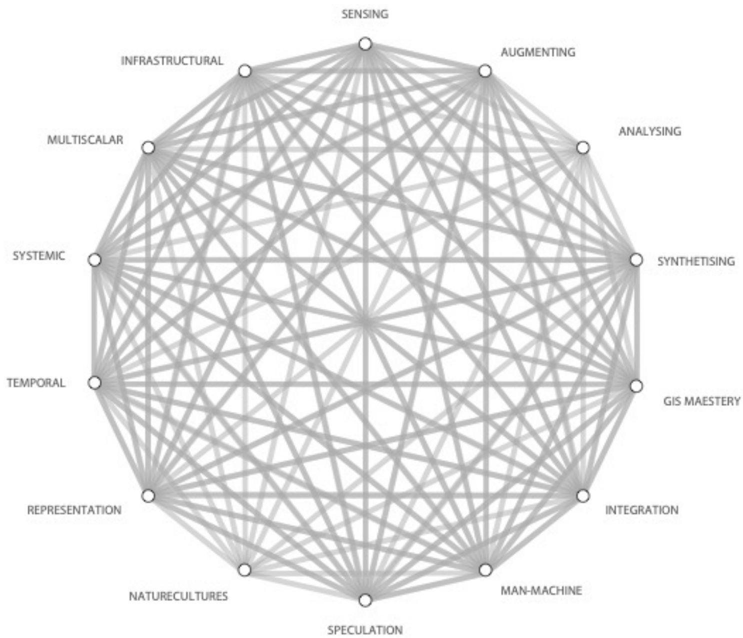


Figure 4.3: connections between competences. ARC

These values are used in radar diagrams (fig. 4.2) evaluating each exercise throughout chapter 5. The grading has been adapted to capture best the different studied approaches and corresponds with the highest and the lowest capacities of students that have pursued the courses. These competences are not independent but interconnected. The connections between them will also be enquired in the analysis of the exercises and represented in a chord diagram (fig. 4.3).

4.4 Setting up the *laboratory*

The *laboratory* described in **Part two** implies a certain *"mise en abyme"*: a series of university courses and their outcomes are analysed by the same person who created, organised, accompanied and evaluated the courses. However, it is key to point out that half of the courses were conceived before any work started on this thesis. Therefore, there was no opportunity to create bespoke briefs for the courses that would fit perfectly with the purpose of the thesis. On the other hand, the methodologies and pedagogies explicitly developed for all courses were comparatively experimental, intending to broaden the perspectives of the participants. This thesis serves as a second reflection. It inquires into the goals, means and outcomes of this pedagogical experience, with the added benefit of some distance and perspective. The advantages, positive results, and suggestions for further development are identified along with the students' mistakes, difficulties and challenges. This iterative review of the courses, approaches, and students' design processes takes the form of research for design and highlights aspects of the pedagogy of GIS for designers.

All students on the courses for the exercises analysed below were consistently encouraged to build the exact path they desired to explore the possibilities of GIS. The proportion of time dedicated to teaching the use of GIS was never higher than 20% of the total – less in the case of the studios. This corresponds to the basic knowledge of GIS required to start operating with the information. For the remainder of the time, each student learned further GIS-specific tools or processed the information with methods belonging to critical spatial thinking.

The *laboratory* consists of a series of courses, part of the Architecture Bachelor and Master program of the Faculty of Architecture at the Karlsruhe Institute of Technology. They take three different forms: *Entwurf*, Seminar and *Stegreif*. A design studio takes place across a whole semester and corresponds to 12 ECTS –1 ECTS corresponds to 30 hours of student work. The task is to analyse a specific urban situation, understand its particularities, and come up with a design proposal that contributes to a higher urban quality. A seminar also spans one semester and is weighted with 4 ECTS. The goal is to analyse a given urban situation and understand the forces that come into play. It is not necessary to produce a design proposal for it. The last format, *Stegreif* –*'impromptu'*– is a short exercise. Here, a brief spatial task is articulated, and the students come up with a proposal within roughly one month, with or without an intermediate critic. This is awarded 1 ECTS, and its goal is to stimulate the students' ability to come up with prompt contributions and sharp ideas in a much-reduced period of time. The courses' length, hourly investment, and the rhythm of the discussions with the teaching faculties are key to understanding the framework in which the students' processes are monitored.

4.4.1 GIS courses, keystone of the *laboratory*

Between winter semester 20/21 and summer semester 2024, three seminars, three design studios and one *'Stegreif'* took place in the Chair of Landscape Architecture at the Karlsruhe Institute of Technology. These worked extensively with nature, urban data analysis and spatial thinking. They embody the experiences where the use of GIS technologies to face architectural and urban design challenges with urban nature is inquired into.

Course Title	Course Type	ECTS	Timing	Number of Students	GIS Exp. Stud.
Data-Driven Urban Nature Lab 1. Karlsruhe	Seminar	4	Weekly 1,5 h/week 13 weeks	6 Bachelor 4 Master	0
Data-Driven Urban Nature Lab 2. Basel	Seminar	4	Weekly 1,5 h/week 13 Weeks	5 Master	0
Data-Driven Urban Nature Lab 3. Zürich	Seminar	4	Quarterly 3 h/quart. 7 quart.	4 Bachelor 11 Master	0
Upcycling Kriegsstraße Karlsruhe	Design Studio	12+2	Weekly 7 h/week 13 weeks	15 Master	2
Urban Gaia LRS 2050 Offenburg	Design Studio	12+2	Weekly 7 h/week 13 weeks	12 Master	2
Urban Hydrotopos Karlsruhe	Design Studio	12+2	Weekly 7 h/week 13 weeks	1 Bachelor 9 Master	0
Zirkel's ecological occurrences Karlsruhe	Stegreif	1	2 workshops 4 h/worksh. 2 weeks	13 Master	8

Table 4.4: Courses whose exercises will be examined in chapter 5.

The next pages describe the framework, goal and approach for each of the GIS courses. Despite an extended tight separation of scientific disciplines and design actions, the courses aimed to introduce the students to a form of design by science, where the focus lies on the generation of their own design paths and methods, informed by data. The courses are designed to equip students with the necessary skills and knowledge to critically question and design urban environments through focused computational data processing. They encourage the avoidance of sterile and superficial visions of nature, which are commonly described as greenwashing. That is, for example, adding some alibi-vegetation to a traditional design scheme to signal a presumed sustainability. Instead, the exercises encompass the visions of urban nature described in chapter 1, understanding the urban reality as complex ecosystems that require innovative visions to address the challenges of urbanisation, loss of biodiversity, climate change or social inequity, among others.

These main ideas and the course structure are consistent through all the formats: first, a theoretical framework looking at best practices. Then, a series of hands-on GIS training workshops, where essential tools and techniques for data analysis and visualisation are introduced. And finally, a situated exercise where students apply their gathered knowledge into a real-world case-study. This sequence fosters a deeper understanding of the relationships between nature, society and technology.

The specific goal and deliverables depend on the duration of the courses. Since there is only one GIS workshop in the case of the '*Stegreif*,' the goal is limited to producing a mapping document that emerges from the provided datasets. An indication of how this mapping could eventually trigger a design proposal is expected, but no design is requested. The whole process takes less than two weeks.

Seminars and design studios span thirteen weeks and include five GIS training workshops. The seminar deliverables comprise a series of cartographies that deepen a specific feature of urban ecosystems through spatial computational analysis. A speculative scenario is expected, although it may not be formulated as a complete spatial proposal. Conversely, the final goal of the design studios is a design scheme impacting several scales. GIS processing tools are deployed all semester long but are intensively used in the first third.

In this sense, every format highlights different aspects of the first steps of designers creating mappings to explore speculative scenarios with urban nature. Seminars deepen in tool use, inviting the students to imagine possible applications to their design tasks. Design Studios build up from very limited GIS tool knowledge, focusing primarily on how to really incorporate it in their design process. *'Stegreifs'* take advantage of their previous GIS experience to apply it in producing a quick design idea. Thus, each format stimulated diverse competences in multiple ways, although none of them really fulfilled a complete iteration through the British Design Council's double diamond. While the pedagogy and goal of each format may differ, they all share some overarching learning outcomes:

– Equip students with an operative knowledge of GIS principles, approaches and applications.

– Foster self-learning to deepen specific GIS features and envisioning their own methods.

– Critically understand the limits and bias of the self-developed methods.

– Develop graphic competences to communicate the complexity of urban ecosystems effectively.

– Foster critical thinking and contextual speculative scenario formulation.

– Investigate, appraise and develop clear strategies for formulating new naturecultures.

– Incorporate multiscalar and temporal understanding, aligned with an infrastructural and systemic strategy.

– In the case of design studios, integrate spatial data analysis in the design process.

4.4.2 Detailed description of the GIS courses

While the courses share similar global goals, approaches, and themes, each one has several characteristics. These are captured below with a short description of each course.

Data-Driven Urban Nature. Lab 1.0 Karlsruhe

Seminar.. 13 Weeks, 1.5 hours/week. 9 students, none with GIS experience

Due to the COVID Pandemic, the seminar had to take place online. This influenced the pedagogy, making it very step-by-step and fostering individual self-learning. The seminar aimed to dig into urban data and question its value and possibilities as a design tool when designing with nature. While the research areas were given, each student was asked to select a particular dataset and a specific GIS technique to critically analyse one aspect of urban nature in the area. For example, topographies of flooding, movement of people, air quality or urban biodiversity are inquired through Digital Elevation Model, DEM files, sport tracks, environmental measurements or geotagged plant observations and other relevant datasets. Explaining the steps of the adopted methodology and its biases is essential.

The course emphasised providing students with the opportunity to develop speculative urban approaches based on their own spatial analysis methods. It encouraged design paths that are investigative, explorative, theoretically informed, and dealt critically with issues and questions of contemporary relevance. It looked for a sustained and rigorous process of study in all aspects of the students' work. The exercises analysed from this course are: 5.2 *"Green capacity in an urban environment"*, 5.3 *"Pull off the big green"*, and 5.4 *"City perception"*.

Data-Driven Urban Nature Lab 2.0 Basel

Seminar. 13 Weeks, 1.5 hours/week. 5 students, none with GIS experience

The second lab about spatial data analysis and urban nature focuses on the relationships between urban nature and urban fabric. Key topics studied include urban forestry, endemic species and neophytes, as well as the influence of certain tree species in public health, and the health of soils for tree development. No specific study areas were mandated; instead, the students investigated the whole city as a complex organism. Through data acquisition, preparation, and analysis, they focused on one area or the other. Each student selected a particular number of datasets, and through the learned GIS techniques, they critically analysed one or several aspects of urban nature.

To gain a global overview of all students' work, one student summed up all the knowledge acquired in the seminar into a single map. He proposed an apparently simple overlay technique that required sophisticated representation skills and a committed synthesising effort. The result revealed interconnections that were not initially evident. The exercise analysed from this course is 5.1 *"Invasiven oder Einwanderer?"*

Data-Driven Urban Nature Lab 3.0 Zürich

Seminar. 13 weeks, 7 hours/week. 15 students, none with GIS experience.

How does urban diversity affect everyday city life? Which kinds of diversity are relevant for urban planning? How can they be studied? In this seminar, the GIS tools deployed are restricted to those contributing to understanding the diversity of different phenomena. Therefore, the workshops focused on the specific tools and steps to calculate the Shannon Index of a particular dataset. This index is commonly utilised to calculate biodiversity, but is not broadly used for capturing a picture of urban diversity. The seminar deepened knowledge in the use of a particular approach, while providing an overview of software and geographical methods.

In this case, a three step –with three outcome documents– process was defined. First, each student must produce a critical map of the city of Zürich, with a freely selected diversity theme. After its elaboration, they were asked to create a structured blueprint defining the diversity theme's strategic development. With that, they had to formulate a speculative scenario that could initiate a series of architectural and landscape actions impacting diversity throughout Zürich. The seminar looked for a rigorous articulation between a geospatial inquiry and formulating a speculative scenario with urban nature. The exercise analysed from this course is 5.5 *"Diversity of the commons"*.

Street resilient ecologies. Upcycling Kriegsstraße. Karlsruhe

Design Studio. 13 weeks, 7 hours/week. 15 students, none with GIS experience.

This studio focused on urban resilience. Karlsruhe had the opportunity to generate a new resilient green address with the new design of Kriegsstraße. This sustainable infrastructure offers a new way of experiencing streets and open spaces in the city. The studio looked for radical visions creating a successful integration of activities, climate protection, nature and mobility, with concepts that will develop over the next 50 years for a healthier, more sustainable, vibrant and climate-neutral city. The deliverables covered three scales, *'Leitbild'* of the whole city, masterplan of Kriegsstraße, and detailed development of a focus area. The most significant impact of GIS technologies was expected primarily in the first and second parts, where the strategy had to be planned, and pervasive urban data could be analysed to define aspects of the design. The Studio encouraged the students to use data analysis to formulate operative speculative scenarios that trigger, shape and push forward design actions.

Linked to the Studio, the students followed a *"Vertiefung"*: a focussed study where a particular aspect of the studio is investigated in depth. In this case, the thematic axis was urban trees. Students were asked to work together to generate a new dataset about urban trees in private plots, in an activity called *"treespotting"*. The goal is to complete the existing dataset *"Baumkataster"* –tree cadastre– provided by the City of Karlsruhe, which identified the trees in the public space but gave no information about the trees people plant in their courtyards, front gardens and other green areas. The study area is limited to the surroundings of Kriegsstraße, approximately 250 meters to the north and south, and divided into eight segments in an east-west direction, one per student team. The *treespotting* activity took place during a whole day exclusively. The students used different digital apps to geolocate the trees, identify species, measure height and crown width, and photograph each tree and its leaves. Then, all digitalised trees were compiled in a single dataset that could be used for their design scheme, or to perform specific studies about the relationship between the trees in the public realm and those that belong to private plots. The exercise analysed from this course is 5.9 *"The great escape"*.

Urban Gaia. Offenburg

Design Studio. 13 weeks, 7 hours/week. 12 students, none with GIS experience.

The studio speculates with a hypothetical *"Landesresilienzschau"* –***'Federal State Resilience Show'***– in 2050, where the city of Offenburg would exhibit a possible change of the urban reality towards resilience and climate justice. The course was divided into two parts: first, the definition of a *"Leitbild"* or directing scheme for the city of Offenburg, and then, the design of a series of *"Urban Gaia Projects"*, that showed how the *"Leitbild"* could be applied in specific locations. In this case, the general GIS training was reinforced by a parallel task, namely the creation of an atlas of the city, where each team drew custom mappings about different aspects of the city. The exercise analysed from this course is 5.8 *"ECOnnect"*.

Urban Hydrotopos. Karlsruhe

Design Studio. 13 weeks, 7 hours/week. 11 students, none with GIS experience.

This studio dealt with urban water in the city of Karlsruhe. Since it was not restricted to a specific zone or aspect of water –such as high water, riverscapes, rainwater, or soil imperviousness– computational spatial analysis can be key to identifying the theme and the location(s) of students' proposals.

While an intensive GIS workshop took place during the first week, specific GIS-related tasks were required at several moments along the semester, enabling successive moments to merge data analysis, nature and design scenario. The exercise analysed from this course is 5.10 *"Soil: rethink, reconnect, regrow"*.

Mapping Zirkel's ecological occurrences. Karlsruhe

Stegreif. 2 weeks. 13 students, 8 with previous GIS experience.

Karlsruhe's paradigmatical green space, the Zirkel, was mapped using pervasive remote sensing tools. Which natural elements are relevant for its ecological evolution? How do they influence its transformations? How do the existing biotopes interact with human presence? During the '*Stegreif*', the students learnt how to extract, analyse and represent geographic information from open sources with open-source GIS software.

Only one workshop was offered, where GIS basics were presented and explained. This workshop took advantage of the previous GIS experience of half of the students, who form pairs with students who had no GIS experience. During the basics workshop, the first group of students performed the required data mining and created a database for all students. The sensing part finished therefore after the first workshop, and all students worked with the same datasets.

Each team had to choose a specific ecological phenomenon within the given datasets and conduct a brief spatial analysis. As the only deliverable, they had to produce a significant circular mapping of the research area that compiled all their knowledge about the selected phenomenon, plus a series of smaller mappings that would explain how they managed to portray the big map. These smaller maps would show intermediate states of the work or could display separately different factors and indicators used to describe the ecological occurrences in Zirkel.

This course emphasised giving students the opportunity to put simple spatial analysis methods into practice to question the city's current natural status quo. It sought to encourage explorative investigations that are theoretically informed, and dealt critically with issues and questions of contemporary relevance. The course looked for a sustained and rigorous process of study in all aspects of the students' work, with special focus on visualisation of augmented geospatial data. It also encouraged a form of mentoring-learning, where the GIS beginner in the duo learns from the other member, and together they established the learning path they wanted to pursue. The exercises analysed from this course are: 5.6 *"Ecosystems and light pollution in Zirkel"*, and 5.7 *"Auf der Suche nach Raum"*.

4.4.3 Case-study cities

The courses that cover this analysis are focused on four different cities: Karlsruhe, Offenburg, Basel and Zürich. Beyond the geographical proximity that allowed many students to visit them, they share Roman Empire origins –if we consider Durlach, nowadays a neighbourhood of Karlsruhe–, and a prosperous economic future. They can be regarded as *'**Medium-Sized Large Cities**'* –*"mittelgroße Großstädte"*– by population, between 100,000 and 500,000 inhabitants.

According to United Nations World Urbanization Prospects 2022, cities with populations between 100,000 and 500,000 have experienced faster growth rates than larger cities in recent decades. Although bigger cities accumulate more new inhabitants, it is in middle-sized cities that the percentage change is highest, and the rate is fastest. Faster and more vigorous growth of cities of this size makes it pertinent to address how the design goal of Ecocene can be implemented in these places. Table 4.6 shows a study of similar middle-sized cities that demonstrates the importance of looking at this type of urbanisation – including how they host a large portion of the overall population.

Of all aspects, the key similarities between the cities for this study are climatic and ecological. From an ecological and state borderless consideration of the world, where a total of 846 ecoregions are identified (Dinerstein et al. 2017), the four cities are in the heart of the Ecoregion of Western European Broadleaf Forests, along the Upper Rhine Valley. This acts as a vital corridor for wildlife movement, allowing for the migration and connection of various plant and animal species. Settled over the Upper Rhine Graben, they also share geological origins, although both German cities are closer to the Rhine River Floor, surrounded by floodplains and riparian zones. Basel and Zürich are nested against steeper slopes, which generate differences in vegetation and agriculture. They share a very high vulnerability index (Scholze et al. 2020), calculated from combined climatic stressors, exposure, sensitivity and impact indexes. It makes them particularly suitable for adaptation strategies through Nature-Based Solutions.

All four cities are considered *"mittelgroße Großstädte"* by the International Statistic Institute. With differences in population –Zürich 439'000, Karlsruhe 307'000, Basel 193'000 and Offenburg 143'000 habitants– and urban density –Zürich 4,8; Basel 4,1; Karlsruhe 2,1; Offenburg 1,55 people/km2– they cover an interesting range of sizes and urbanisation levels, that go from compact and dense developments to a more spread-out development pattern. The substantial differences in GDP per capita, with Zürich double that of Offenburg, also introduce various means at each city's disposal to face climate change.

Other differences between them are also evident. Zürich has triple the population of Offenburg. Basel has a highly dense population, resulting from a successful industry in a confined territory that does not allow any urban sprawl. Despite these differences, could the results of this study be interesting, not only for these four cities, but for other cities that could be considered similar in population, area, and climatic zone? Freiburg im Breisgau and Strasbourg could be considered within this group.

City	Country	Population *People*	Surface *km²*	Density *people/km²*	GDP per Capita *PPP*
Zürich	Switzerland	434,833	87.88	4,947	$105,141
Basel	Switzerland	193,334	37.02	5,222	$87,142
Karlsruhe	Germany	307,088	99.95	3,079	$60,892
Offenburg	Germany	143,123	78.61	1,824	$48,231
Freiburg im Breisgau	Germany	233,409	76.06	3,067	$60,892
Stuttgart	Germany	630,300	207.35	3,040	$64,321
Bern	Switzerland	143,804	39.4	3,652	$88,214
Lausanne	Switzerland	145,078	41.37	3,507	$89,123
Ulm	Germany	124,828	48.41	2,579	$62,108
Tübingen	Germany	91,399	51.4	1,778	$63,201
Constanz	Germany	83,175	63.97	1,300	$64,210
Innsbruck	Austria	132,493	104.9	1,262	$52,109
Salzburg	Austria	154,211	65.6	2,348	$54,203
Augsburg	Germany	295,186	86.34	3,420	$59,102
Würzburg	Germany	124,449	87.68	1,419	$58,209
Graz	Austria	291,500	127.67	2,292	$32,416
Heidelberg	Germany	162,238	40.3	4,028	$64,129
Bologna	Italy	390,465	144.0	2,711	$45,302
Lyon	France	522,232	48.87	10,709	$45,208
Geneva	Switzerland	200,208	15.93	12,568	$94,210
Strasbourg	France	285,714	78.3	3,653	$45,217
Darmstadt	Germany	159,564	122.08	1,307	$62,310
Mannheim	Germany	307,088	124.09	2,478	$61,209
Nuremberg	Germany	509	180.7	2,822	$63,102

Table 4.5: comparison of some relevant indicators of cities in a near radius to the studied cities. Data from WolframAlpha, date of research 22.05.2024.

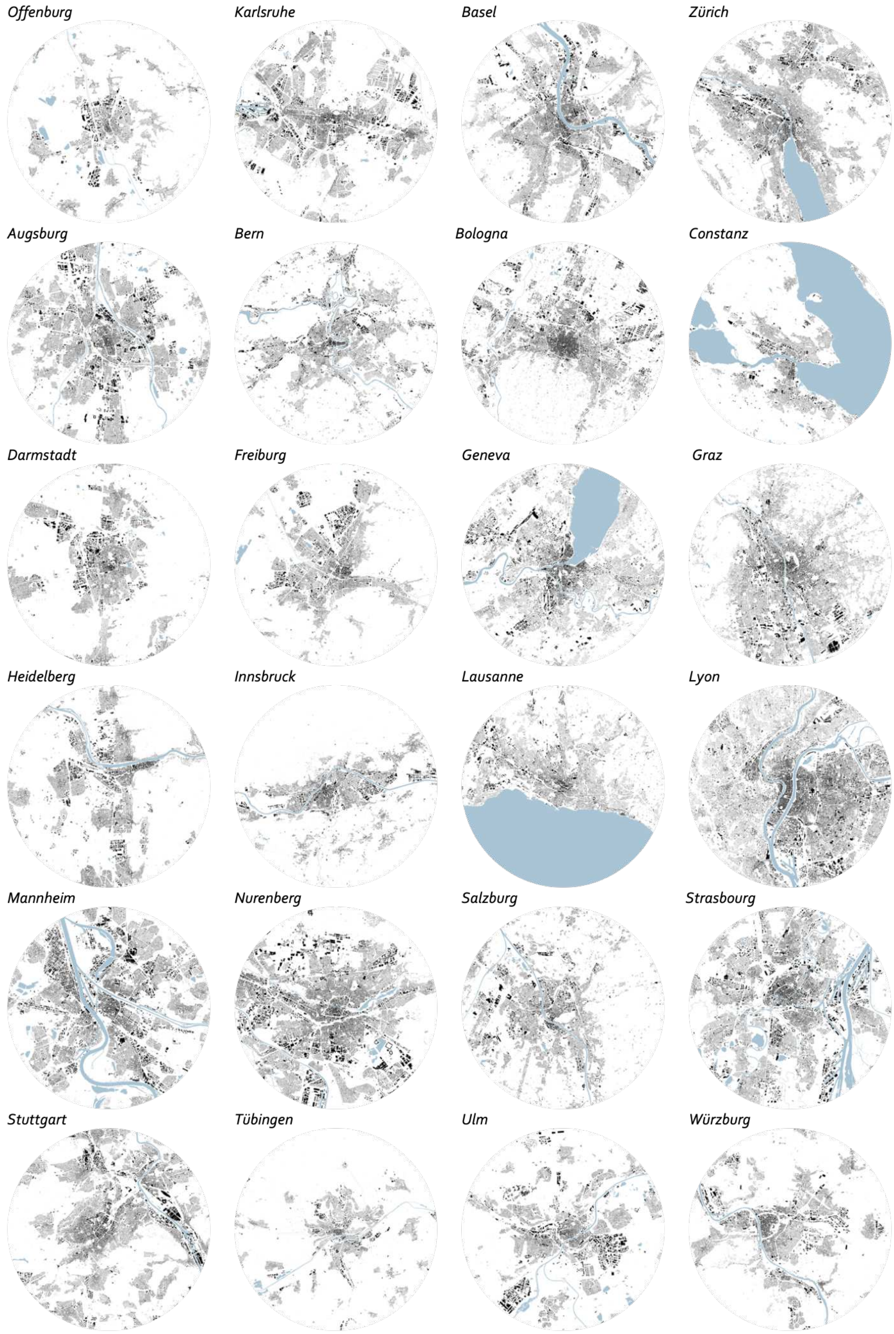


Figure 4.6: Centre-European Middle-Sized Large Cities. Buildings and waterbodies. Source: Geofrabrik. ARC

4.4.4 Data availability

The four studied cities have similarities but also differences in their morphology, their resources –both natural and economic– as well as profound cultural dissimilarities. A crucial example for the purposes of this research is the availability of open data. The results of the courses differed when studying the German and Swiss cities. How did the availability of data affect these results? The following pages investigate and compare data availability in the four cities, setting the starting point of each course. To this end, each city's official open data platforms are inquired, and the results are shown in the following tables for comparison.

First, the number of datasets available for download is examined. The types of files are also investigated, as many datasets are simply PDF files with no geographical or spatial information. Geographical information files are typically GeoJSON, GPKG, SHP, JSON, WMS, WFS. CSV files are a standard format to exchange information, as they can take the form of a simple spreadsheet or even a plain text file. These files can be geospatial if geographical coordinates can be found within the text or the spreadsheet. Nevertheless, budget control spreadsheets are often shared in CSV format. A closer look at each dataset would be needed to decide how many of them are geospatial.

The download of the datasets is crucial to use them in a data analysis. Smaller cities like Offenburg do not offer such a service and only provide a geoportal to visualise data and eventually print it in PDF format. This format is not practicable for performing further analysis. While such platforms can be considered *'informative'*, designers cannot conduct further study. The Karlsruhe platform offers a portal to visualise the data without the option of printing it in PDF, which makes it opaque. On the other hand, it provides a path to seek datasets *'on demand'*, where they can be obtained for research purposes, for example. The Basel and Zürich platforms are more user-oriented, and do more than visualise the data. This enables the download of more relevant geospatial data for further inquiries.

The datasets are organised in categories and themes, so they can be filtered and scanned by content or the thematic families they cover. Each platform defines the categories and the tags differently. This makes them difficult to compare with precision without identifying each singular dataset, although some general insights can be articulated. Karlsruhe focuses heavily on social aspects –*"Bevölkerung, Gesellschaft und soziales"*– and has a balanced spread in mobility, politics, and education. However, it lacks datasets in international and scientific topics. Basel's data platform strongly emphasises environment, politics, and geography, along with broader scope in politics and public security. At the same time, it focuses less on energy and construction. Zürich is highly focused on environmental and population data, indicating a robust dataset collection in urban planning and demographics. It also has significant data in economic sectors and mobility.

Karlsruhe tags are more evenly distributed, focusing on data harvesting and geographic data. Basel tags emphasise civic participation and health, indicating a strong interest in democratic processes and public health issues. Zürich has a vast number of geographic-related tags, suggesting a strong emphasis on spatial data and geo-information systems.

The open data platforms of Switzerland and Baden-Württemberg are also inquired and compared, considering the same key aspects as for the city data platforms: amount, format, categories and themes. However, these official platforms are not the sole source of open data for the designers –and for the courses. Other platforms offer valuable datasets for designers. For that purpose, a last comparison is displayed in Table 4.10, showing how many datasets each platform offers for Germany or Switzerland –despite the surface difference. For example, the Copernicus dataset website refers to the data and information services provided by the

Copernicus Programme, which is the European Union's Earth observation programme. Managed by the European Commission in partnership with the European Space Agency, ESA, the Copernicus Programme aims to provide accurate, timely, and easily accessible information to improve the management of the environment, understand and mitigate the effects of climate change, and ensure civil security. The data provided by Copernicus is free and open to anyone, promoting transparency and wide use for scientific research, commercial applications, policy-making, and public awareness.

Most of the data used by the students for the exercises comes from these platforms and is complemented with other unstructured datasets found on websites such as iNaturalist or Flickr. The tables' analysis concludes that data availability highly depends on the exact city. A similar trend is shown for platforms such as iNaturalist, showing more than 30 times more animal and plant observations in Zürich than in Offenburg. Searching, checking and compiling datasets was one of the first tasks undertaken in all exercises, and many of the further steps in the analysis and design process depended on the gathered data. These differences are considered in the next chapter, which compiles the exercises' analysis and explores the impact of data availability on design processes.

	Offenburg Geodaten Portal Offenburg https://geodatenportal.offen-burg.de/Osiris5/		Karlsruhe Geoportal Karlsruhe https://www.karlsruhe.de/mobilitaet-stadt-bild/bauen-und-immobilien/geoporta	
Download datasets	0		127	
Non-geographic	0		~ 66	
GIS-dataset	0		~ 61	Some CSV unclear
% of GIS-dataset	-		48 %	
PDF	-		55	
CSV	-		35	
GeoJSON/GPKG	-		49	
SHP	-		19	
JSON	-		4	
WMS	-		-	
WFS	-		-	
DXF	-		-	
Other	-		5	Excel, Word
Categories / themes biggest	-		55 Bevölkerung, Gesellschaft und soziales 27 Mobilität 25 Verwaaltung, Politik und Wahlen 17 Bildung, Kultur und Sport 15 Regionen und Städte 9 Umwelt und Klima 8 Wirtschaft and Finanzen 6 Gesundheit und Verbaucherschutz 2 Justiz, Rechtsystem und öffentliche Sicher-heit 2 Landwirtschaft, Forstwirtschaft und ,Nah-rungsm. 2 Energie 1 Wissenschaft und Technologie 0 Internationale Themen	
Tags /keywords 10 most used	-		55 datenbw-harvest 24 geodaten 17 Motorisierter Verkehr 12 Zeitreihe 10 Parken 8 Haushalt 7 Haushaltsplan 6 Radverkehr 6 Wahlen 5 Aufenthaltsdauer	

Table 4.7: comparison of data availability in the official geoportals and/or open data portal of Offenburg and Karlsruhe. Date of research: 15.09.2024.

	Basel Open Data Basel Stadt https://data.bs.ch/pages/home/		Zürich Stadt Zürich Open Data https://data.stadt-zuerich.ch/	
Download datasets	292	82% updated in 2024	806	
Non-geographic	161		~ 400	
GIS-dataset	131		~ 400	
% of GIS-dataset	45 %		~ 50 %	
PDF			16	
CSV			520	
GeoJSON/GPKG			348	
SHP			359	
JSON			173	
WMS			382	
WFS			381	
DXF			314	
Other			609	164 GDB, 99 TIFF, 20 ZIP, 12 XYZ
Categories / themes biggest	83 Territory and environment 64 Politics 55 Geography 55 Mobility and transport 45 Population 38 Tourism 34 Health 29 Administration 19 Public order and security 15 Legislation 13 Culture, media, inform. society, sport 10 Construction and housing 10 Energy		240 Umwelt 208 Bevölkerung 169 Bauen und wohnen 128 Basiskarten 118 Verwaltung 107 Mobilität 56 Volkswirtschaft 43 Energie 33 Politik 27 Soziales 25 Freizeit 25 Gesundheit 14 Tourismus	
Tags /keywords 10 most used	48 Whalen 41 Demokratie 28 Abstimmung 37 Teilhabe 21 Coronavirus 20 Corona 19 COVID- 19 16 Bevölkerungsbestand 16 Krankheit 15 Parlament		841 geodaten 477 geoportal 350 vektordaten 279 sachdaten 255 stzh 243 tabelle 224 ktzh 222 zeitreihe 158 sasa 139 punkdaten	

Table 4.8: comparison of data availability in the official geoportals and/or open data portal of Basel and Zürich. Date of research: 15.09.2024.

	Offenburg Geodaten Portal Offenburg https://geodatenportal.offenburg.de/Osiris5/	Karlsruhe Geoportal Karlsruhe https://www.karls-ruhe.de/mobilitaet-stadt-bild/bauen-und-immobi-lien/geoporta
Datasets on de-mand	Bestellformular für Forschung und Lehre (DWG, DXF, SHP, 3D_modell). Maximum zone: 1 km2 Stadtplanauschchnitt, 3D-Model, Bodenschät-zungskarte, Schwarzplan, Liegenschaftskarte (Flurstücke, Gebäude, Topographie), Orto-photo (2013, 2015, 2017, 2020 2022), Land-schaftsplan 2030 (Freiraumstruktur, Natur Ladnschaftssch, Naturhaushalt), Flächennut-zungsplan 2030, Höhenlinien 2016, Biotope, Schutzgebiete, Bäume, Grünflächen und Park-anlagen, Bohrstandorte, Kanalkataster, Lärm-karten. WMS Service on demand for Luft-bilder, Regiokarte.	
Data to view/print PDF	Stadtplan, TK 25, TK 50, Kataster (ALKIS 2024), Topographie, Flächennutzungsplan, Bebauungspläne, Stadtplanung (Gebietsein-teilung, Aufstellungsbeschlüsse, Abweichende Zuständigskeiten), Bodenrichtwertkarte 2023, Umweltdaten (Bioope, Waldbiotope, FFH-Ge-biete, Vogelschutzgebiete, Naturschutzge-biete, Landschaftsschutzgebiete, Naturparks), Luftbild (2012,2015,2018,2021), Baulückenka-taster. Fachpläne: Bebauungspläne, Fernwärmeplan, Flächennutzungsplan 2030, Landschaftsplan 2030 – Freiraumsstruktur, Natur und Natur-haushalt.	
Data to view/ no print	No other datasets Hhintergrundkarten (9),, Gebiete, Historische Karten (1876, 1943, 1948 1965), Themenkarten (Sport, Sozial…)Umweltzone, Solarkataster, Agenda 2030 – Nachhaltigkeit in Karlsruhe, Naturschutzgebiete, Landschutzgebiete, Wasserschutzgebiete, FFH-Gebiete, Klimaan-passungsplan, Klimaanpassungsmaßnahmen, Hochwassergefahrenkarte, Lärmkarten.	
Other formats	No other formats Several Apps and platforms to visualize da-tasets Digital twin: 3d City model (only view)	

Table 4.9 (both pages): comparison of data availability in the official geoportals and/or open data portal of Offenburg and Karlsruhe. Date of research: 15.09.2024.

	Basel Open Data Basel Stadt https://data.bs.ch/pages/home/	Zürich Stadt Zürich Open Data https://data.stadt-zuerich.ch/
Datasets on demand	API	
Data to view/print PDF	Many datasets to download presents different formats to download, and it always offers the possibility to see the datset online (as a map, a table, or whatever format).	Almost each dataset to download presents different formats to download, and it always offers the possibility to see the datset online (as a map, a table, or whatever format).
Data to view/ no print	Same as above.	Same as above.
Other formats	9 Dashboards (Sportanlagen finden, Feinstaubabmessungen auf Balser Tramlinien).	178 Showcases: dashboards, hochhaus-viewer, lier leben die reichsten Zürcher, etc. 27 Webappas, 26 Aplikation, 24 Datenjournalismus, 24 Webmap, 19 Datenvisualisierung, 11 Publikation, 9 3d-Stadtmodel, 9 Blogpost, 8 3D, 8 Animation, and more.

4.5 Concerns and limits of the methodology

A recurrent question arises when discussing spatial data analysis for architectural design: why should designers –students, in the case of this research– invest time and effort in learning another approach? This is a particularly pertinent question if it involves learning how to work with or even program specific software, which is not widespread in architectural training nor used in many professional practices. The following sections provide a look into the enormous potential of these digital technologies and demonstrate the appropriateness of integrating them into the architectural teaching curricula, and, by extension, in the practice of architecture – especially if that architecture prioritises a symbiotic existence with urban nature. There are, however, some concerns that may limit the methodological efficiency of this *laboratory*.

Design skills and academic setting

One of the primary challenges is the students' level of design proficiency. Certainly, these methods may enhance their design skills, but some students lack the required design experience to benefit from them fully. Exploring this theme in an academic setting, where the design abilities are still in the initial stages, makes it more challenging to measure the impact of learning these competences than if the students were experienced professionals. Moreover, the design tasks that the students are asked to fulfil do not correspond to those of the everyday practice of an office. The extension of this *laboratory* towards the professional sphere will be explored in Chapter 9.

Dataset reliability and accuracy

The lack of transparency of computational processes is also concerning. Many of the operations and transformations are invisible to the human eye, and they can lead to fundamental errors and biases. A clear protocol of the steps followed to get to the final result is key to ensuring the reliability of the process. Assessing the process behind black box tools improves calibration of the processes, enhancing the generative processes (Fricker et al.2023). Given the limited timeframe of the courses, the following phases after the dataset proof were prioritised over thorough data inspection. The emphasis of the courses lies in improving design processes and learning the methodology, rather than in the resulting designs themselves. There may even exist other datasets, different from the ones used by the students, which could ultimately lead to a more accurate result. These datasets are updated and mutate constantly, and new ones are generated continuously. Working in such a changing paradigm implies that the first step for designers is gaining data literacy to develop their own methods.

Data opportunism

F. Peter Ortner describes *"data opportunism"* in the framework of parametrical –architectural– design. Although the software, methods, and tools used in these courses differ from Ortner's, the generated dynamics are similar. In Ortner's course, a student *"perceived the studio as an effort to create design from data, and for this reason searched for datasets that are most conducive to generating parametric form. This data-opportunism allows the availability of data to pre-determine the choice of design direction"* (Ortner 2019). Students understand that the task is to create a data-driven design and therefore favour the datasets that will presumably be better able to complete the task over other datasets that could be more interesting for the precise object of study but less operational. Some –good– students end up using datasets for the sake of a data-driven design, rather than for their suitability. That is why Ortner comes up with the construct *"design-driven data"*, which should embody the kind of data that must be generated to fulfil a design task best. Thus, to avoid data opportunism, the designer should shift from the available data to *"design-driven data"*. To a greater or lesser extent, this phenomenon is also reproduced in some of the exercises described in this thesis. The right mechanisms to avoid it must be defined and implemented.

Limited toolset

Finally, this *laboratory* only covers one of the multiple tools that could be used for this task. The use of parametric design, Building Information Modelling, or generative AI could significantly impact the students. In fact, those students who were able to use other software and combine this into their research showed highly enhanced performance. They could use GIS in combination with more advanced tools and with a higher associated impact in terms of a shift in their design practice.

	Baden-Württemberg Open Data für BW https://www.daten-bw.de/		Switzerland Open Data Swiss https://opendata.swiss/en	
Download datasets	1'334		11'089	
Non-geographic	~ 315		~ 6'589	
GIS-dataset	~ 737	Some unclear	~ 4'500	Some are unclear
% of GIS-dataset	55%		40%	
PDF	831		585	
CSV	180		3'309	
GeoJSON/GPKG	-		7	
SHP	-		312	
JSON	72		814	
WMS	983		2'919	
WFS	659		1'448	
HTML	-		3'376	
Other	-		-	
Categories / themes biggest	670 Regierung und öffentlicher Sektor 671 Regionen und Städte 140 Umwelt 109 Bevölkerung und Gesellschaft 70 Landwirtschaft, Fischerei, Forstw. 69 Verkehr 69 Wissenschaft und Technologie 48 Bildung, Kultur und Sport 7 Wirtschaft und Finanzen 4 Justiz, Rechtssystem und öff. Sicherheit 3 Gesundheit 2 Energie		3'777 Regions and cities 3'208 Environment 1'998 Population and society 1'733 Education, culture and sport 1'631 Government and public sector 926 Economy and finance 830 Transport 755 Agriculture, fisheries, forestry and food 442 Energy 329 Health 329 Justice, legal system and public safety 2 Science and technology 0 International issues 0 Provisional data	
Tags /keywords 10 most used	645 opendata 565 gdb-gdi-bw 564 inspireidentifiziert 562 ngdb-gdi-de 553 bauleitplanung 552 bebauungsplan 552 bodennutzung 552 lokal 552. verkehr 552 villingen-schwenningen		669 abstimmung 662 fsdi-federal-spatial-data-infrastructure 640 woman 623 man 614 gender 431 national 411 population 376 gemeinden 348 kantonzuerich 333 education-and-science	
Other formats			106 Showcases	
Other platforms	Landesanstalt für Umwelt Baden Württem. https://udo.lubw.baden-wuerttemberg.de/public			

Table 4.10: comparison of data availability in the official geoportals and/or open data portal of Baden-Württemberg and Switzerland. Date of research: 15.09.2024.

5 Analysis of the exercises' processes

This chapter covers an empirical investigation of ten students exercises, which mobilise certain methods for the formulation of speculative design proposals with urban nature. The author took advantage of the privileged position allowing him to follow the design process week after week, observing how their investigations advanced. The following table compiles an inventory of exercises, in relation to the methods they share.

Seminar. Data-Driven Urban Nature Lab 1.0 Karlsruhe	
City perception	*pictures, subjectivity, multiple perspectives*
Green capacity on an urban environment	*surface analysis, test scenarios, graphic compare*
Pull off the big green	*personal tracking, collective cartography*
Seminar. Data-Driven Urban Nature Lab 2.0 Basel	
Invasive or neophythe?	*graphic storytelling, spatial hypothesis*
Seminar. Data-Driven Urban Nature Lab 3.0 Zürich	
Diversity of the commons	*spatial index calculation*
Design Studio. Street Resilient Ecologies. Upcycling Kriegsstraße	
The great escape	*own dataset creation, data-driven site finding*
Design Studio. Urban Gaia. Landesresilienzschau Offenburg 2050	
ECOnnect	*multispecies justice, multiscalarity*
Design Studio. Urban Hydrotopos. Karlsruhe	
Soil: rethink, reconnect, regrow	*mapping overlay, distributed robustness*
'Stegreif'. Mapping Zirkel's ecological occurrences	
Ecosystems and light pollution in Zirkel	*combined data sources, modelling scenarios*
Auf der Suche nach Raum	*diversity study, spatial cohabitation*

Table 5.1: List of analysed exercises. Title and keywords.

The exercises are investigated to understand which competences were learnt and developed. Then, it is discussed how these competences influenced the design process. Lastly, the interrelation of the mobilised competences is explored. At the end, a radar diagram represents the competences that the student made best use of, and a chord diagram shows the relationship between the competences during the design process.

This chapter takes position to:

– *show* speculative design methods emerging from data analysis: case studies across scales and programme;

– *discuss* the impact of these methodologies on the design workflow, as well as on the thematical perspective chosen;

– *study* how the position towards the design task can be enriched through a data-informed approach, and consider its limitations and challenges;

– *reflect* on the required competences that enable new forms of practicing, and on the most suitable forms of auto-pedagogy for further self-development.

In the other volume of this thesis, a series of annexes are compiled. Annex B gathers the graphics of the student's exercises printed in bigger size for better comprehension. Having two separate documents allow the reader to have both open at the same time.

5.1 Invasiven oder Einwanderer?

This exercise addresses the spread of invasive neophytes within an endemic plant community using GIS tools. There are currently about 600 neophytes registered in Switzerland. Only 58 of them are classified as invasive and dangerous. Due to increasing temperatures caused by climate change and globalisation, this number will continue to rise in the future, what is becoming a *'natural'* process. It is key to learn how invasive neophytes behave and learn to build new balances with them.

Description of the exercise. The initial intention of the exercise was to alert of the potential danger of neophytes in urban spaces. Datasets from the Basel Data Portal were used as a basis for researching this topic. The almost 200'00 observations were not only geolocalised but also classified by species and also by potential risk. As the observations were also ordered by year of monitoring, a temporal evolution was very easy to portray.

Data sensing

Figure 5.1: Classified Neophytes in years: 2006—2009, 2010-2013,2014-2019. Gabriel Stark.

The student learned from botanical literature that waterways and railways are typical paths for introducing neophytes. Observing the obtained dataset, it is possible to agree with this. Therefore, observations in the surroundings of these pathways are temporarily blended, looking for the origin of the remaining observations, grouped in different hotspots, as well as the reasons for their thriving.

Data augmenting

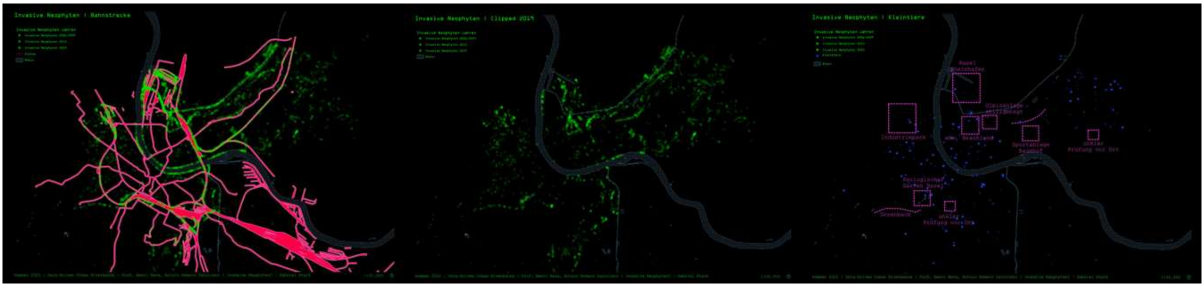


Figure 5.2: Extraction of railway and waterways zones; unknown origin hotspots; small animals. Gabriel Stark.

These datasets were filtered and compared according to other interesting ones, that could be the origin of the introduction of the plants. For example, building permissions of construction sites were filtered from approximately 170,400 general applications. These were progressively fine-tuned into earthworks to determine if the neophytes' origin was the movement of soils. The resulting maps demonstrate effectively that this is with great certainty not the case. The student's cartographies successfully captured the different time cycles and rhythms of plant propagation and earth movements. The spread of neophytes within time, parallelled to the building dynamics of the city, demonstrates no correlations, despite the evident entanglement of nature and built areas.

Further similar spatial enquiries are conducted with other datasets like farmers' markets or local festivities, as they also risk transporting soil and, with it, seeds. Besides, observations of small animals that are not endemic in the region are geolocalised and crossed with the neophyte observations. Though the student showed great disappointment when none of the hypotheses explained the origin he was looking for, he understood that he could effectively demonstrate that those hypotheses were not the source of the plant introduction. During the investigation, the student understood that simplifying the intricate relationships of neophytes and the city was a mirage. However, he could contribute to the discussion with robust answers to his initial hypothesis through sharp maps portraying very fine-grain information detail.

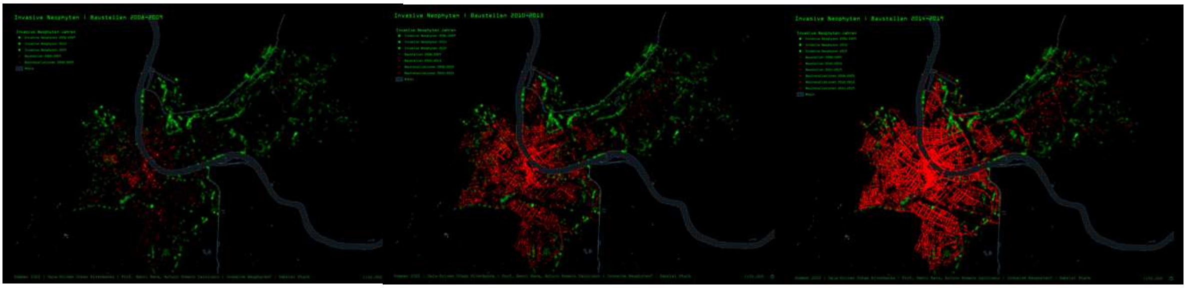


Figure 5.3: Building permit applications –red– and neophytes –green– in different years. Gabriel Stark.

Data synthesis

After these investigations, it was clear that rivers, streams, and railroad tracks were the main home of these invasive plants. Contrary to the initial assumption, hardly any invasive plants were registered in public green spaces. This investigation's level of detail and fine grain reflection is extraordinary for a singular Seminar, even for other more intensive formats, such as a design Studio. In a regular analysis, the main aspects to study are picked from websites such as Google Maps and placed by hand in CAD drawings that the students prepare. Being able to gather all the data, geolocated and in consistent datasets, encouraged the student to carry out analysis that he did not before, nor learned from the course's explanation. Instead, he started enquiring to demonstrate the facts he found in botanical literature spatially. The student developed his own research methods and learnt on his side the necessary tools to perform the study he wanted to carry on.

Critical reflection. This exercise started with a danger alert about urban neophytes. However, it turned into something more complex. How did the use of the mobilised technologies affect this path? The initial datasets are open and easy to acquire, and the majority consisted exclusively of geolocated points with some information attached. The successive hypothesis generated new quests for datasets, in a form of research-in-action through iterative questions: can neophytes arrive along the train tracks? Can they arrive along watercourses? Do they arrive at these points through soil movements like building sites? The student was able to demonstrate different answers spatially. Each hypothesis he discovered in biology literature was converted into a map through additional datasets, proving the hypothesis right or wrong for this case-study. These iterative augmentations of the datasets are a strength of the workflow.

However, it was the accurate representation of the temporal dimension of the datasets that triggered further enquiries. He tried to understand how the presence of neophytes affected other aspects, such as nutrient cycling, soil erosion, and other factors that contributed to the further expansion of the invasive species. These are called feedback loops in Systems Thinking (Meadows 2012), that amplify or dampen the effects of changes within a specific system. Parallelly, the work *"Wild cube"* of the artist Louis Weinberger also influenced this exercise: a grand cage is placed in the streets of Graz, where no seeds are planted, no watering is scheduled, and no access to human beings is granted. Time does all the work: plants start growing and thriving without external intervention. Understanding the feedback loops and the powerful vision of Weinberger's work contributed to recognising Basel's neophytes' agency, consciousness and social relationships. Borrowing Descola's animism ontology (2013) allows to understand that the neophytes spread, adapt and compete with other species –agency–, they sense and respond to environmental cues –consciousness– and they interact and impact ecosystems –social relationships. Learning from different disciplines, such as art, can lend their approaches and narratives, which can effectively guide the student in the making of a mapping.

Figure 5.4: Beitrag zur Documenta X (1997): "Das über Pflanzen / ist eins mit ihnen", Lois Weinberger. Photos: Dietmar Walberg (right) and Dieter Schwerdtle (left). Creative Commons Attribution 4.0 International license.

At this stage, Timothy Morton's ideas of interconnectedness and *"hyperobject"* –discussed in chapter 1– can help understand neophytes better and apprehend how GIS technologies are suitable for investigating them. The student used GIS technologies to locate the neophytes –the hyperobject– geographically and within time, allowing him to understand better the proliferation of these species beyond the threat to local plants. Obviously, this research method cannot be enough to disentangle all the forces that shape the spread and behaviour of plants throughout the planet. However, it is possible to state that GIS allowed him to study neophytes' behaviour further: he could approach the arrival paths, the spread rhythm, the level of danger, and the interdependence with other factors such as soil movement and built infrastructures. He imagined a graphic and statistic-based method to observe plant and non-human spatial intelligence.

This cyborg alliance of humans, technology, and the biosphere also echoes Donna Haraway's ideas. Technology creates profoundly situated knowledge that enquires about what the American philosopher understood as multispecies ethnography. Using GIS methods, the student tries to understand a non-human-centric exploration of the intersections of Basel's ecosystem. Coming from an almost alarmist starting point, the project derives through technology to a more complex construct, where all stakeholders have agency and impact their entanglement in different forms. By the end of the semester, the student could start speculating: what if neophytes were *'nomads'* –*"einwanderer"*, in the original German– and not *'invaders'*? What if urban spaces with neophytes could be the experimental field for new ecosystem balances? What if these laboratories contributed to the thriving of biodiversity through social action? These spaces, partially built or partially abandoned, could profit from a hybrid nature that fosters new social values. Matthew Gandy explores in *"Natura Urbana"* (2022) how Berlin's abandoned plots –*"Brachen"* in the original german, includes the idea of 'non cultivated', while *"descampados"* or *'un-fields'* in Spanish, as proposed by Ábalos & Herreros (2000), speaks for extracting the countryside aspect to them–, have spontaneously regrown and become the place of social resistance. A place where a new form of hybrid nature has given place to a new form of social interaction.

The question of who generated the dataset and how could it be updated in the future also arose. What if people from Basel contributed to monitoring species through Social science?

Knowledge of anonymous *'ordinary'* citizens brings innovation possibilities (Hecker et al. 2018). A different student of a precedent Bachelor's course, also worked with the idea of biodiversity, but with a dataset about the city of Karlsruhe. It was created by the spontaneous contributions of biologists and biologist enthusiasts who geolocalised plants growing south of Karlsruhe. The Bachelor student classified over 40'000 plant observations and created a series of cartographies exploring city biodiversity –see Figure 5.5. The student had not designed a residential building in his studies yet, but after two months of learning QGIS was able to create compelling graphics to reflect about the city centre's biodiversity. He first thought that he may find higher biodiversity in the city's natural surroundings rather than in the city centre. Still, the analysis of the data indicated precisely the opposite. Indeed, as the student explained, this hypothesis cannot be just assumed with the gathered dataset, due to the lack of consistency in data collection. However, he could merge his design skills with computational spatial analysis, navigating in complexity and reflecting on the forms of understanding and representing urban nature.

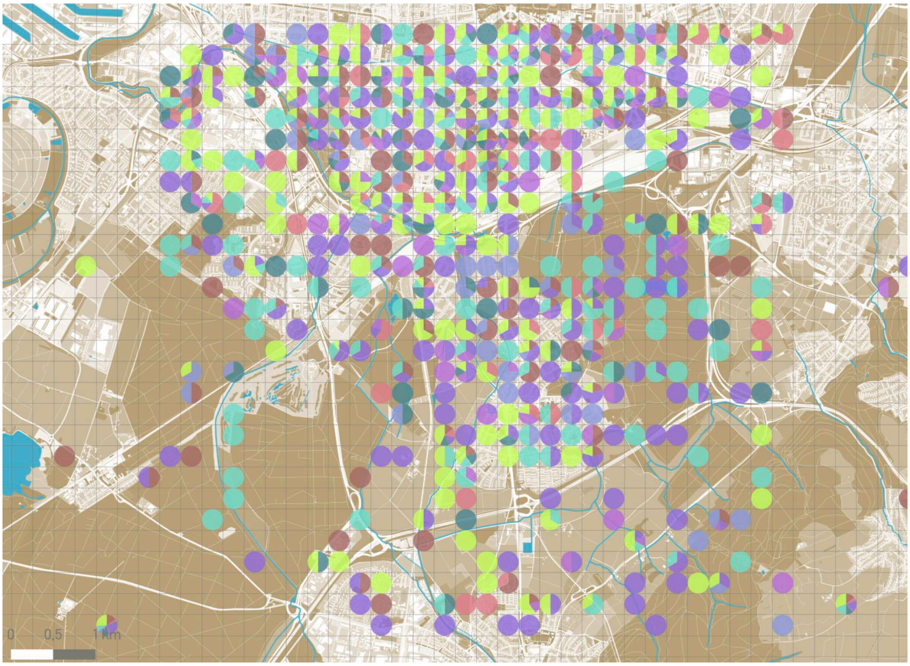


Figure 5.5: Biodiversity in the south of Karlsruhe, Oliver Leitzbach.

The botanical institution that published this dataset invited this Bachelor student to present this work at their yearly meeting. There, experienced geographers and ecologists acknowledged that his research methods were *"experimental"*. Some were even quite critical of an approach that did not *'solve any problem'*, but most of them described the students' work as inspiring. They were just commissioned to portray a series of communications explaining Karlsruhe's biodiversity to the public. They agreed that the fresh approaches of the student had brilliantly drawn ideas emerging from lateral thinking that they could build on. The student, who had only known QGIS for a few weeks, could build a robust narrative about urban biodiversity, highlighting different aspects in his findings. For instance, the highest recorded biodiversity is found in the most urban and dense areas. Of course, this also alerted the student to reconsider possible bias introduced by a non-structured data observation collection. The rising awareness of the possible introduced bias is the key to further questions about the methodology: What methodologies are most accurate when using citizen science? How could architects benefit from them? This example illustrates how even a very limited experience with GIS can considerably impact turning traditional GIS analysis methods into fresh forms of knowledge expansion.

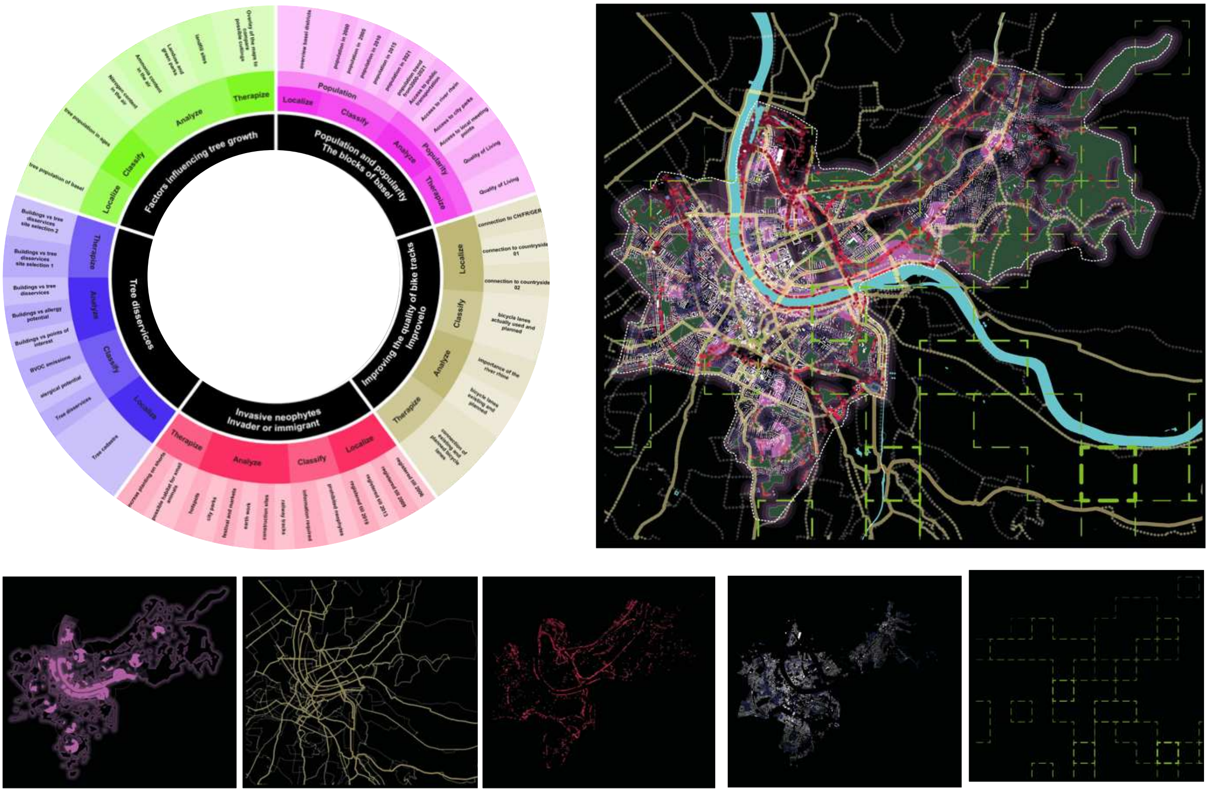


Figure 5.6: Composite of the complete Seminar Data-Driven Urban Nature Lab 2.0 Basel, with the work of all the students. Gabriel Stark.

Augmentation through all students' datasets

Further work. Building up on the different speculations of the other four students in the Seminar, the student who analysed Basel's neophytes distribution proposed a next step to bring together the investigations of all Seminar participants. First, he identified how each proposal was localising, classifying, analysing and therapising the topics they were treating: from factors influencing tree growth, to the influence of green infrastructure for using bike tracks or choosing a place to live. It also incorporated the theme of the neophytes and the other work analysed in the previous section, tree disservices. He selected one aspect of every topic and found the graphic representation that enabled a rich and complex lecture, remaining accessible, though. This extravagant superposition was the catalyst for different forms of speculation, as all the themes are closely connected –neophytes, soil health, trees' disservices. Beyond a supposed technical objectivity, this exercise opened further discussions that would further develop each individual topic. The value of this cartography lies in its capacity to describe a natural reality of the city of Basel that stimulates understandings of its urban nature that were previously unveiled.

Figure 5.7: superposition of mappings of five different students. Gabriel Stark.

Tools for reflection

This last map uses ambiguity and uncertainty as the basis for the representation, resolving in a *"non-standard map that shows its constructedness"* (Drucker 2014). The graphic effort of the work's second part, where the mappings of five different students were combined, deploys a remarkable synthesis capacity. Giving one colour and one graphic style –points, surfaces, lines, buildings– to each study, it can portray the complexity of the different networks studied, while being able to differentiate all of them. The evocative texture of the final mapping gives space to the person that looks in it some kind of hint that seems to remain unveiled. He evoked, for instance, how some streets with high allergy potential showed almost no bike use or neophyte penetration. These wild guesses may require further serious study to really understand if they are at all sustained, but the student now has some tools to initiate research-based design proposals. He can now start building data-funded speculative scenarios.

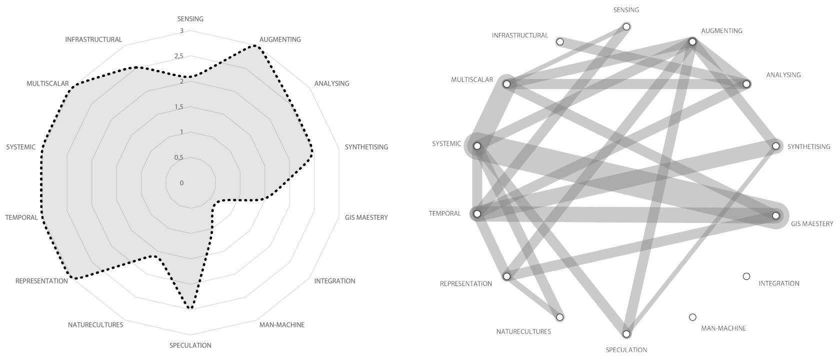


Figure 5.8: Exercise 5.1. Radar diagram and chord diagram. ARC

5.2 Green capacity in an urban environment

... what if?

The following exercise investigates a neighbourhood's environmental adaptability by converting roofs and façades into building elements that host vegetation. Far from attempting a viable result, it operates in a pure speculative territory, and is based on a quantitative study. It is easy to understand what one green roof means, but what would it mean if all roofs were green? And what if the facades were also covered with vegetation? How far can this scheme go? Which are the benefits and dangers of it?

Data sensing

Description of the exercise. The data analysed comes from a formal information request to the *"Transparenzportal Karlsruhe"*. They provided a comprehensive collection of building footprints, numeric data indicating the cornice height, and the type of the roof: flat or sloping. Data availability implied that each student had to work in a specific area, in this case, the neighbourhood around the former airport, that is nowadays just an unbuilt area with no particular use or biodiversity quality.

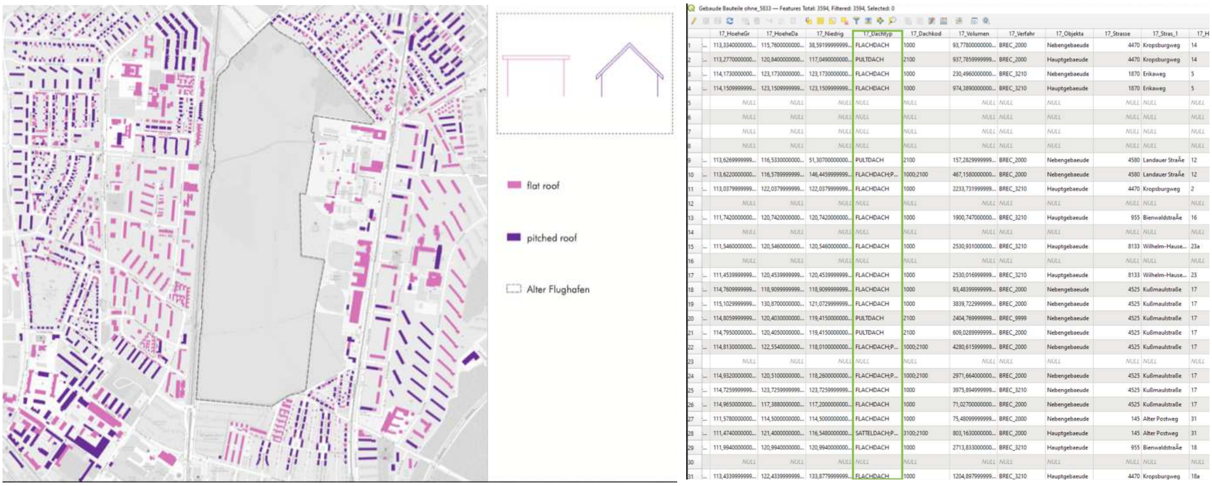


Figure 5.9: Classification of the buildings according to roof type. Jasmine Párraga Lázaro.

The following manipulations used mapping as a form of graphic calculator to classify, modify, and generate a series of hypotheses. The surface of roofs is graphically calculated, assuming percentage reductions for constructive elements like parapets or lift overrides. The surface of facades is also graphically calculated through different hypotheses for window openings as per common German standards. With them, the surface study of the building paraments of the buildings in the area is completed.

Data analysis

After the graphical computing of the areas, several speculations are formulated: what if all flat roofs were converted into green roofs? What if all sloped roofs were also transformed into green roofs? And lastly, what if all facades were converted into vertical gardens? A comparison of the different scenarios is then performed: what are the implications of each one, their technical possibilities, and their societal and environmental implications? The strength of this work is the mastery of quantities, measurement and proportion. Even if such scenarios are highly unlikely, being able to compare their impact with the potential impact of the transformation of the old airport is a powerful instrument to question the green development of the area. But above all, it gives a sense of measurement to the map reader, who can very easily comprehend what these abstract measurements mean.

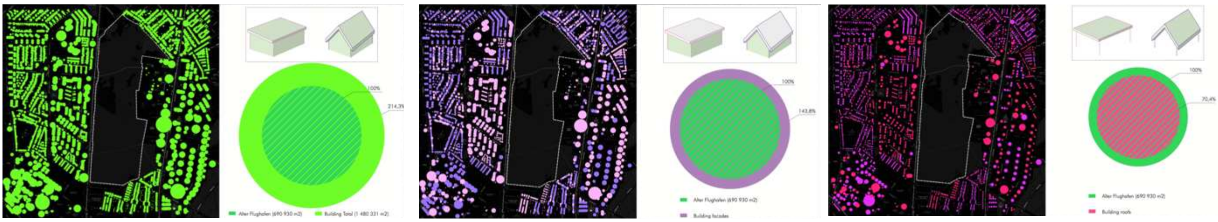


Figure 5.10: Green capacity of the buildings as per roof type, facade type, and the addition of both. Jasmine Párraga Lázaro.

The required data to perform this exercise for the whole city of Karlsruhe was not available in the Transparenzportal. Therefore, the student proposed to estimate a rough upscale to understand the impact of this idea in the scale of the city, comparing the green capacity of the built environment with the forest areas within the city.

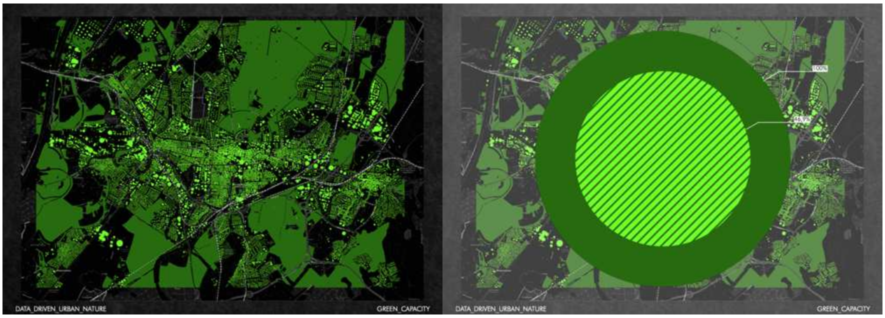


Figure 5.11: Green capacity of the city of Karlsruhe. Jasmine Párraga Lázaro.

Critical reflection. This work showcases the radical difference of a person's work when using pervasive data analysis. Before this course, the bachelor student in Architecture only had access to one introductory urban design Studio and had not yet had the opportunity to even participate in a course to design a housing block. The ease of processing significant amounts of data and a massive scale compared to the previous treated scales exemplifies how this Seminar with GIS tools empowered the student. Beyond scale and complexity, digital data analysis naturally led towards a piece of work that operates with speculation, a framework that had not been used in the previous courses.

Scenario development

This case study is a paradigmatic illustration of pure speculation with urban nature. Whereas the idea of green roofs and facades is not a novel form of natureculture, the speculative scenario of imagining them ubiquitously on every building element, raises new questions and opportunities to envision this hybrid landscape. Numbers, rather than adjectives, matter: saying *'huge'* is vague, a new synthesis of metrics for sustainability is needed (Thackara 2014).

From a unique and simple dataset, this exercise excels in the data augmentation, which has become a key issue for training AI (Haba 2023). The student's capacity to formulate hypotheses for windows and building elements as per statistical values is empowered by QGIS' graphic calculator. Rather than landscapes, those hypotheses look at cities as *"datascapes"* (MVRDV 1999) that offer hints to define the transformations of cities. This exercise builds on the idea that green progresses too slowly, and small green deeds are insufficient (MVRDV 2014). The sense of dimension and proportion displayed is profoundly multiscalar, tying up construction detailing, architecture and urban green infrastructure, and particular actions with societal impact. The tool to work with this matter is measurement: *"when architecture becomes increasingly difficult to differentiate from urbanism it comes into the field of quantities, infrastructures, and also time and relativism"*, as stated in *"Green Dream"* (MVRDV2014). This book explains how the *"Green city calculator"* they created functions. It is a planning and design tool that evaluates the existing cities' environmental performance, as well as planned policies and developments –and their impact: *"we need to design new perceptual aids to understand the state of our natural, human and industrial systems"*. A tool to imagine speculative scenarios of greener cities?

Storytelling

The representation of the proposed speculative scenario is then key to enhance understanding. Edward Tufte (1983) explains how clear and concise visualisations help viewers grasp complex information quickly and easily. Furthermore, the graphic visualisation helps to reveal insights, in this case by graphically comparing the potential surface of buildings with the surface of the old airport. For Tufte (1990, 1997), a well-crafted visual narrative captures the viewer's attention and makes the data more interesting and engaging. The storytelling of the exercise is purely visual, and perfectly comprehensible for all audiences, not only scientists or data analysts. The narrative of the student effectively operates as a form of visual metaphor, helping to make complex concepts comprehensive and memorable. It is remarkable how the mobilised visual discourse can evoke an emotional response in the audience. Compared to the surface of the old airport, which everyone in the neighbourhood knows, it activates an emotional resonance that can be positive when looking for citizen engagement, empathy and a call to action. Nevertheless, this can be potentially problematic if the subject is oversimplified, looking for manipulation of the audience, and persuading them without providing sufficient evidence and context. It has the risk of becoming a form of visual data populism.

Critical thinking

The principles of critical thinking may help to root the scenario in a robust design line that encourages accuracy and avoids oversimplification. Particularly considering consequences across disciplines. Learning from *"The Economics of Ecosystems and Biodiversity"* (Brink 2011), it can be better explained how biodiversity and ecosystem services have a measurable impact on local and global economies. Brink's lateral thinking and solid statistical perspective provide an operative framework that helps this exercise avoid possible critics of escapism or lack of connection with reality.

This exercise works like a manifesto, clear and placative. It can be understood as the return to a classic understanding of mathematics and trigonometry as a visual and graphic science. Everything is graphically calculated on the digital map, and replacing buildings, roofs, or facades by circles with the same surface makes it very easy to understand. It understands the built environment as the infrastructural substrate for additional forms of nature, imagining an extensive and systemic natureculture. It also deploys a sophisticated understanding of the impact of small-scale actions on a big scale, whether the whole neighbourhood, or even the entire city.

However, the connection between the proposed scenario and the implementation of an architectural, urban or landscaped proposal remains unresolved. While the *'metrics'* seem mastered, the 'aesthetics' of the proposal are still to be discovered. *'The greenest city'* portrayed in *"Green dream"* (MVRDV 2014) –as a result of implementing the green city calculator– brings together quantity and spatial quality within a speculative scenario. The exercise rather situates itself in the practice of *"The Why Factory"*, as described by Winy Maas (ibid.): *"these architectural hypotheses, built on facts rather than intuition, can observe, extrapolate, analyse and criticise our behaviours and societal structures. A systematic work with data is an attempt to resist specific styles"*. Despite the lack of *'style'*, this student's exercise is limited by its lack of spatial translation. Further work displaying possible spatial strategies should be the natural next step.

Some other aspects of the exercise are manifestly lacking, such as a thorough temporal understanding. Nevertheless, the technical mastery of augmenting skills contributed to formulating a systemic, multiscalar speculation that excels visual representation. It should not be understood as a projected scenario, but as the tool the student used to reflect about the consequences of the imagined scenario.: who would be most affected or benefited from it? What economic development would be needed? How would this scenario affect open spaces' greenery? How can building construction systems contribute to cities' natural capital?

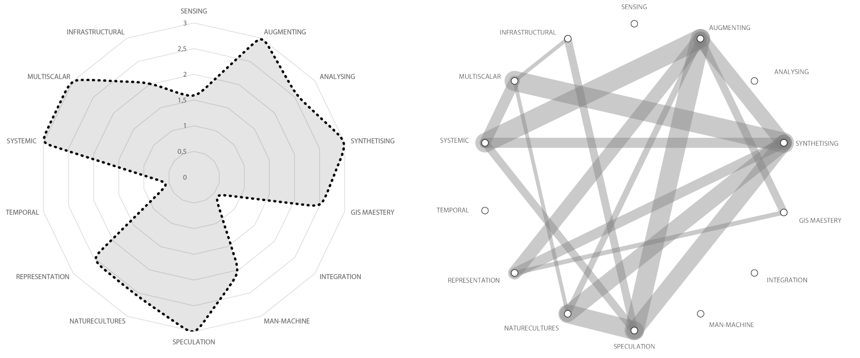


Figure 5.12: Exercise 5.2. Radar diagram and chord diagram. ARC

5.3 Pull off the big green

This work investigates the accessibility of Karlsruhe's main green infrastructures and the paths leading to them, and it speculates on the reprogramming of the thresholds between the consolidated dense city and the surrounding big natural areas.

Description of the exercise. The data analysed is mainly GPS tracks, in a representative quantity, circa 3'800 urban trips. They were available open data from different online platforms, and they are organised in three categories: 1'200 running tracks from komoot and GPS-Tour; 1'100 bicycle tracks from komoot, outdooractive, Bikemap and Rad-Karlsruhe; and 1'500 offset tracks from PenStreetMap - GPX-Mass-Publication 2013.

Data sensing

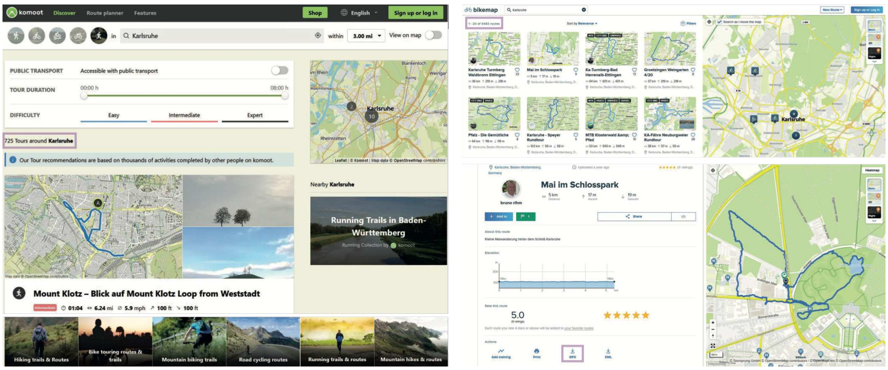


Figure 5.13: websites where the different tracks were downloaded from. Johanna Markus.

The number of tracks is considered sufficient to start the analysis, and the quality of the tracks -the number of points and the accuracy of their position- is also proven. They may not represent the general population, though, as the platforms they come from are oriented to share sports routines and exchange with other people interested in building up physical performance. Nevertheless, this sample is considered representative of people using the whole city as a playground for sports, either running or cycling. The study is then centred in this segment of the population.

Figure 5.14: Usage heatmaps of streets, paths, bike lanes and routes. Johanna Markus.

Data augmenting

All tracks are proofed, arranged, and superposed. Every track is divided into segments of equal distance to obtain a point cloud that can be analysed as a heatmap, revealing the streets and paths most used by runners and bikers.

The obtained heatmaps draw precise figures of the city's actual usage by this population segment. Some axes are identified, and certain continuities revealed. This experimental and personal cartography of movements is confronted with the official planning documents of the city of Karlsruhe, specifically *"Räumliches Leitbild Karlsruhe"*. In it, the intention to strengthen a green ring is clearly stated, taking advantage of some of the existing infrastructure, and the citizens' current use. The comparison of both documentations, the official and the extracted from people's movements, reveal the areas of opportunity to fill in the gaps to achieve the planned ring.

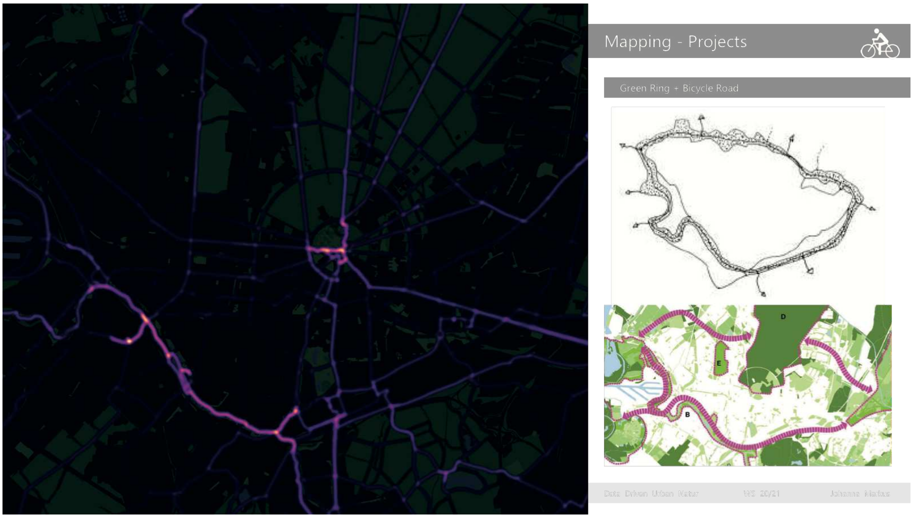


Figure 5.15: Urban thresholds to nature. Johanna Markus und Karlsruhe Leitbild.

The ring form of the planned path ties together many of Karlsruhe's most pregnant green spaces. This circular shape is perpendicularly crossed by several *'radial'* pathways, that look for the great landscape from the city centre, following the classic *'fan-structure'* of the city as planned in the baroque times. Some of these centripetal pathways correspond to the original structure of the city, others have been established through regular use of the city. The intersection of this future ring structure and the radial paths to the big green are considered as sensitive thresholds that can host new urban functions linked to man-powered mobility, sport and urban nature.

Data synthetising

This work explores a possible future scenario where the whole city becomes the gym of the inhabitants, where they can go riding a bike or running. What if these thresholds between consolidated city and surrounding parks and forests offered specific infrastructure for the users of this new kind of sport? What would they need? Showers, lockers, areas for relaxation? Where would they be placed? How would they interact with each other? How would the perception and the phenomenological experience of these people change? Which synergies with natural environments can be found at these places?

The open-minded analysis of the shared jogging and cycling routes allowed to define the problematic and revealed the design opportunities, and their scattered locations. Karlsruhe's Leitbild defines a strong contour, actively encouraging the densification within the existing perimeter of the built city, while coping with suburban spread. How should this edge look like? Which infrastructures should it have? Can it be more permeable towards the outside? How to invite people to slip across this border? The overlay of the limits of the built environment with the paths that people already use to do sport indicates where a new form of activity could happen. Taking advantage of the current use of these paths is a sensitive starting point. Parallelly, it highlights places along the city's perimeter where the permeability is not yet optimal. Another kind of infrastructure could be imagined there to fight this situation.

Figure 5.16: Urban thresholds to nature. Johanna Markus und Karlsruhe Leitbild.

The design intentions reflect a critical view on the use of the city that opens new perspectives in the use of the city as a sport field. It also manifests its constraints due to the extensive but limited data. The use of GPS data generated by mobile phones would be, of course, more precise and potentially unveil other locations and trends. The student also acknowledges the possible bias induced by the use of the tracks, not considering other factors of each runner such as gender, age, health status, social background, and economic level. Further investigations in this direction would refine design proposals.

Another student conducted a similar study in another 'Stegreif' titled *"Data-driven urban prototypes"*. In it, they used a similar dataset, but only for jogging in the city. The goal was to better understand the extensive use of the city as jogging infrastructure, in a quick and short exercise. This dataset and application may seem very direct and banal, with no spectacular consequences apart from understanding where people run nowadays in Karlsruhe. Nevertheless, during the final presentation, one of the Jury members, an internationally renowned landscape architect who leads an office with more than one hundred employees worldwide, was very impressed with the drawing. He explained how much he would have needed this exact drawing the week before, but for another city. He presented a new mobility concept linked to sport to the Mayor of a big European city. The planners' previous experience supported the argument for the new mobility, their classic analysis of the network, and their robust design scheme. They nevertheless lacked such a drawing showing the current use of the existing infrastructure. It would have clearly and fully supported the decision to connect the sport pathways in one or another manner. This anecdote exemplifies the scarce use of pervasive data analysis in the day-to-day practice. The reasons for such a deficiency, not only in the professional architectural world, but also in urban planning, are not part of the scope of this thesis but are expected to be connected with several of the factors investigated in these pages.

Critical reflection. Students not using digital data analysis typically go on site, do a couple of interviews with the users –joggers, in this case– and start the project from the qualitative information those two or three people provide. The data sensing of this exercise becomes a breakthrough innovation in the design process. Despite the data opportunism in the data selection (Ortner 2019) –the student just starts questioning what can be learnt from the dataset she could quickly get– it could be interpreted as a first step towards citizen science. She is reinventing how knowledge is produced and acted upon (Hecker et al. 2018), integrating design, science and society, and letting citizens become active stakeholders that actively set the agenda (Moedas 2018). To properly perform this exercise within the citizen science framework, the data generators should be informed beforehand, ideally involved in other moments of the design and not only in the data acquisition. Kieslinger et al. (2018) provide a comprehensive method to evaluate citizen science that includes further parameters such as scientific, socio-ecological or economic factors. Nevertheless, Hecker et al. (2018) question *"Can citizen science benefit learning across different ages and stages in individual learning curricula?"*, and this exercise clearly exemplifies the radical change in design culture of an architectural student when incorporating, at least, some of the principles of citizen science.

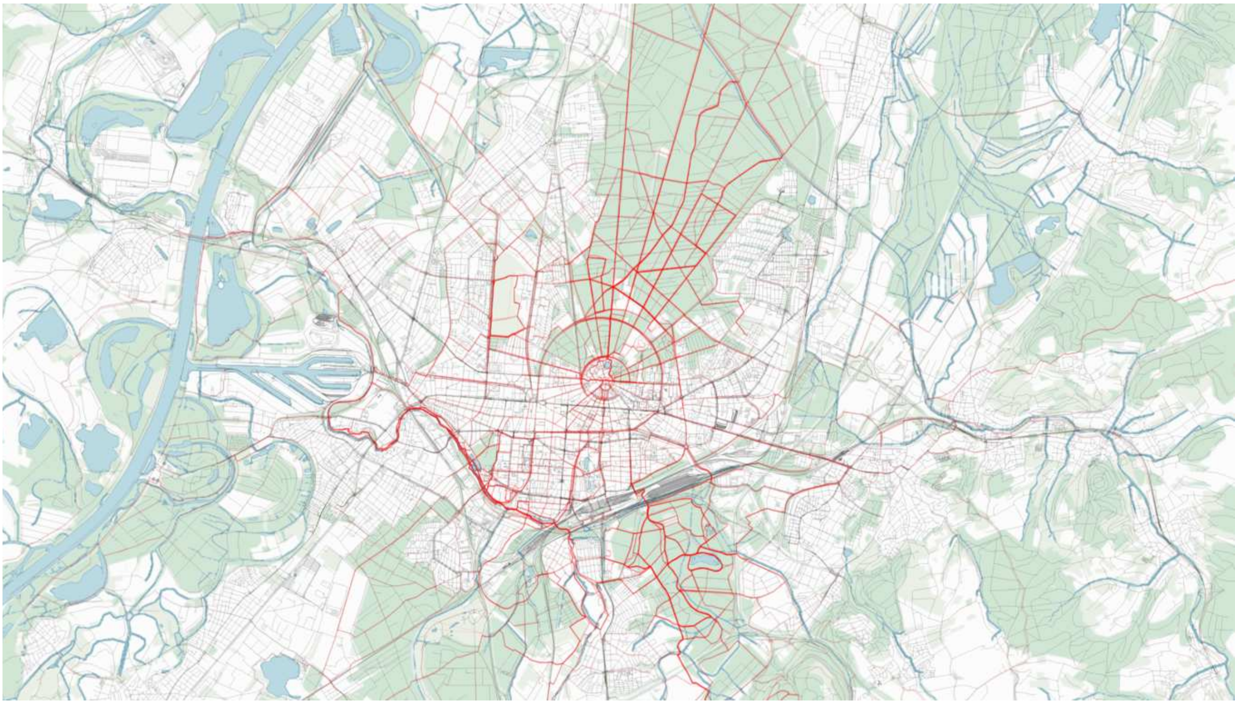


Figure 5.17: Where do people run? 'Stegreif' "Data-driven urban prototypes" by Yahan Wang.

The student did not need to learn sophisticated statistical analysis; she used graphical tools that architects are comfortable with. The representation of the dataset revealed usage patterns of streets and paths, and communicated insights about inhabitants' behaviour (Tufte 2001). Citizen science has the ambition to have relevant societal impact and contribute to policy changes (Hecker et al. 2018). When the student overlaps the real use of the urban network for sport with the –still under construction– planned 'ring', she provides the guidelines to inform and modify the planned proposal to gain societal acceptance. The graphic of heatmaps is straightforward and can be easily interpreted without professional knowledge, making these mappings a powerful instrument for discussing a possible project within a participative process. The small-scale proposal and its scattered distribution encompass the implementation of a bottom-up questioning of this approach, which would be very easy to conduct.

The exercise reveals emergent properties linked to the interconnectedness of different elements, which roots it within the principles of Systems thinking. Instead of breaking up the complexity of the usage into smaller, more comprehensive parts –interviewing just some joggers, for instance–, the exercise examines the situation by understanding the relationship between planning, existing infrastructure, actual jogging routines and the cultural conception of the city as the place for sport. This aims to identify a key feature in System thinking: leverage points (Meadow 2008). They are critical places within a system where small changes can have significant impact. These points are in some cases counterintuitive, and the student manages to identify them thanks to the graphic overlapping of the produced heatmaps, the existing green infrastructure, the mobility network and the planning objectives.

These leverage points are identified as the best places to incorporate small sport facilities such as urban showers, which have a broader impact on the overall mobility of the city. This multiscalar impact of the project arises from the question 'what if the whole city and its green infrastructure become the fitness Studio of the citizens?'. This speculative city has a network of possible small infrastructures close to the thresholds between city and surrounding forests and agricultural areas. Following a trend started by people looking for larger horizons where their everyday sport takes place, the proposal explores the impact of expanding these sport routines to a bigger public. What would people need to improve their experience there? How can new forms of relationships with the natural environment be fostered? These ideas mobilise Dunne and Ruby's ideas (2013) about perception change. They affirm that using speculative design may inspire new forms of thinking and behaving. A proposal like this exercise searches for profound societal change, and becomes infrastructural in the sense that James Corner uses the term. The design scheme serves as a platform for possibilities beyond the planned, as the outcomes of the mobilised actions remain uncertain. Can these small projects in the threshold of urbanised and more 'green' areas become catalysators to biodiversity? Could nonhumans profit from them? Could humans use them differently? Will more people start using the showers to go jogging to work? Could that use impact the mobility paradigm of a middle-sized city, quickly traversed running in a short run?

Despite the original idea of the project, questioning the accessibility of greenery around the city, the capacity to formulate a powerful hybrid form of natureculture is, in this case, not the strongest point. Though, it is remarkable how the scenario and the proposal emerge from the sensed and synthesised data. Moreover, the data representation not only triggered the idea of the project, but also indicated the distributed location where it should take place. The formulated speculation has a multiscalar impact linked to Systems Thinking, as it takes the form of small infrastructures with minimal local implications, but strongly networked. This may unleash a powerful impact on overall urban mobility, as well as on the perception of leisure and sport throughout the whole city. Public space as the new field of experimentation.

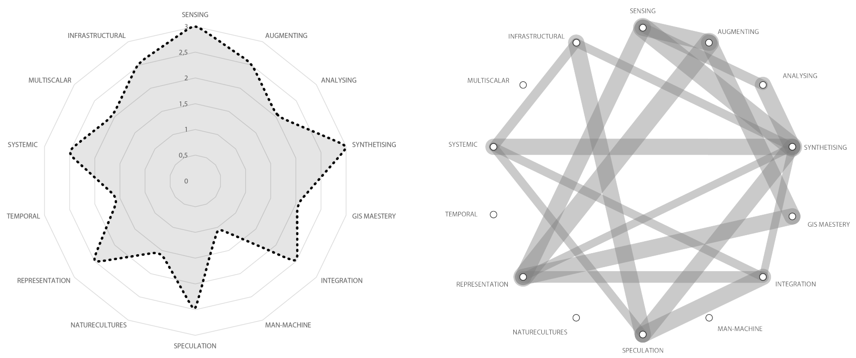


Figure 5.18: Exercise 5.3. Radar diagram and chord diagram. ARC

5.4 City perception

This work questions urban image through analysis of geotagged pictures from social media. Approximately 200'000 images are acquired from the social media *"Flickr"*, which is specialised in photography with aesthetic value, where users share images beyond everyday life. In this sense, the photos do not necessarily represent life in the city but capture visions the photographers wish to portray about Karlsruhe.

Description of the exercise. The student started initially generating pictures of a site herself, walking around and capturing everything she thought was relevant. Such an approach was time-consuming and poor in quantity; besides, the resulting dataset only represented her perspective. Looking for a kaleidoscopic city portrait, as many eyes as possible are welcome. The Flickr dataset that she gathered consists of geotagged images of countless users and valuable associated metadata: further information to each capture, such as title, tags, and exact day and time where the photo was taken.

Data sensing

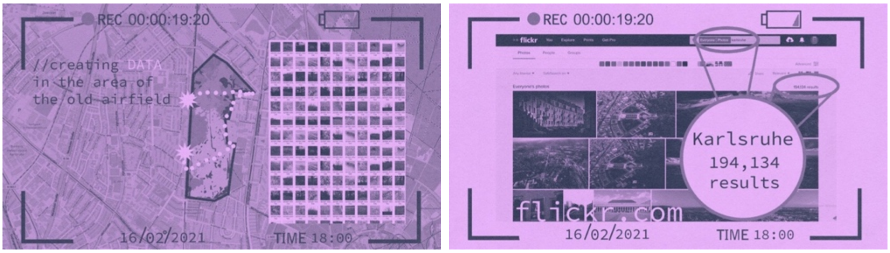


Figure 5.19: Left to right: self-generation of picture data vs. collecting picture data from Flickr. Karla Jukic.

The dataset is then questioned by the tags of the pictures, which users assigned them. It is then easy to filter them with tags such as *'nature'*, *'forest'* or *'sundown'*. The result is an immediate representation of the places where people perceive or wish to portray those concepts.

Data analysis

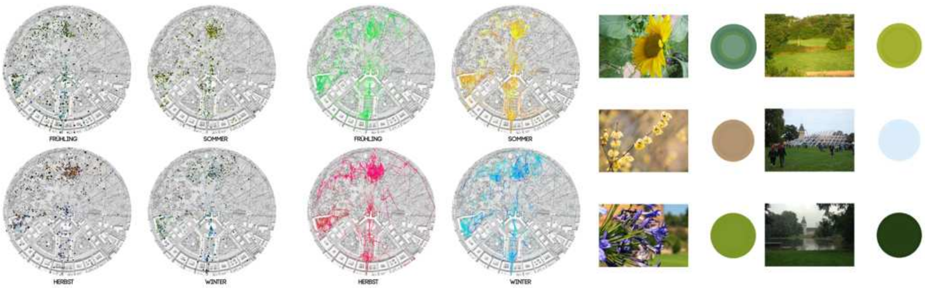
Figure 5.20: Geotagged images presenting tag ,'sundown'. Karla Jukic.

Every map becomes a community's portrait of a specific concept in different places. For example, it was very easy to detect that there are two hotspots to experience sundown: the Rhein harbour and the terraces over the hill of Durlach. Following this approach, the dynamics of urban life can be analysed through successive mapping.

Other exercises exploring the use of social media

In other Seminars and workshops, some students worked with the same data source, applied it to different places. One student worked in Karlsruhe's '*Zirkel*': he reduced every image to a circle with a crown that showed the most prominent colours of the image, and studied the seasonality of the colours.

Figure 5.21: Left: geotagged images by season; right: most common colour in each picture. Oliver Leitzbach.



To perform such an exercise, the student decided to learn some code programming, as the functionalities he needed to mobilise were not part of the standard ones of the software he was using, QGIS. Such a learning experience was not requested or expected in the course. He had no previous coding experience. However, with the help of a Large Language Model, ChatGPT, he composed the code to conduct the analysis he imagined. Without this computational knowledge, he could not approach his research idea.

Similarly, another student used this database and a similar concept to inquire about the colours of the island of La Réunion. She computationally mechanised several automatic processes to simplify, classify and group the images. She could then create maps of the colours of each season, trying to understand from a distance how the image of the island changed within time.

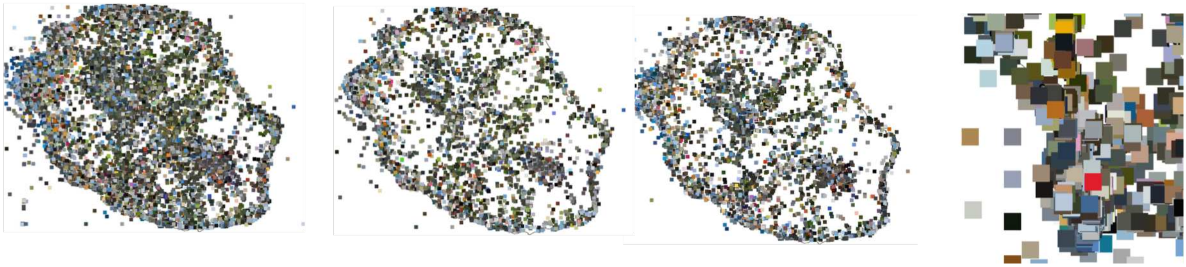


Figure 5.22: From left to right: Geotagged images represented by season: all, summer, winter; Detail of the map. Aliénor Mayer.

These three exercises working with Flickr datasets delivered novel visions on the territory they were exploring. The three used the same dataset to launch different questions to their case study areas: where specific actions or situations took place, how to understand the seasonal change of colours within a small area, and how the perception of colour changes every season. These experimental approaches were successful in pursuing their own analysis method. Some even started learning to write code using Python with the help of open repositories and artificial intelligence. Code writing was not required to fulfil the course task. However, they were motivated enough to learn certain simple computational actions, creating and owning a personal method that could be potentially refined and elaborated, if more time was available.

Bias identification

It is remarkable that these three students reflected thoughtfully on their own processes and came up with pertinent questions about the biases introduced. For instance, one student realised that the Flickr pictures do not represent all age ranges: kids' and older people's perspectives are systematically absent. Besides, it shows an apparent gender inclination, with an estimated 60% male users. Moreover, these images are often taken by tourists and not locals –something that another student worked with in another workshop by splitting the city of origin from the current city of the photograph. Besides, a certain '*theatralisation'* of the images may create *'mise en scènes'* that even perturb the colour of the images. The fact that the images are public on social media also opened the question of whether the images reflect a certain reality or if they try to *'be liked'*, representing not what is there but what people want to find in them. That was the student's hypothesis to explain why many of the Reunion Island images had similar colours for sky and mountains, regardless of the moment of the year. The student using artificial intelligence to classify the colours of the pictures also questioned the accuracy of the classification, that, given the number of images, is entirely unsupervised. A quick check of the results evidenced that the script had not worked well enough, compromising the results that were produced. It is rare that the students reflect on the bias of their own design tools: the digital method encouraged them to become more critical.

Critical reflection. A classic process by students to visually investigate an area usually involves a direct site visit, which is documented through photographs. Working on a large area such as a whole city or a complete island requires further methods. Especially, when wishing to incorporate other people's visions. The experimental approaches that the students developed correspond to the proposed pedagogy, where a learning experience is suggested, so that each person finds their own way towards the questions and methods that interest them. This approach goes beyond problem-based learning, and proposes *"Inquiry-Based Learning"* (McKinney 2021), where the trigger of the work is not necessarily a problem, but rather a piece of research. In this case, the students explored the limits of the technological methodology they implemented.

Learning from computational humanities, it is possible to work with quantitative and qualitative data simultaneously to identify semantic aspects of the urban realm. Several scholars (Serrano Estrada et al. 2022) discuss social media analysis, highlighting the ability to extract quantitative patterns from qualitative expressions. In this particular exercise, the use of photography tagging derives into patterns of use of the city. It is key to identify bias introduced by the self-created methodology. A deeper understanding of qualitative digital methods could be beneficial to obtain results that are better anchored in established social sciences.

The idea of extracting information from social media data is extended mainly for commercial use and has been tried to expand towards a more social use. Computer scientist and technology theorist Alex Pentland (2015) explores what he calls *'social physics'*, trying to predict the future behaviour of people as physics does of molecules. For this approach, it is key to understand how data can be harnessed to impact urban planning and design of natural infrastructures: *"over time we anticipate that social media will be essential in producing a new generation of urban design and planning tools that address how to make urban space more environmentally and socially resilient"* (Plunz et al 2019). By leveraging the collective intelligence of citizens through their photographs, this exercise offers insights into patterns of use –both spatial and temporal– as well as thematic associations between tags and themes. By analysing the vast amount of information from multiple perspectives, it is possible to identify seasonal patterns, daily rhythms and longer-term trends.

Digital ethnography

The approach adopted by these students not only offers insights into the use of different territories but also mobilises tools of digital ethnography to enquire how people use and interact with digital technologies to create and share meaning. Digital images can be understood as cultural artifacts reflecting their creators' values, beliefs and experiences (Pink et al. 2016). Analysing these images contributes to gaining insights into the cultural significance of these spaces: how the images are framed, where the focus is set, or the choice of subjects may reveal how people interpret the urban environment.

As discussed before, platform-specific affordances shape online interactions (Hine 2015): using Flickr to share the images may influence the type of images produced. The students' explorations allowed them to question the boundaries between online and offline spaces. Building on ideas of digital ethnography (Pink et al., 2016; Hine 2015), it is possible to question how people use social media to connect with and represent the physical world. Was social media a form of documentation or a way to express opinion?

Human geography
Space+memory=place

The students enquired about the process of creating meaning through digital media, lending ideas from human geography. The concept of *'place'* is complex and multifaceted. It certainly involves the main subject of architectural design, space's physical dimensions: location, dimensions, or characteristics such as colour, shading, temperature or humidity. However, it also encompasses the cultural, historical, and social dimensions that give a space a particular and unique character. How to create a sense of place, then? It is required to superpose experiences, interactions and memories over a particular space, which creates meaning and significance. Each person creates a different bond to the space, and each person's representations of that place contribute to the social construction of the meaning of a place. How to incorporate digital representation of places? How do social media images contribute to the cultural construction of a place?

Sensemaking

Citizens contribute to creating a sense of place through their social interactions, both in the physical and the digital world. Sensemaking methods can be powerful for creating speculative scenarios from people's social media contributions. First, during identifying dominant perspectives, gaps and contradictions: understanding better prevailing narratives, views of the world or inconsistencies. Also contradictions as mapping opportunities (Grootens 2020). Then, sensemaking can be used to challenge existing assumptions and explore alternative possibilities. Analysing social media images within a paradigm that does not try to control and monitor –such as Smart Cities is often criticised of doing–, designers can build up on the social, ecological and technological systems to create new future perspectives. The entanglement of novel ecological visions, social perception –from social media analysis– and digital technologies can effectively be used to formulate futures armed from sensemaking –see Figure 5.14.

Figure 5.23: From control to entangled social, ecological and technological systems. Chester et al. 2023

The speculative power of these works operates in two simultaneous layers: the urban speculation, and the own speculation about the methodology itself. On one side, they use social network data to analyse the use of urban spaces, more precisely the image of nature within their respective research areas. In a traditional exercise, students explain the use that they imagine, or the use that they can infer through the information that they can read. Still, in this case, they are confronted with a material dataset that guides the portraits they compose: digital maps of nature-related concepts.

In this case, the capacity of augmenting the dataset with fine GIS mastery and fine-tuned man-machine alliances is in the core of their innovation. Moreover, when the students explored these alliances by themselves and on their own initiative. Being short mapping exercises –Seminar or 'Stegreif'–, they did not have to end up with a design proposal. However, it is clear that the translation of these investigations into a speculative but formalised and situated design scheme is not evident.

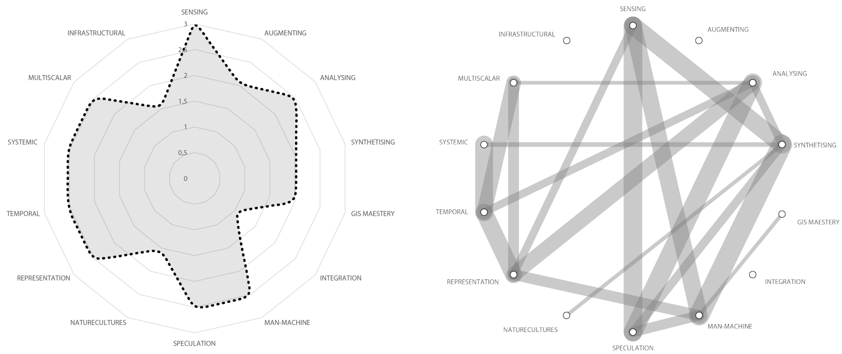


Figure 5.24: Exercise 5.4. Radar diagram and chord diagram. ARC

5.5 Diversity of the commons

This work investigates the diversity of public spaces within the city of Zürich. It questions the benefits of such possible diversity and crosses this information with the surface for street parking. In doing so, it enables a possible near future where the mobility shift that we are experiencing allows to reprogramme the parking spaces into authentically diverse commons.

Description of the exercise. The data analysed is mainly shape files from the *'Geschäftsbereich Park- und Grünanlagen'* –parks and green areas– of the city of Zürich. It includes forty-seven categories, such as flower fields, bog beds, forest parks or wild hedges. Different flooring materials are also differentiated. This dataset is contrasted with a comprehensive collection of parking spaces on streets. For simplification purposes, the size of each park space is considered 2,35 meters by 5,00 meters.

Data sensing

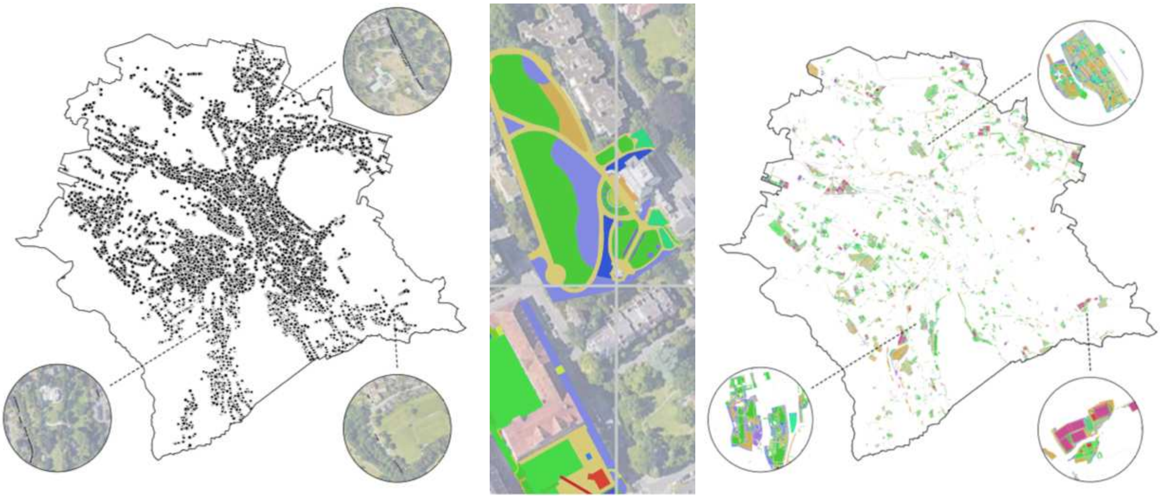


Figure 5.25: Left: localisation of the parking spaces; centre: detail of the classification of the commons; right: classification of the commons. Alexander Albiez.

Data analysis

The number of zones is enough to perform a diversity analysis, although the level of detail is not consistent throughout the city, which may interfere with the final diversity results. These areas do not comprise some parks and remarkably no forest areas, which definitely impacts the results of the periphery of the city, where these forest zones are mostly located.

A grid of 200 meters by 200 meters is established to calculate Shannon Index within each cell. The size of one cell and the eight cells surrounding it englobe an area of 360'000 m^2, that is easily reached by foot around each point: 300 meters walking a straight line. Using graphic calculation, the zones with highest diversity are shown as height curves, where green shows the highest diversity –Shannon Index >2–, and yellow medium diversity –Shannon Index >1. In order to cross this information with the surface available for the commons studied, a red circle is drawn based on the amount of surface within each cell. Similarly, the surface of parking spaces is represented on the same scale in black circles. It is noticeable then that some areas with the most prominent surfaces are not those with the highest diversity. Besides, small red circles within big black circles express the areas of opportunity, where much more surface is dedicated to parking as to the urban commons.

The representation of the diversity as a topography effectively conveys the areas that require higher diversity, and its overlapping with the surfaces of green areas and public parking places on the street create an accurate description for each 200 meters by 200 meters cell. This map identifies not only where action is necessary, but also its scale. The obtained heatmaps draw precise figures for the city's actual usage. Some axes are identified, and certain continuities revealed. This experimental and personal cartography of diversity draws a unique and unveiling portrait of Zürich.

Digital mapping

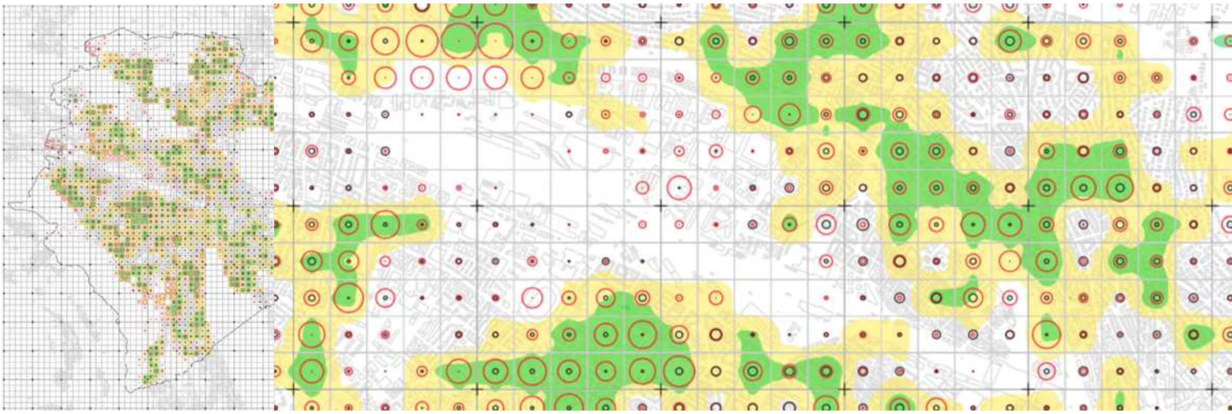


Figure 5.26: Left: Shannon Index of public spaces in the city of Zürich, detail; right: whole city. Alexander Albiez

This work aims to join its quantitative approach with a possible future scenario. It builds up from the hypothesis of a mobility shift reducing the use of personal cars radically. This makes many parking places on the streets redundant and unnecessary. What if most street park places were not necessary anymore and they would be occupied with diverse functions for the urban commons? What if the lack of diversity in green areas could be fought with these spaces? The data's fine grain and the park places' overall reduced surface work perfectly together, generating multiple possible responses in a site-specific approach that could even allow great space to public participation and governance.

Interpreting diversity through speculation

Figure 5.27: Image of an existing street in Zürich and visualisation of the speculative scenario. Alexander Albiez

Focusing on the diversity of green spaces rather than on their quantity or surface requires computational help when working throughout the whole city.

Critical reflection. The pedagogical strategy of this Seminar offered the possibility to deepen one particular feature: the calculation of the Shannon Index, a parameter measuring the diversity of a particular feature in the city. Similar to Fricker's (2021) study on pedagogy for computational design thinking, the focus is shifted from the *'how'* towards the *'what'* and the *'why'*. The intensive and robust training on the specific tool to be used just took three weeks. This left enough time to explore the motivations to use it –the *'why'*– and better understand the manifold aspects of diversity –the *'what'.*

Enquiring the limits of the idea of diversity

Starting with the latter, the work with the compiled dataset contributed to better describing the boundaries of diversity. Uncritically considered as a *'positive'* value, it was key to contrast these naif visions with critical thinking methods. First, understanding the exceptionality of the selection of the metrics to consider. Cities enquired through data analysis frequently focus on averages, frequent phenomena or *"the similar"* (Santamaría-Varas et al. 2022). The study of dissimilarities and urban inequity is also a common approach. The value of diversity is less inquired. This approach can be interpreted as a computational study of Jane Jacob's ideas (1961) of urban mix-use for vibrant street life. However, she did not explicitly discuss the diversity of the green infrastructure of cities.

A Bachelor student in the same course, enquiring about the diversity of another urban figure, started questioning the value of the Shannon Index to measure diversity effectively. Shocked by his mapping results, which he interpreted as wrong after checking several locations *'by hand'*, he identified two factors that made the results questionable. First, this index operates with relative values for each cell and cannot compare throughout absolute values of the whole city. And second, the dataset ignored a metric that was more common in dense areas, which generated a similar index in zones that were clearly different in their diversity.

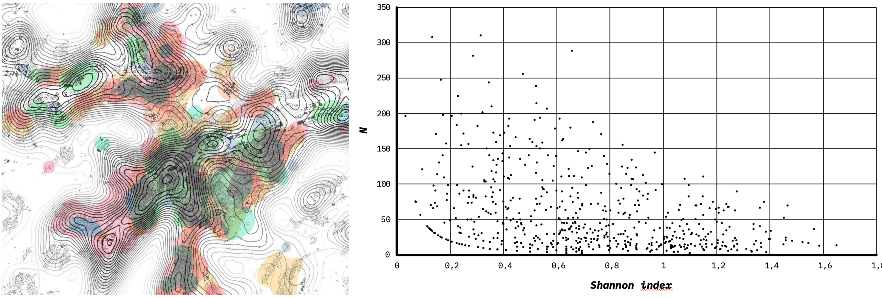


Figure 5.28: Mapping building use diversity and Shannon Index distribution. Benjamin Heitz

Enquiring the limits of the tool itself

Limited to only using one tool, the student could better use it to inquire into the idea of diversity itself, as well as the suitability of the tool. Although it was not in the scope of the course, the enquiry method allowed this student to pertinently question his methodology and the bias of the Index for this purpose. In these courses, computational data analysis is not expected to substitute other forms of investigation or design, but to complement them. A potential risk of relying only on these methods is undoubtedly to fall into a trap of technological solutionism that ignores other methodologies and perspectives that must complement the enquiries. This course's remote sensing approach would have benefited from site visits, interviews with the neighbours, or study of historical development. Due to time and budgetary restrictions, this did not happen. A dangerous distance to the enquired subject can be generated by an *'overalgorithmisation'*, if not contrasted through other enquiry methods.

Finishing the analysis of the main exercise examined in this section, it places itself within the future scenario of substantial shrinkage of the use of private cars in the city, resulting in a reduction of the public parking spaces in the city of Zürich. Building up on this, the student proposes a speculative scenario that is possible through digital computation, given the number of green areas and parking places in the whole city. The spatialisation of this scenario arises directly from overlapping several parameters and indexes, generating a topography of possibilities. The small interventions would be then opportunistically accommodated following this topography, in the form of networked *'micro-ecosystems'*. The design thrives in generating this novel nature paradigm, that does not need big surfaces. Instead, it strives to enhance the diversity of green spaces, biodiversity, and cohabitation with non-human entities. The scenario formulation is complemented with an in-depth critical analysis of its positive and negative impacts, which help evaluate today's practices with small urban green pockets. The proposal functions beyond the optimisation paradigm and inscribes itself within the three distributed paradigms of de Monchaux in *"Local Code"* (2016): robustness, redundancy and flexibility. As discussed in biology, he pleads for distributed robustness as one of the major factors to enhance resilience. The flexible and entangled network of diverse *'micro-ecosystems'* proposed by the student takes Local Code's approach to a modular and combinable approach. It could be interesting to extend this kind of enquiry to the other cities of similar size along the Rhine that this Thesis covers. Would the results be identical? How can the approach be rooted in the specific situation of each city?

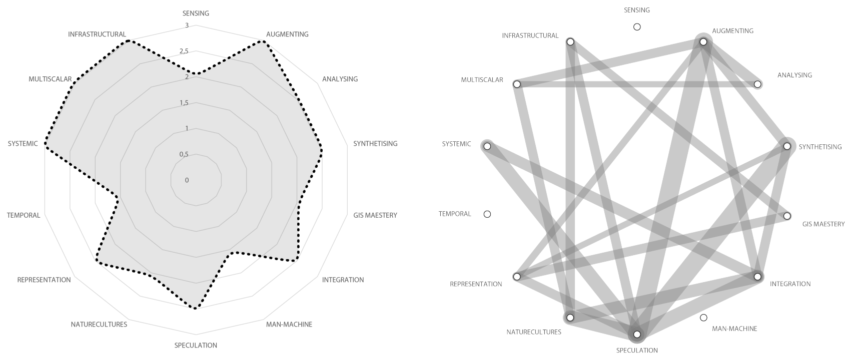


Figure 5.29: Exercise 5.5. Radar diagram and chord diagram. ARC

5.6 Ecosystems and light pollution in Zirkel

Not all creatures dread the dark. Light pollution benefits certain animals, particularly those preying on insects who, paradoxically, are attracted to artificial light sources such as street lamps and illuminated buildings. Spiders, hedgehogs, frogs, toads, some mouse species, and certain bats exploit these areas for the abundant food supply, with spiders building webs near lights and bats hunting flying insects. However, this unnatural insect concentration disrupts the food web and predator-prey relationships, causing ecological harm. Conversely, over 60% of nocturnal creatures suffer from light pollution, which disrupts their activities like pollination, reproduction, and foraging. Artificial light near LED street lamps reduces plant pollination by almost two-thirds, affecting food supply for daytime pollinators like bees. Light pollution also leads to billions of insect deaths, disorients birds, and affects aquatic life.

Figure 5.30: Species affected by artificial light at night in Zirkel. Elena Heilig, Sebastian Dremel.

Description of the exercise. This exercise identifies the coexistence of the brightest and the darkest zone of the city centre of Karlsruhe, in a very limited area. It enquires the possibility of creating zones and urban prototypes fostering mutual interdependence, where the contact of these areas benefits the ecosystem's development.

Data sensing

Four different datasets were collected for the preparation of this short exercise. First, a night light intensity image of the whole city, with a resolution of 30 meters. In it, it was clear to identify that Zirkel hosts the articulation between the most illuminated urban area and the darkest one, due to the presence of Karlsruhe's castle and Hartwald Forest. The second dataset contains all streetlamps, categorised and classified. The two other datasets are social media's platform Flickr pictures in Karlsruhe and iNaturalist animal observations in the zone. All datasets are open data, and easy to find.

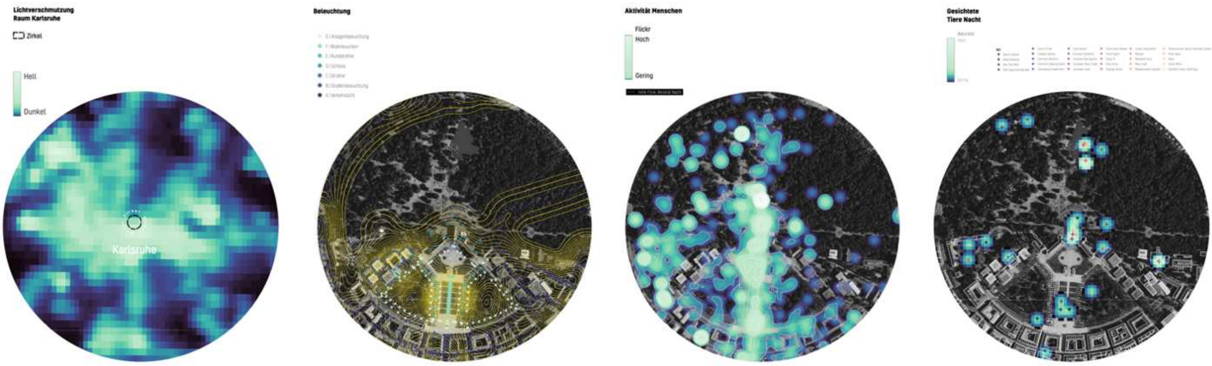


Figure 5.31: Left to right: Night lights in the whole city of Karlsruhe; Zirkel's light infrastructure; Flickr activity at night; Nocturnal animal observations. Elena Heilig, Sebastian Dremel.

Data augmenting

The last three datasets are investigated through several operations. A series of intensity hypotheses are attributed to the different streetlamps, to get a more accurate image of the light influence in Zirkel than the 30-meter pixel night aerial picture. The outcome is a form of 'topography of light intensity' with curves indicating its gradient. The Flickr dataset is filtered to show only images taken by night, as the images' metadata include the exact time of the shot. The resulting heatmap is weighted through the different times, having the most weight those shots taken in the darkest hours. Lastly, the animal observations are also filtered per observation time, and the different species are investigated to understand their interdependences.

The final mapping collects all previous augmented cartographies, portraying a playground of different species within a light gradient landscape. It looks for opportunity zones for interspecies encounters and focuses on the contact zones between illuminated and dark areas, which many animals perceive as a sharp barrier. With this, the mapping gains a certain non-human perspective, making how they experience the site visible. It also incorporates the movement of people in the area by identifying the places where people share images for social media. With it, it also investigates the places of encounter between human and non-human. Undoubtedly, the thematic orientation of the exercise is a result of the available data, a particularly acute issue in a short exercise like this one. The use of multiple digital datasets, which incorporate a high complexity due to the number of streetlamps, Flickr images, and animal observations, would make it impossible to pursue this investigation without GIS datasets and digital computation.

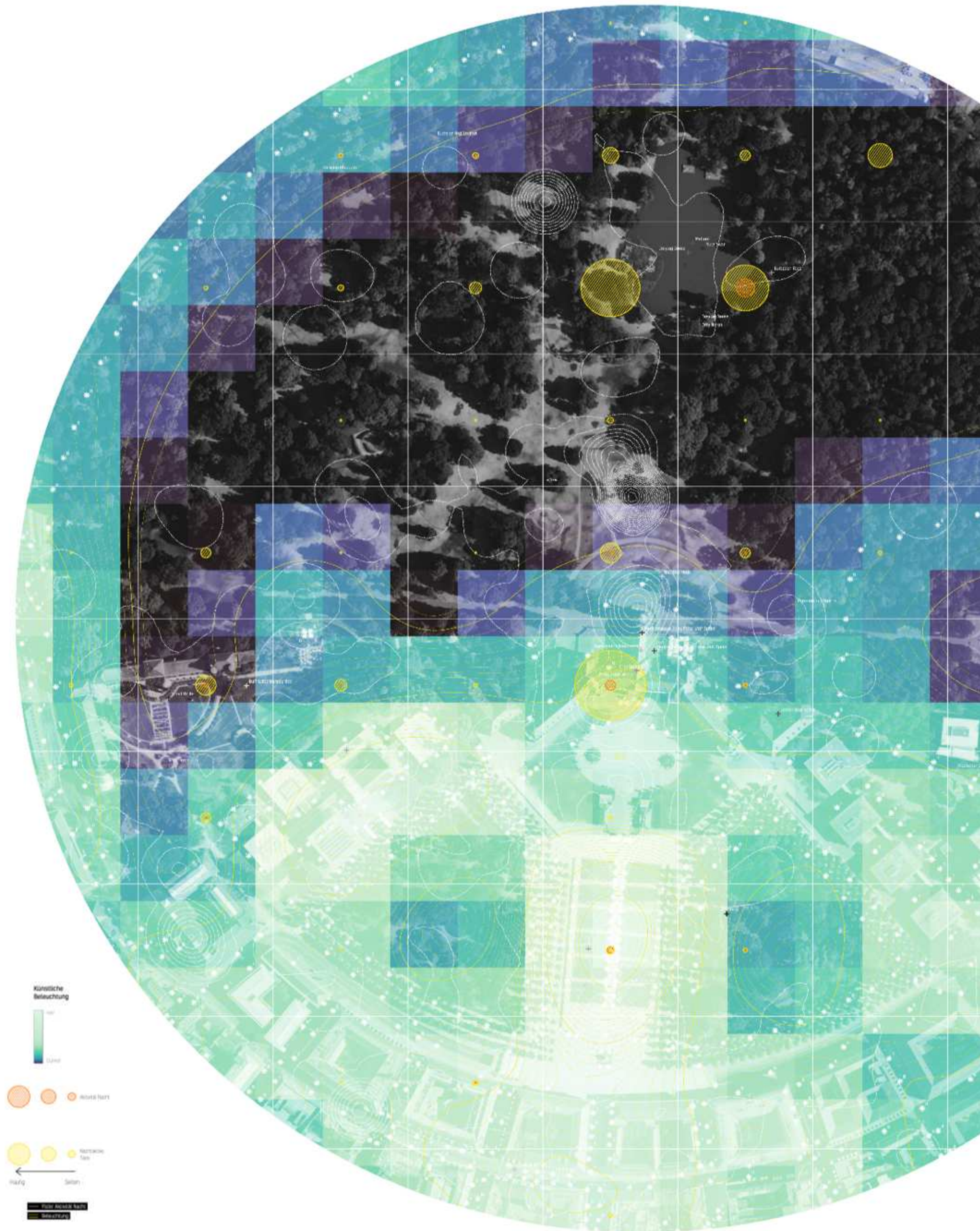


Figure 5.32: Nocturnal ecosystems in Zirkel. Elena Heilig, Sebastian Dremel.

Once the impact of artificial light on non-human ecosystems is verified, a question arises: what if this contact area was an ecological opportunity in the hinge between light and darkness? What if the cohabitation of light and shadow is a driver for thriving ecosystems? Which species could benefit from this exceptional situation? Where would be located the most susceptible areas to host these symbiotic ecosystems? How could the ecosystem embedded in these areas be provided with natural infrastructure that contributes to improving it? Which landscape figures would host this infrastructure? How would people approach these non-human oriented prototypes? The exercise deals with reflections questioning the relationship between people and non-human agents and tries to imagine a possible future of interdependencies.

Speculation

Critical reflection. Though it takes a very short time to outline a proposal, the exercise evinces pertinent data sensing and the use of several techniques such as weighted heatmaps, temporal classification, and spatial analysis. The superposition of all these investigations generates a composite mapping that is open to further interpretation and becomes a strong base for a possible future critical design.

The short nature of a 'Stegreif' –completed in less than two weeks–, together with the lack of GIS experience of half of the students, left no option but compiling the datasets in the first hour of the workshop, which could be considered as *"data opportunism"* (Ortner 2019). All students used the same data, regardless of their approach. Nevertheless, they were able to launch spatial enquiries that incorporated complex and sensible forms of network thinking. Notably, the iNaturalist dataset, locating plants and animal observations in Zirkel, allowed them to investigate considering Timothy Morton's idea of *"mesh"*. They could easily portray some intricate networks that could split in different temporal cycles: hourly, day/night, or by season –see fig. 5.33, produced by a different student team.

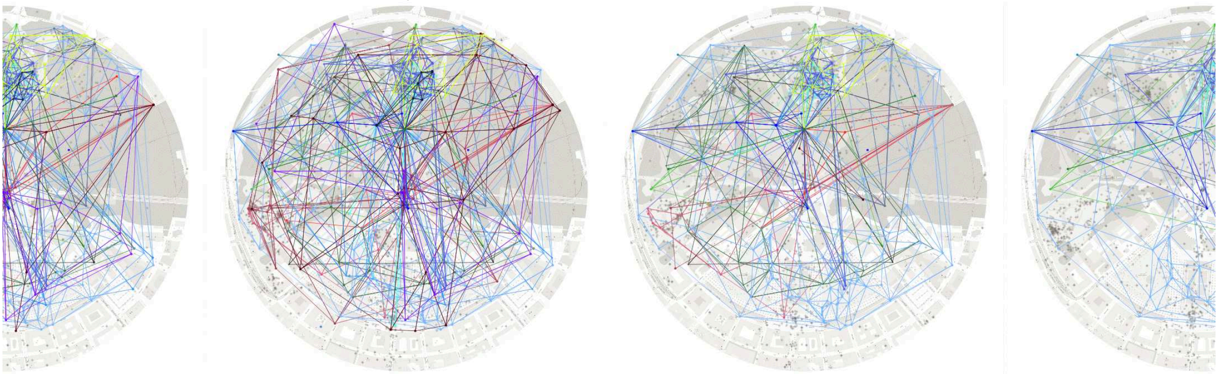


Figure 5.33: Zirkel's seasonal ecological networks in spring, summer, autumn and winter. Mohamed Akrimou, Anna Mayer

This exercise makes good use of remote sensing techniques and manages to prepare the data meaningfully. It starts with an initial idea of *'protecting animals from light pollution'*, which considers Zirkel's ecosystem a passive entity to be conserved. This concept evolves thanks to the powerful cartographies they produced, highlighting that the issue in this zone embodies the juxtaposition of the darkest and lightest zones of the city. This spatial analysis is enriched by system thinking: the representation of the species inhabiting the nightscapes of Zirkel. Imagining a series of landscape devices that serve as an infrastructure for an ecosystem that inhabits the light-darkness interstice is systemic, becoming a novel form of natureculture. It also considers human presence –through the images taken at night–, but *'only'* as another species on the playground.

The spatial analysis of the complex data would inform the process of locating the landscape prototypes. These are not imagined, as this was only a 30 hour exercise. Although the students could explain some possible next steps towards a design proposal, the integration of mapping in a design proposal has not been proven in this case. During the final presentation, questions regarding the specific light frequencies arose, and comments were made about the benefits and opportunities embedded in the proposed speculative scenario and how they may shape a precise design scheme. The work *"Multispecies Chandelier"*, built by the Spanish architects TAKK in 2024, resonates with many of these themes. A hanging device with plants and other man-built spaces for multiple species incorporates several lighting devices. The emitted light, seen by the human eye, is classed in eight different colours that, beyond aesthetic value, provide benefits for plants, insects and several night species. Additional light spectrum could further enhance the effects on fauna and flora. The prototype enacts a celebration of a place for interspecies encounters. It exchanges energy, light, nutrients, information. It generates very specific conditions around it, shaping the landscapes it is placed in.

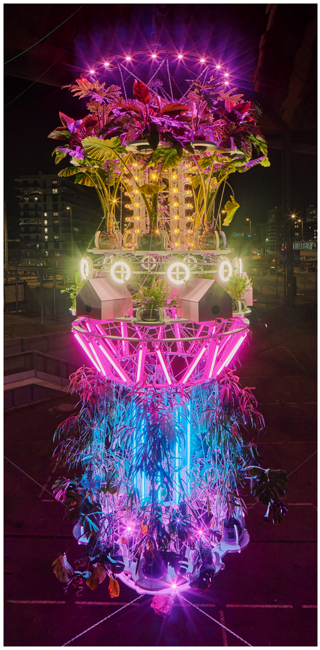


Figure 5.34: Multispecies Chandelier, TAKK. Image: José Hevia, courtesy oft he author

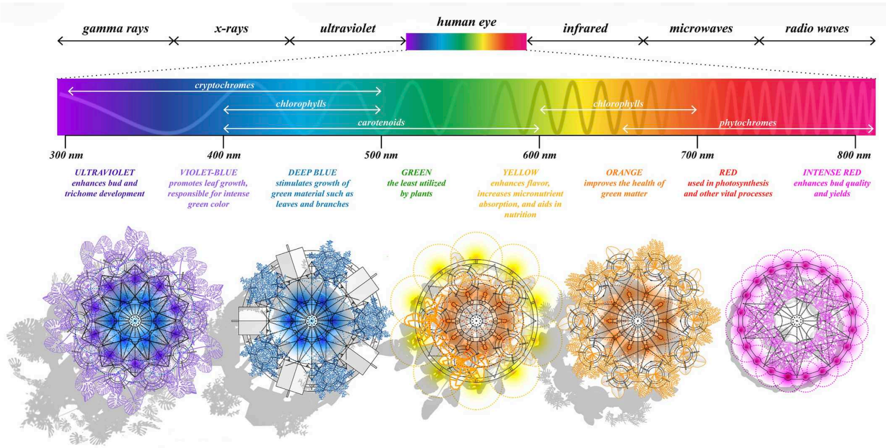


Figure 5.35: Multispecies Chandelier, TAKK.

This exercise excels in imagining hybrid landscapes where the cohabitation of human, non-human and technique produces an unexpected result. Imagining dispositives beyond *'nature-inspired'* schemes, fully integrating human and non-human interaction through novel uses of digital mapping.

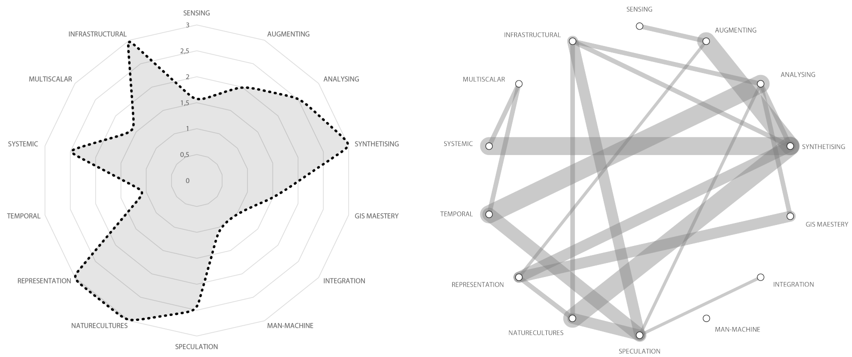


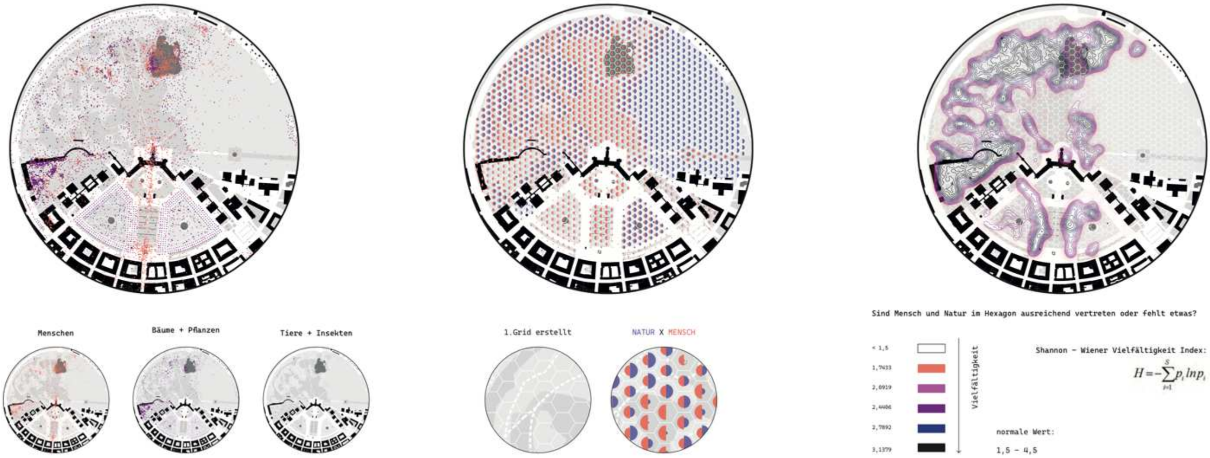
Figure 5.36: Exercise 5.6. Radar diagram and chord diagram. ARC

5.7 Auf der Suche nach Raum

The proposal uses open data to study the Zirkel area in Karlsruhe to observe ecological events. Is this area equally used by humans and nature? Initially, this space was designed for human dominance. In 1715, the palace was built as the residence of Margrave Karl Wilhelm of Baden-Durlach in the Hardtwald forest. The Baroque-style palace included a forecourt, and gardens divided into pleasure, orangery, animal, and pheasant gardens. However, much has changed since then. Some areas once used for hunting are now nature reserves, and the park is open to the public. Humankind's vision has also shifted from dominance over nature to being part of a symbiotic system. Initial steps have been taken, but cohabitation of humans and nature could be further promoted. This exercise delves into this path and seeks spaces encouraging human and non-human cohabitation.

Description of the exercise. Using data from OSM, Flickr, iNaturalist, and the city of Karlsruhe, Zirkel's residents/visitors are identified and examined. Trees, plants, insects, and animals are mapped under the category *'nature'*. Several maps are then created, the first identifying singular occurrences of fauna, flora, and human presence, as determined by geo-localised social media posts. The second one tries to capture cohabitation of human and non-human, identifying different degrees of interaction. Finally, after creating an analysis grid, visitor diversity per cell is measured, and the diversity index –Shannon-Wiener Diversity Index– is calculated.

Figure 5.37: Left to right: use of Zirkel; proportion of usehuman/non-huan; cohabitation through diversity index.



Nicolas Astudillo, Klára Vašáková.

The spatial analysis of the augmented datasets starts with an overlap of them, trying to understand the implications of each one. An index below 1.5 indicates low diversity, highlighting areas for potential improvement to promote cohabitation. Merging different kinds of representation, and introducing a certain degree of ambiguity, the infographic construct reveals a possible topography of human-non human interaction. This new landscape can be seen as an *'associated milieu'* (Simondon 1958), a dynamic environment encompassing natural and technical elements in mutual influence. The students propose to imagine this milieu hosting small architectural proposals that provide space while reducing the pace, fostering forms of encounters that otherwise would be ignored. This exercise deploys graphic techniques to build knowledge from the representation of statistical data, while mobilising principles of computational systems thinking. The students shape-by-do their own design path, assembling several GIS techniques that they knew but never used in this way before.

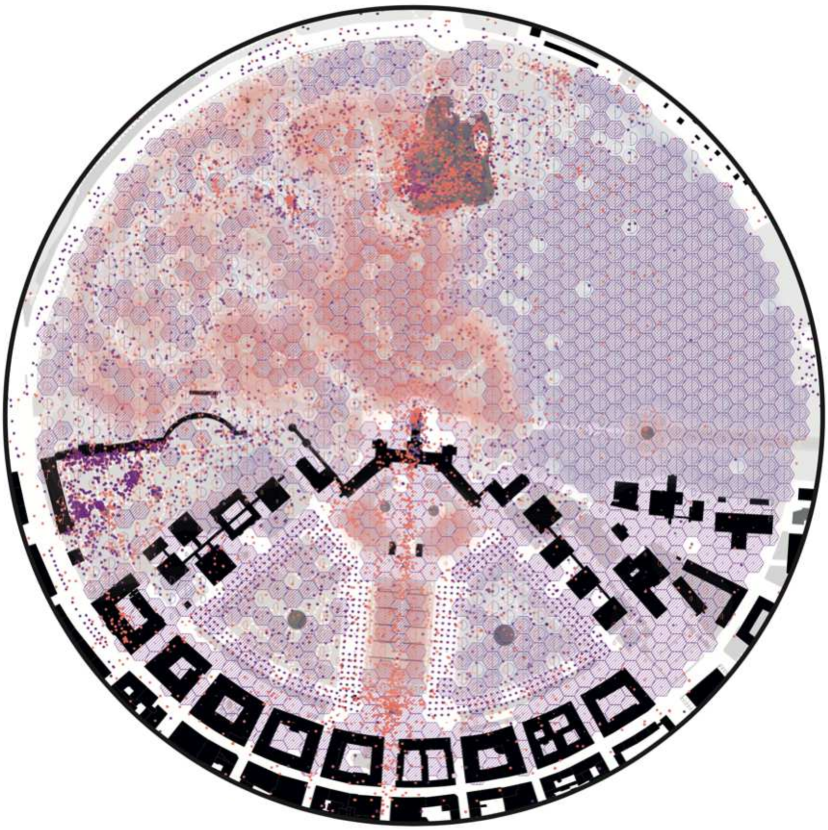


Figure 5.38: Final mapping. Nicolas Astudillo, Klára Vašáková.

Critical reflection. This exercise embodies a critical exploration of the required data to research into human and non-human cohabitation. The *'Stegreif'* format makes its process different from other examples: at least one of the students in the team had to have experience with QGIS, and an extremely short period of work. The students had to handle their outcomes after 30 hours of work, therefore, the datasets were given to them, so no time had to be used in data mining –and assuming the consequential data opportunism (Ortner 2019). Armed with certain previous GIS mastery and having the datasets from the first moment, the students delve here into the dataset's augmentation, interpretation, and synthesis. They skilfully use one of their most powerful assets, graphic representation of spatial relationships. The resulting mappings describing the distributed intensity of cohabitation in Zirkel reflect their effort to understand better this phenomenon: how and where it happens, inviting the map reader to question the forces that shape the cohabitation.

The goal initially fixed by the students, to enhance cohabitation in Zirkel, speaks for the values of Ecocene, but the technologies to inquire into such a goal are not conventionally agreed upon. Thus, this exercise would be situated somewhat in the field *"B"* of Christensen's type of projects –see table 2.2. This leads to a form of experimentation, where innovation is expected to lead to practices that push technical development further. As Christensen identifies, in such cases, the best procedure is trial and error, looking for technical developments that help designers to fulfil the agreed goal. The use of standard datasets and geographical tools within the Smart Cities paradigm is, in this case, *'hacked'* by the students, which could be considered a *"practice of dissent"* (Paredes Maldonado, 2020). Social media post analysis is commonly used for customer profiling, but it is not an extended approach to understanding human and non-human spatial relationships in public spaces. Reimagining possible methods to question the given datasets is a key part of this work. It is necessary to reappropriate technologies in ways to make them part of the effort; it becomes imperative to construct new ecological relations to technical beings that already exist or that are to be invented. In this sense, this exercise successfully reappropriates basic spatial analysis techniques to reimagine forms of cohabitation. The student's competences to augment, analyse, and synthesise the provided information are developed thanks to their experimental approach to technology.

This exercise exemplifies how to take action through integrating two of Gandy's (2022) identified perspectives of urban ecology –see section 1.5. First, the idea of observation of nature, updated with digital tools, and compiled by different people in a form of '*citizen sensing*'. Should the students not use any GIS technology, they would have visited the site once to observe it, and most of the observations compiled in their mappings would not have been perceived. This form of remote sensing should, in any case, replace direct exposure to the site. Still, enriching that approach by trying to apprehend sophisticated aspects of behavioural ecology and contact zones of humans and non-humans is considered valuable. Besides, this exercise is related to Gandy's idea of gaining non-human perspective into what he calls *"ecological pluriverse"*. The students were not merely representing the geolocation of animals and plants, but using the datasets and their augmented representation to shift from anthropocentric visions on nature towards an ontological diversity that recognises non-human agency. However, the time constraints and the proposed datasets were insufficient to attain such goals. They were enough, though, to allow the students to reflect about the datasets they would need to undertake research actions that could take them closer to that *"ecological pluriverse"*.

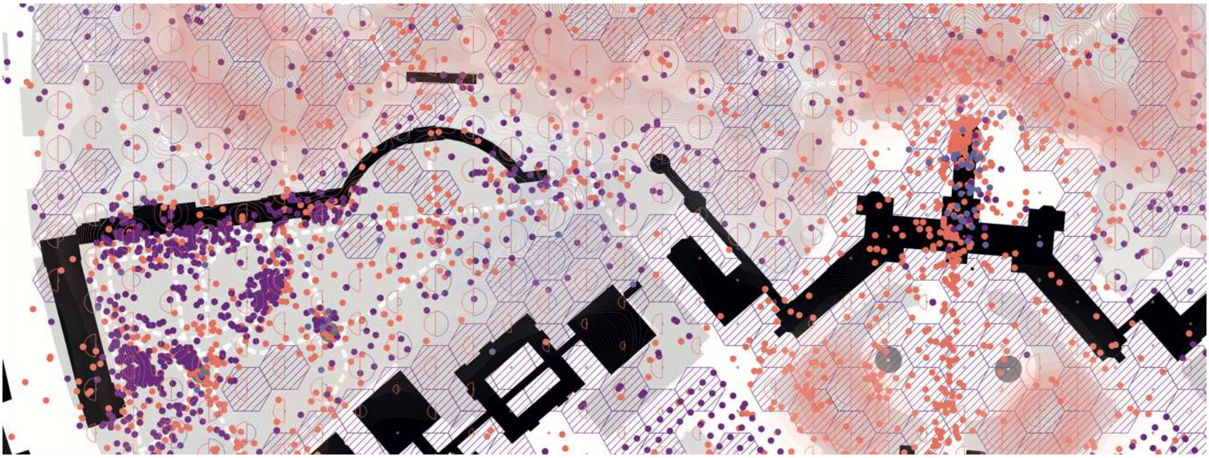


Figure 5.39: Extract of the main mapping. Nicolas Astudillo, Klára Vašáková.

The very personalised form of mapping that the students present not only provides an interesting base to discuss the forces shaping cohabitation, but also *"bridges the gap between research and design as separate disciplines"* (Roggema 2017). Empowered by GIS techniques, they manage to ideate personal forms of representing data that take them towards a design proposal. The big final mapping overlaps all previous mappings, generating a new '*topography of cohabitation*': zones where more interaction is detected, and areas where it could be enhanced. This spatial approach, presented by the exercise title –'*looking for space*', in original German– presents several difficulties. First, given the limited granularity of the provided data, can it be considered enough to extract such conclusions? The value of the exercise lies more in this case on the evolution of the student's workflow, rather than the result's precision. As they identified, they could perform a finer form of work should they have different datasets. Both exercises in Zirkel show the limitations of the datasets for smaller areas. Similar datasets are used in other exercises for the whole city, such as 5.4 or 5.8, and their granularity and level of detail seem more adapted for more significant areas than a local park, such as Zirkel.

Finally, it is possible to consider this exercise a counter-practice that builds knowledge mainly by interacting with data augmented, analysed, and synthesised with forms of representation. This guides the students towards a proposal that emerges from the data handling.

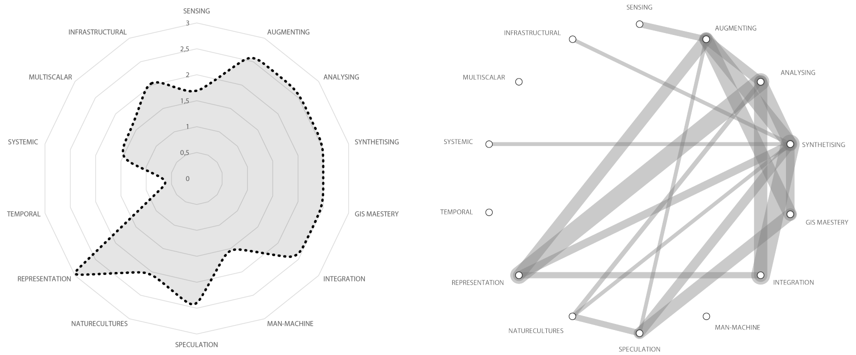


Figure 5.40: Exercise 5.7. Radar diagram and chord diagram. ARC

5.8 ECOnnect

In this exercise, an ambitious landscape strategy is planned to connect local and regional ecosystems through the city of Offenburg's urban space. The resulting benefits for human and non-human health promote biodiversity and address the decay of the Urban Gaia.

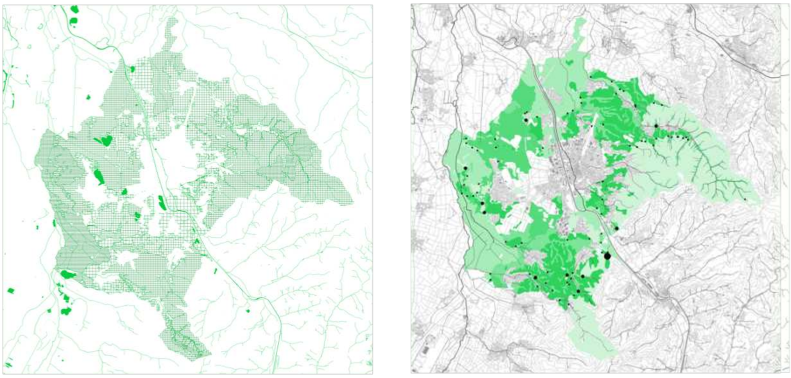


Figure 5.41: Soil permeability, Soils, Soil thresholds. Oliver Leitzbach, Elisa Muhr.

Description of the exercise. The starting point was the observation of non-human forms of life inside the city of Offenburg and in its environments. First, a series of cartographies of the plants, animals, fungi, and other forms of life are created. The data can be found on several online platforms, such as Global Biodiversity Information Facility or iNaturalist. They operate as a collaborative effort to identify ecological occurrences throughout the planet. Every person can contribute from their mobile phone, just by following some simple steps, which creates the force of these wiki-shaped platforms. Other datasets are compiled, from sources like the city of Offenburg or Open Street Maps, localising gardens, parks and green infrastructure in the city, as well as parking lots. Those places within the urban contours are most sensitive to evolve, whether by the current presence of nature, or for their potential for transformation in a car-free paradigm. Ecological occurrences are classified, studied, and crossed with another factor: soil. A thorough study of the region's peculiar geomorphology reveals different compositions and well-delimited zones. The friction areas between different soil zones are identified as potential biodiversity hubs, which are verified through the data compiled from iNaturalist and GBIF.

Figure 5.42: Left to right: existing parking lots; existing urban tissue; adapted urban tissue. Oliver Leitzbach, Elisa Muhr.

The students understand that *"all around us is habitat [for non-human]"*. If cities are the places where non-human entities live as well, the question is, how can the attractive substrate that will host that biodiversity be promoted? Taking the soil thresholds condition as an example, this strategy is extended to the ECOnnect pathways, where the mixture of soil, humidity, air circulation and constructive conditions generates a fertile ground to build new ecosystems. And, with them, new relationships with the people who also use this new form of green infrastructure. The project takes the form of a network of multispecies corridors. The main ones build a cross: north-south, taking advantage of the existing river Kinzig and the surrounding green areas. The east-west corridor connects two zones identified in the soil analysis maps as biodiversity hubs due to soil configuration.

Critical reflection. This proposal's strength lies in the deeply held conviction of creating spaces within the city that are primarily conceived from a non-human perspective. It investigates future scenarios where urban green infrastructure benefits, of course, human health – both physical and psychological. As a collateral effect. Because the design decisions are driven by a novel declination of what urban nature could be. What if existing and new biotopes could find their path through the built realm? How would this affect the relationship of citizens with the surrounding non-human entities? The starting point is reusing existing parking lots and low-intensity green zones. These places will host the reconstruction of various ecological conditions within the city to create new biotopes. The design itself is considered a test ground for biotope variations along ecological penetrations in the city. This new green infrastructure is notably lacking in the city centre and will be the setting for close encounters between humans and non-humans. They will foster the creation of new bonds with urban nature beyond previously transited paths. This speculative design is driven by the careful study and overlap of the different datasets: soil, ecological occurrences, land use. This will not only determine the location of the stepping stones and the paths that connect them but also define the biotopes' characteristics and scale while reshaping human relationships with urban nature.

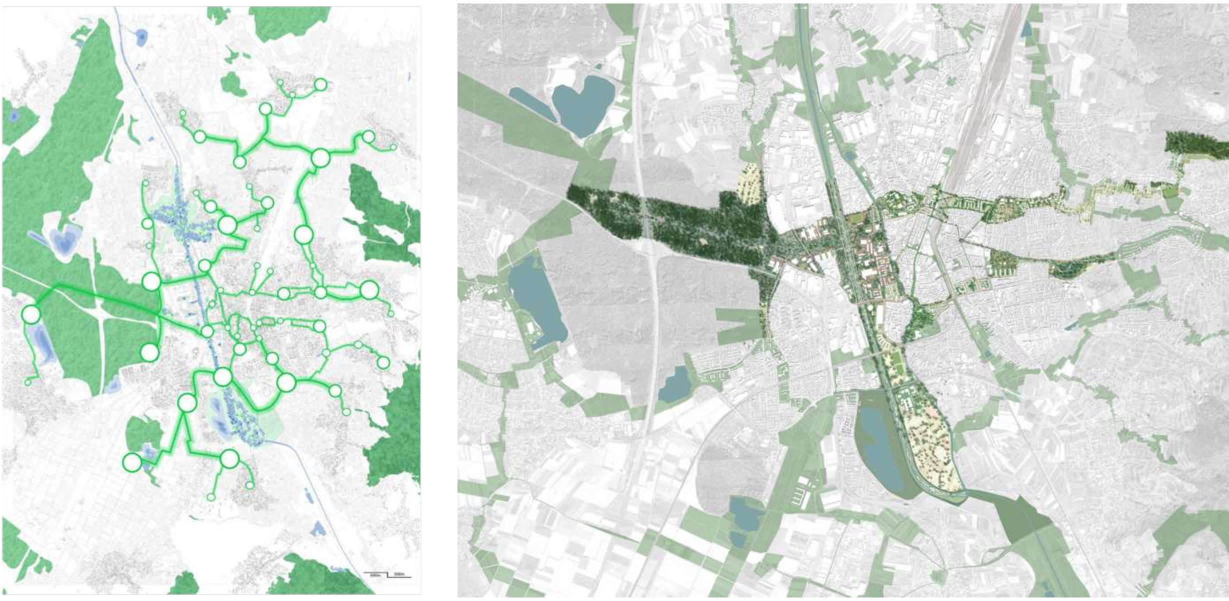


Figure 5.43: Left: first conceptualisation; right: final design. Oliver Leitzbach, Elisa Muhr.

The first ideas emerging from the mappings pointed at several paths, which the proposal could consolidate. After the mapping exercise, the students felt distanced from the territory, probably due to its considerable extension. As a complementary approach to mapping, they made an eight-kilometre walk, following the east-west corridor, while making a video. Trying to capture non-human perspectives, the video was primarily filmed at soil level, hardly ten to fifty centimetres above ground. The combination of the mapping work with a phenomenological approach of the site was the actual trigger of the design scheme.

Figure 5.44: Captures of the video along the east-west corridor. Oliver Leitzbach, Elisa Muhr.

This design operates in multiple simultaneous scales: from a borderless pan-European geological, climatic, and biological entity to underground mycelium networks. Along this scalar journey that builds up from the Eames's *"Powers of ten"*, several intermediate scales are considered: the regional Ober Rhein 10^6, the metropolitan region of Offenburg 10^5, the urban centre 10^2, the neighbourhood square 10^3, the green pocket 10^2, the open and lively soil 10^1. The availability of data through all these scales makes possible successive mappings covering the different situations studied, and, more important, to be able to produce a proposal of ECOnnection for each scale. The ability to comprehend all scales connected, hosted by the upper ones and hosting the ones underneath like a Russian doll situates the project close to Boehnert –Ecocene– and Morton –mesh– ideas. The design operates in the interconnectedness of each scale and in the interdependences between scales. What enables this proposal to be situated and spatially precise? The possibility of simultaneous digital mapping through all scales.

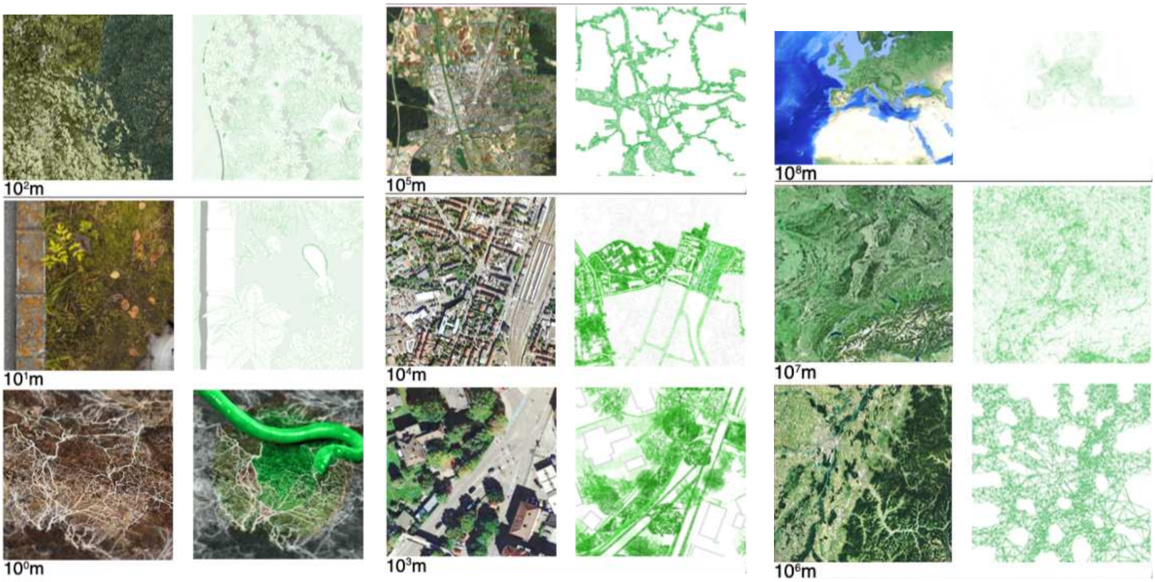


Figure 5.45: ECOnnect scales through 'Powers of ten'. Oliver Leitzbach, Elisa Muhr.

The previous exercises were part of a Seminar –exercises 5.1, 5.2, 5.3, 5.4, 5.5– or a 'Stegreif' format –5.6 and 5.7–, while this exercise and the following two are part of a design Studio. The difference between formats is explained in detail in section 4.4.1. Apart from the time involvement, the main difference lies in the deliverables, which, for the Seminar and 'Stegreif,' can be considered more like a *'design approach'. In contrast*, a complete design proposal is expected at the final presentation of the design Studios. In this sense, the Seminar exercises had more time to delve into the use of GIS throughout the semester, and these Studio projects mainly mobilised GIS techniques during the first three or four weeks, quickly moving towards a design proposal. The most important value of these three last exercises is their capacity to convert their mapping explorations into a complete functional design scheme.

As architectural students, they are often given a well-defined design Studio brief that leads to the design of a specific building or group of buildings. Urban Studios are already a bit more open and consider the urban question as a wicked problem. Certain urban Studios such as this one invite the students to start the reflection even from the initial design process, where the question to react to has to be defined. Therefore, the students were given only a thematic axis, in this case, *'non-human'*, but no specific problematic or situation to solve about or for it. They had to generate a proposal that dealt with the thematic axis at the scale of the whole city – *"Leitbild"* in German. Still, they had to articulate the issues, challenges, trends, weaknesses, and opportunities that the design had to face. In this sense, the first task was to understand the current situation of Offenburg's non-humans and define the aspects that were urged to be tackled. After a first puzzled reaction, where they discovered a task they had not faced before, the data sensing phase was the trigger of understandings that dealt with broad visions of urban nature. The definition of the city as the lack of continuity of the regional biodiversity encompasses the *"discontinuity"* ideas of Descola. Once the goal was set, to restore some forms of non-human continuities within the city of Offenburg,

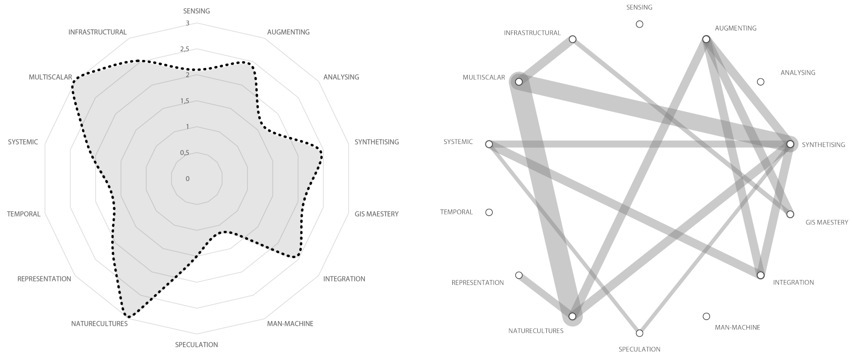


Figure 5.46: Exercise 5.8. Radar diagram and chord diagram. ARC

5.9 The great escape

This proposal focuses on redesigning Kriegsstraße, which is heavily burdened by traffic, noise, and emissions. The project identifies Kriegsstraße as a significant barrier within the city, making it challenging for pedestrians, cyclists, children, and the elderly to navigate. Besides, it constitutes one of the heat island poles in Karlsruhe, with an evident progressive ecological impoverishment. The design concept emerged from personal experiences and observations, particularly noting the stress hotspots at major intersections. Key elements include connecting existing green areas to create a network of cooling and fresh air zones and establishing *"Resilient band-aids"* to strengthen the tree network of resilient trees. The central feature is a bike path running through the middle of Kriegsstraße, ensuring a swift east-west route. *"Oases"* replace former stress points, providing high-quality green spaces for relaxation. These areas include water features, small hills, seating, and lighting installations to create a pleasant atmosphere even at night.

Figure 5.47: Left to right: resilient oasis, before and after. Patrick Eissele, Anna Klotzki.

Description of the exercise. This piece of work mainly deals with the tree cadastre of the city of Karlsruhe, which geo-localises trees in public spaces. Many other urban trees are missing, such as trees in private plots and the urban forest, which penetrate the very centre of the city. Nevertheless, the cadastre is also helpful in identifying tree species, although not much further detail is provided.

Data augmenting

The information extracted from this dataset is crossed with botanical literature that allows the students to classify the robustness and resilience of the different species. This leads to a map where resilient trees are portrayed, making evident *"resilience gaps"* in the city green network. One of the goals of the Leitbild is the connection of existing green infrastructures through streets that are accompanied by rows of resilient trees. This way, the first action of the design scheme is to fill in the gaps with *"resilient band-aids"*: groups of trees that adapt to the current climate and make the overall network more robust.

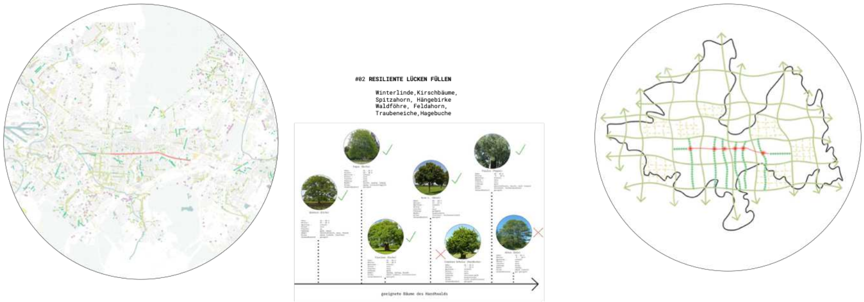


Figure 5.48: Resilient trees network Karlsruhe and non-resilient gaps. Patrick Eissele, Anna Klotzki.

Data synthesising

Building on the idea of the "resilient band-aids," the design scheme is completed by introducing resilient oases in the main intersections of Kriegsstraße. These oases complete the continuity of the city's resilient network while providing the location of several architectural and public space prototypes.

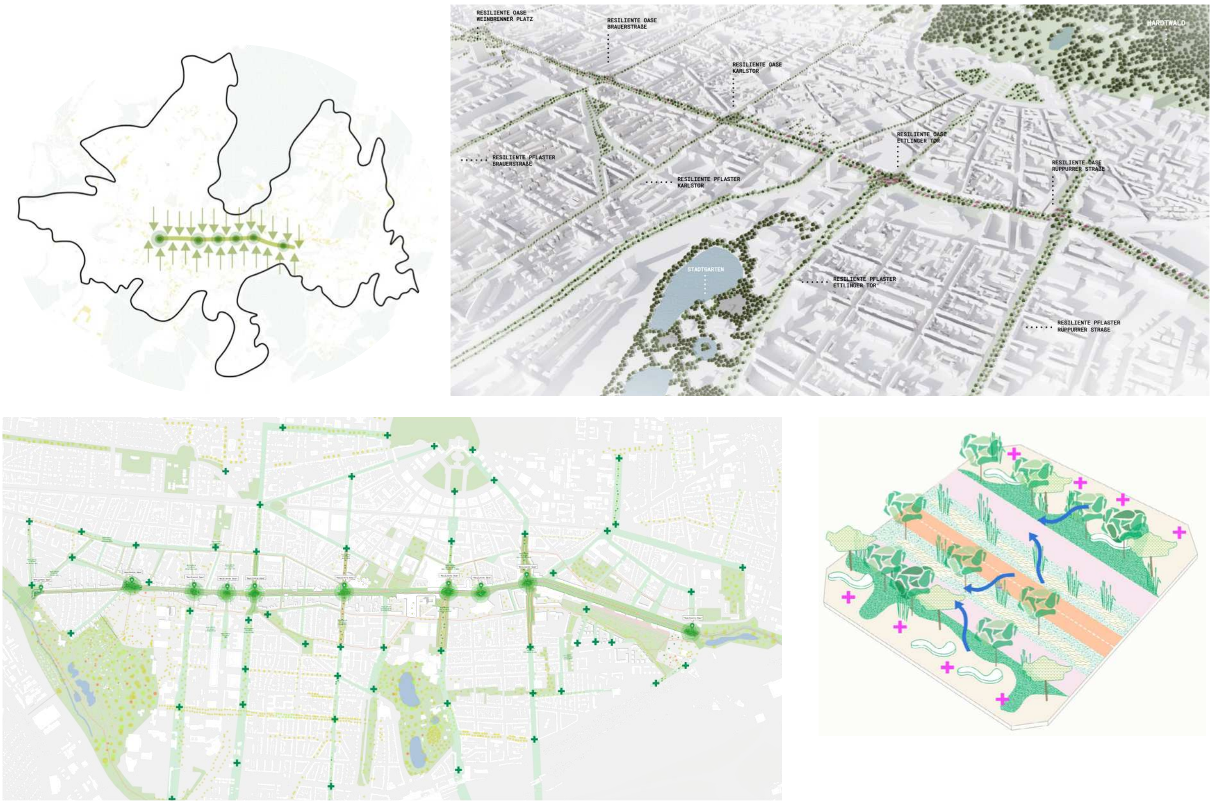


Figure 5.49: Resilient trees network Karlsruhe and non-resilient gaps. Patrick Eissele, Anna Klotzki.

One of the students in the team also portrayed an additional assessment of the resilience of trees in private courtyards in Karlsruhe. Initially, public trees were evaluated for resilience. The analysis focused on identifying resilient trees –depending on several factors such as resistance to drought, climate adaptation or endemic species– among those collected, revealing a notable increase in resilience towards the west, likely due to both mapping inconsistencies and the strong gardening culture in the Weststadt area –see fig. 5.50. Of 846 collected trees in the treespotting action, 326 –about 38.5%–, were considered resilient. The Weststadt features large, interconnected courtyards with dense gardens, hosting many resilient trees. The second step involved examining the impact of these resilient trees on nearby park areas. The analysis determined which zones in Karlsruhe parks are within 50 meters of a resilient tree, highlighting park edges with resilience deficits and evaluating the climatic benefits for park areas.

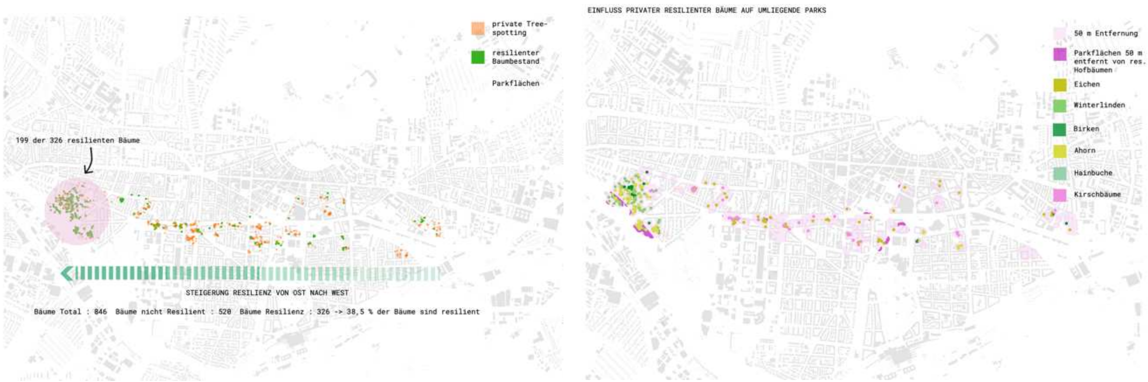


Figure 5.50: A comparative study of the resilience of trees in public domain and private plots. Anna Klotzki.

Critical reflection. This work incorporates data sensing, augmenting, and analysis from the very early stages of the project. This definitely contributed to defining the location of the design actions to be taken, and how these actions should be implemented. The idea of the *"resilient band aids"* came up during the fourth week of the course, just one week after the last GIS workshop. This demonstrates how quickly the students understood the power of the new tools they were learning, and how they did not understand them as mere analysis tools but used them in a proactive and explorative manner.

The most relevant aspect of this exercise is the students' dataset creation. They acknowledge the value of the existing tree cadastre but could also identify that it only captured a very limited ecological reality of the urban tree population. In this sense, the new dataset that all students put together stems from *"design-driven data"* (Ortner 2019), information that is not available but is required to fulfil a design task. Identifying and analysing the trees on private plots allowed the students to rethink the resilient tree network, building robustness from redundancy (de Mochaux 2016) and symbiosis between species.

The proposal uses the tree dataset to generate a speculative proposal, where a network of resilient streets hosts climate adaptation, non-motorized mobility and social interaction. In these new forms of streets and squares (the oasis), nature, urban space and architectural prototypes work symbiotically. The mappings generated in the first weeks to identify the places of the *"resilient band-aids"* and their implications are simple but very effective. They clearly identify the points and areas that need this kind of green infrastructure.

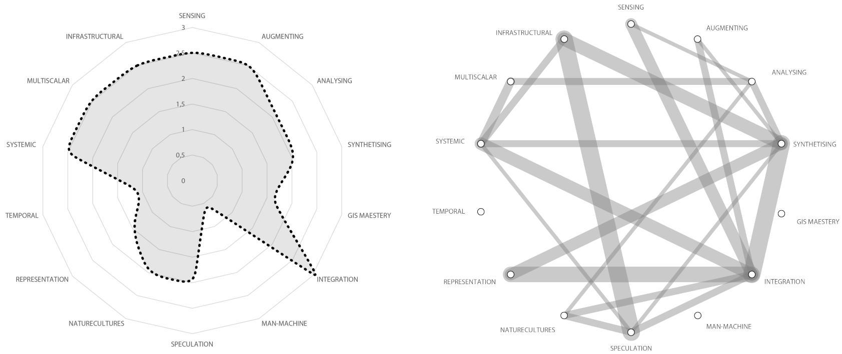


Figure 5.51: Exercise 5.9. Radar diagram and chord diagram. ARC

5.10 Soil: rethink, reconnect, regrow

This proposal considers urban soil a key ecological interface that hosts numerous human and non-human interactions. Different anthropogenic actions, from industrial sites to local graveyards, menace the environmental functions of soils. This danger is particularly grave in areas close to water streams or where it can easily infiltrate the underground aquifers. The design scheme looks for forms of therapy for these soils, creating new regenerative landscapes that offer the inhabitants unique urban spaces weaving yet unconnected neighbourhoods, while enhancing the health of the substrate ecosystems.

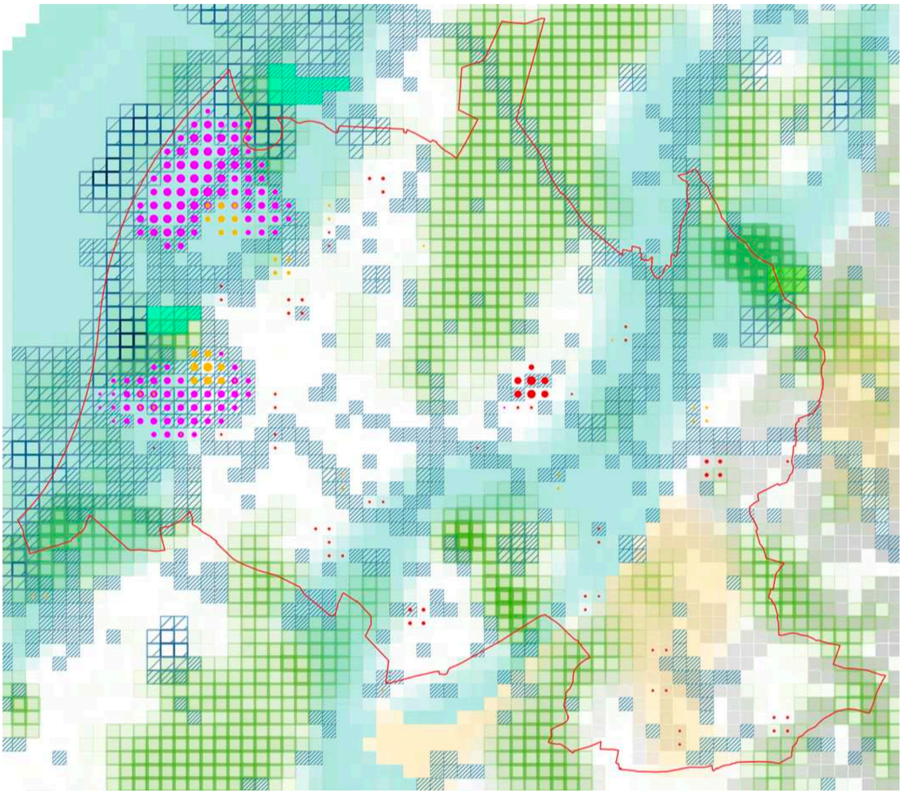


Figure 5.52: Analysis cartography of Karlsruhe. Isabela Cardona, Sophie Weiss.

Description of the exercise. The starting point of the exercise builds up from McHarg's principles, identifying in a large area around Karlsruhe the areas with highest ecological value, such as forests and waterbodies. This is crossed with hydrogeologic datasets –see fig. 5.50–, pointing out critical points between the different elements. Employing a similar methodology to *"Design with nature"*, the exercise also points out critical uses of urban soil that have become a menace to the balance of the underground ecosystem. Large industrial sites such as oil refineries, dumpsites, or landfills represent a major hazard, sealing surfaces and augmenting the imperviousness that hinders water cycles from recharging uniformly subterranean waters and providing sufficient nutrients to the soil. Adding up to these damaging sites, graveyards are also identified as dangerous, due to leachate release, just as landfills. This way, the most relevant natural values for and the most hazardous hazards for soil health are represented in the same drawing.

The course brief asked to investigate urban water and its relationship with urban form, but did not name a specific problem to solve or a precise area to treat. The resulting cartography of the students guides the intervention, identifying stress points and areas of opportunity. The riverine areas along the Alb –see fig. 5.51– become the field where different forms of soil therapy can generate new typologies of spaces. There, ecosystem treatment will be paired with places for memory –the new typology of soil-repairing cemeteries– and urban reconnection.

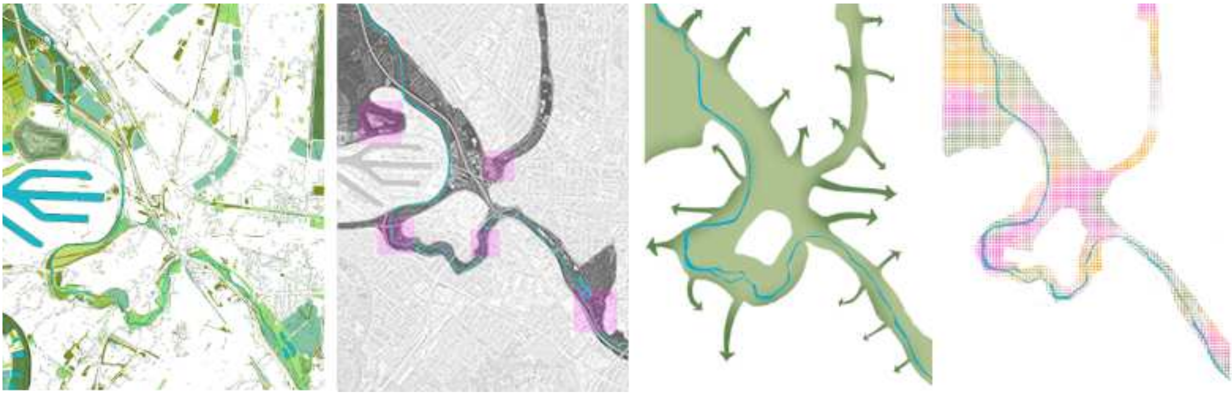
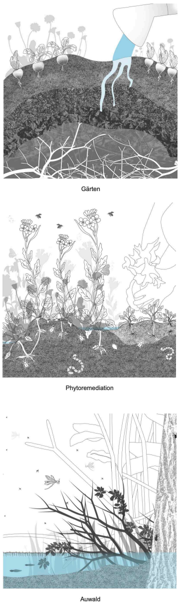


Figure 5.53: From left to right: Existing green and blue infrastructure, hazard zones, affected area, and soil therapy types applied to the Alb riverbanks. Isabela Cardona, Sophie Weiss.

The urban design strategy consists of three distributed actions, following the different situations identified in the first map: soil reinforcement, soil filter, soil care. The first occurs in the riparian forests that are recurrently flooded and require different planting to allow gradual water infiltration, contributing to biodiversity enhancement. The second one corresponds to the new cemeteries: rich biodiversity environments where phytoremediation slowly filters nutrients to the soil. Novel forms of burial, such as Capsula Mundi, are proposed, allowing better integration in the water cycles of the area. The third one corresponds to a soil treatment through neighbourhood gardens, where the dwellers of the closest buildings care and repair the areas uncritically planted with lawns for decades.

Critical reflection. This exercise, as well as the two precedent ones, is produced in a design Studio, which implies that the final product had to be a well-defined urban design proposal. Thus, the time dedicated to learning GIS techniques was reduced to two or three weeks, which is clearly insufficient to portray more sophisticated data analysis, such as those depicted in the first five exercises. On the other hand, in these three last exercises, it is possible to deepen the steps between mapping and a design proposal emerging from a speculative scenario. This proposal's *"what if…?"* question could be formulated as: what if regenerating degraded urban soils—such as former cemeteries, landfills, and areas affected by soil contamination—became key spatial connectors to urban watercourses?



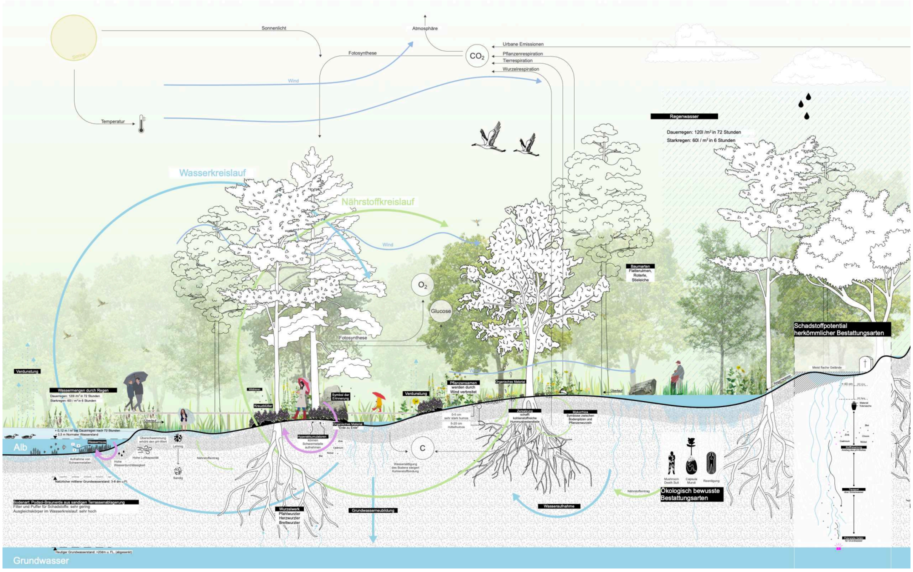


Figure 5.54: Section of the three soil treatments and detail of the three systems. Isabela Cardona, Sophie Weiss.

After a simple data gathering from open data portals, the students could make a refined work augmenting and synthesising the collected information the map of fig. 5.50. Two key aspects emerged from it. First, the thematic perspectives the students identified as the problem to react to: urban infrastructures such as waste disposal sites, large industrial areas or cemeteries were often placed close to water streams directly over aquifers, risking underground water pollution. Secondly, the map also indicated where these interactions were taking place throughout the whole city of Karlsruhe.

Figure 5.55: Masterplan of the Alb meander zone showing the three soil therapies in their context. Isabela Cardona, Sophie Weiss.

This proposal echoes McHarg's approaches and de Monchaux's *"Local Code"*. The mappings of the metropolitan region of Karlsruhe revealed the areas that suffered more stress from this kind of anthropogenic actions. The proposal aims to enhance the city's distributed robustness and resilience, treating each endangered area accordingly. Due to time constraints, only some of the areas have been developed in detail, becoming exemplary design schemes that could be similarly extended to other parts of the city identified in the first cartographies.

One of the values of the first cartography is its graphic abstraction. The technique employed, dividing the territory into cells and superposing the information of each parameter in each cell, is quite compelling. It generates a topological surface, which is very precise about the information and simultaneously separates the map reader from the detailed reality of the context. Other students also deployed this research technique; see Fig. 5.53–, with different graphic codes, and researching various aspects. The students had to try out different approaches, exploring several possible hypotheses. Finally, they discover a particular relationship between industrial areas' soil imperviousness and adjacent watercourses. This was at the origin of the design proposal: they could locate their actions and define the thematic direction of the problematic to which they would react. This experimental path exemplifies the reflection-in action processes proposed by Schön –see 2.1.1.

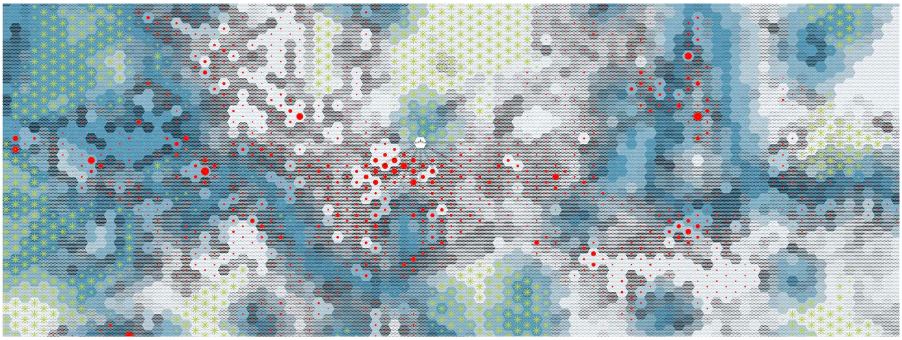


Figure 5.56: Map representing Karlsruhe's in-balance between imperviousness surfaces, water bodies, and built volume. Jakob Wolf, Aaron de Haen.

This exercise epitomises perfectly how even a significantly reduced GIS mastery can have a powerful effect on the design process. A couple of uncomplicated analysis techniques are enough to create cartographies unveiling relevant aspects for the design task. In this case, a proposal promoting cohabitation in hybrid landscapes fully integrates with the speculative question. However, further aspects regarding the transformation of these areas within time should be expected in this kind of proposals. Questioning the relationship of GIS and design, Michael Batty (2018) defines design of cities as the *"process of generating physical artefacts which meet 'agreed' human (social and economic) goals pertaining to specific points or periods in time and space"*. His main point regarding the required evolution of GIS use for design is to consider cities as growing and evolving systems, requiring tools to foster design as a growth process (ibid.). In this sense, simple data overlapping can only be a first step towards better GIS integration with the design process. More prolonged periods than an 11-week semester are certainly required to achieve such results.

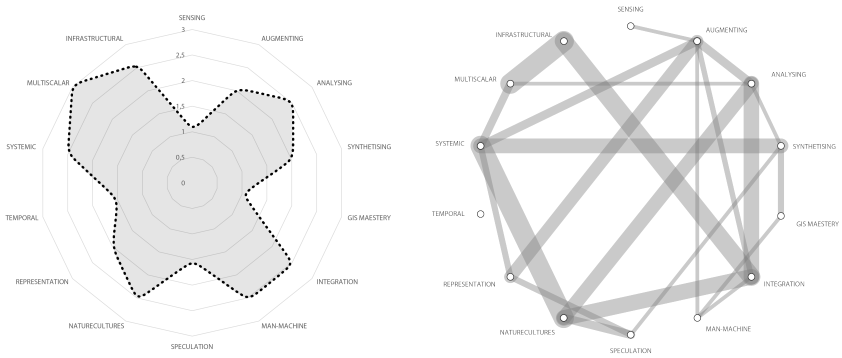


Figure 5.57: Exercise 5.10. Radar diagram and chord diagram. ARC

5.11 Summary of the exercises' analyses

None of the ten analysed exercises is a perfect and replicable example of what *Mappings exploring Speculative Scenarios with Urban Nature* should be –it is questionable that such perfect practice exists at all. However, each one contributes to understand the outline of the practices that *MESSUN* embodies. Therefore, the analyses portrayed in this chapter converge into three subsections, summing up the knowledge extracted from student's design processes observation. First, the competency development is enquired through the radar and chord diagrams drawn for each exercise. Then, a series of typologies of impact are identified throughout all examples, and finally, *Mappings exploring Speculative Scenarios with Urban Nature* is confronted with other possible design methodologies.

5.11.1 Radar, chord diagrams: competency development

Following the analysis carried out throughout this chapter, a graphic superposition of all radar diagrams and chord diagrams is represented in the following pages. It is possible to extract several interpretations from this aggregated analysis, not only about each of the competences in the given spectrum, but also as a nuanced insight into the systemic relationships binding these competences together. Interpreted through the radar and chord diagrams, the design paths undertaken in the *laboratory* do not only merely display isolated skill acquisition but instead reflect an intricate web of interactions. This interplay unfolds how data-literate, critically reflective designers can navigate speculative natural-urban futures.

First, there is an uneven but meaningful distribution of the fourteen competences articulated in section 4.3 across the exercises. While certain competences consistently are clearly more developed, other less prominent reveal crucial connective roles. Among the most salient are graphic representation, synthesising capacity and systemic and multiscalar thinking, regardless of variations in GIS proficiency or the granularity or quality of the datasets utilised. The exercises demonstrate how, even at the intermediate level of sensing, augmenting or any other operational capacity, the students' ability to convey complex spatial interrelations through clear, multilayered mappings is remarkable. The explorative and speculative nature of the assignments seem to catalyse this phenomenon: students dealing with unfamiliar ideas about urban nature become progressively empowered to produce sophisticated visual outputs.

Similarly, the synthesising capacity is perceived as remarkable and enhanced, regardless of the variable level for competences such as sensing, augmenting, analysing or overall GIS mastery. Exercises lacking profound analysis or not mobilising substantial sensing techniques manage to synthesise interesting results. The findings suggest that while these initial operational competencies constitute the foundational scaffolding of the design process, they are not preconditions for a powerful synthesis. The laboratory's methodology privileged flexibility over procedural adherence, allowing students to move fluidly across stages, resulting in strong synthetic propositions even where earlier phases are underdeveloped. These decoupling challenge linear models of design learning. Instead, they reinforce the iterative and reflective ethos aligned with Schön's *"reflection-in-action"* paradigm.

The relationship between competences becomes particularly illuminating if examined through the lens of integration and systemic awareness. In many exercises, analytical outputs and design proposals display a visible gap, considered as a partial failure to embed GIS-generated insight seamlessly into the speculative scenarios. However, this lack of integration is not interpreted as a deficit alone: it exposes the tension between data-rich analysis and creative design speculation. A tension that, rather than hindering, underscores the need for iterative, back-and-forth loops between the two. Similarly, the chord diagrams illustrate that competences such as integration in design, GIS proficiency and human-nature technology alliances are rarely developed in isolation. Instead, they act as conduits linking the operation, imaginary, processual and field-based competences into a holistic form of practice.

Certain competences show intrinsic dependency patterns. For example, exercises displaying advanced systemic and multiscalar understanding almost invariably exhibit higher infrastructural comprehension. The interweaving of these three competences suggests that once students engage with broader-scale, multi-layered datasets, their cognitive orientation naturally shifts towards understanding urban nature as a dynamic infrastructure. One where natural and built environments co-evolve. Thus, fostering multiscalar awareness stimulates infrastructural perspectives. In contrast, temporal thinking remains comparatively underdeveloped across many exercises. Limitations in dataset availability and the student's computational abilities to manage dynamic time datasets may be part of the reasons. This observation reinforces the importance of data selection: it influences the design output and the specific competences developed. The deficiency in temporal engagement indicates that methodological constraints, such as the absence of a particular form of data, can structurally delimit the design imagination.

Certain heterogeneity is observed around the competence of naturecultures. This inconsistency can be traced to the students' diverse degrees of familiarity with post-humanist theories, together with the inherent challenge of integrating non-human agency within their computational mappings. However, when successfully mobilised, this competence tends to correlate with higher levels of speculative capacity, underscoring the deep entanglement between ontological reorientation and imaginative potential. Finally, regarding speculative thinking, the exercises reveal uneven deployment. Explorative and speculative design is a central pedagogical objective, but not all projects reach the critical-reflective depth envisaged. Notably, speculative capacity appears most developed when students achieve a balance between systemic understanding and representational clarity, suggesting that competences do not simply accumulate linearly but resonate synergistically. The radar and chord diagrams offer hints to interpret competence acting as anchors –graphic representation, synthesis, systemic awareness, and multiscalarity–around which others orbit. No single competence stands isolated; instead, each is embedded within a web of mutual reinforcement, suggesting the *laboratory*'s strength to reveal this entanglement.

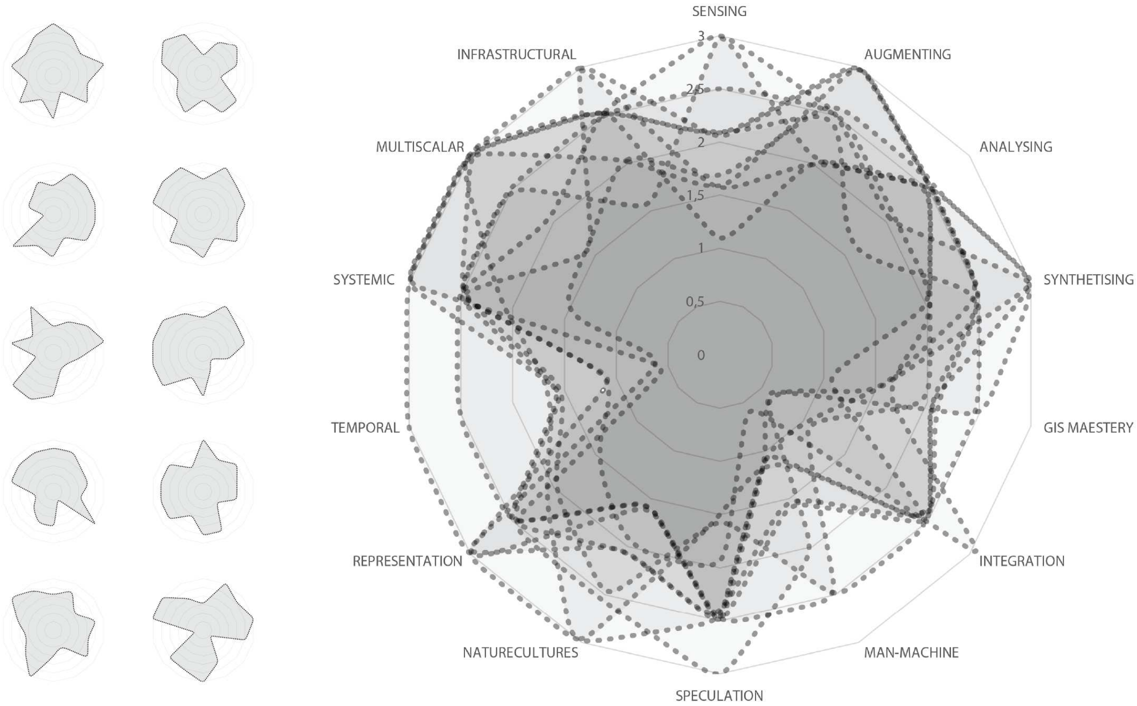


Figure 5.58:: Radar diagram with all exercises, and each exercise separately. ARC

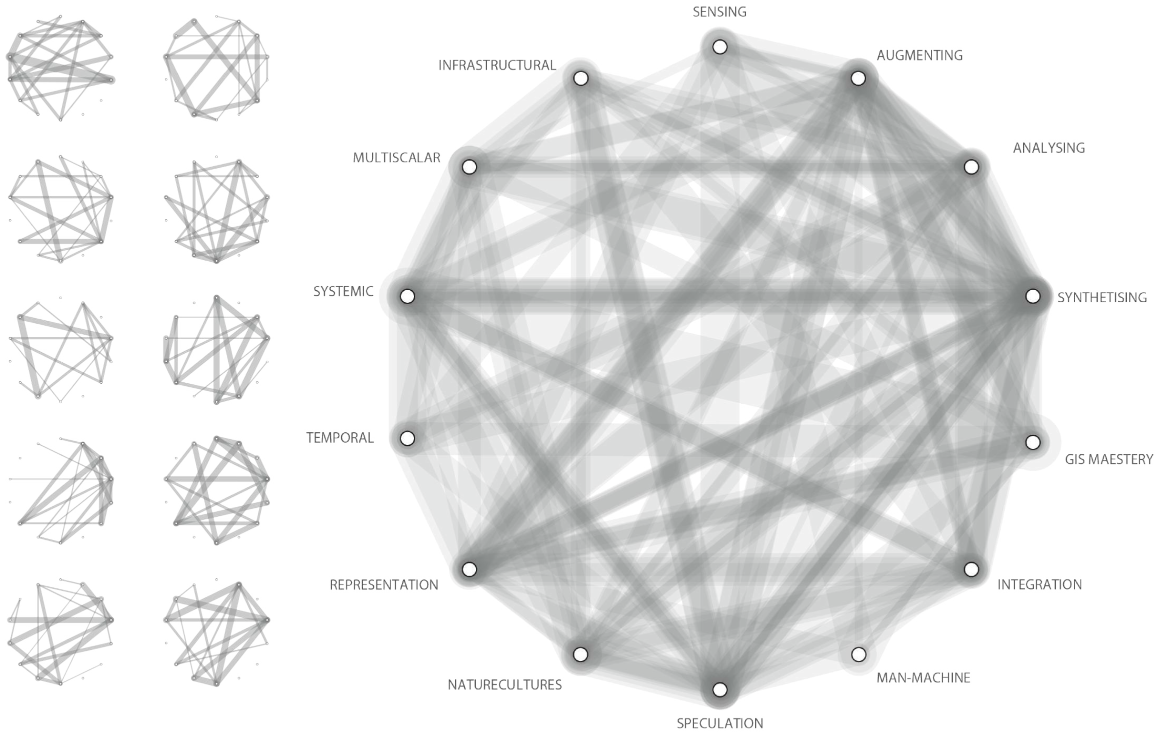


Figure 5.59: Chord diagram with all exercises. ARC

5.11.2 Typological classification of the design impact

The comparative analysis of all exercises' design processes and their related professional competences reveal a design panorama spanning themes, scales, and methodologies. The ensemble of all students' work covers a vast design territory that can now be categorised in different typologies of impact on design. This classification provides a second form of answer to research question 1, identifying how the introduction of computational analysis of geographical datasets influences design production.

First, the introduced methods and developed competences enabled the formulation of unexpected urban lectures. The most obvious example is the use of social media imagery to gain multiple perspectives about nature in the city. The unpredictability of the results becomes a powerful asset for discovering unveiled trends and patterns. However, many different exercises fit within this category, showcasing a broad panoply of methods that foster different perspectives from which to make sense.

Secondly, it is possible to identify a typology where the meaning of the problem definition –see Figure 2.1, British Design Council's double diamond– is explored in all its complexity. The quantification task of the exercise dealing with the green capacity of the existing buildings around Karlsruhe's former airport is a good example. Computational analysis methods help to delve into the different aspects of the research subject, identifying diverse facets, interrelations and interdependencies. The exercise inquiring into the diversity of the commons in Zürich also embodies this impact: understanding an elusive concept such as diversity and displaying graphically different layers of its meaning on several maps was only possible through the mobilised technologies.

Furthermore, the computational analysis methods learned contributed in other cases to refining or reorienting the problem definition. More nuanced knowledge is gathered, revealing that the initial research question may not be as pertinent as initially supposed. This is the case of the exercise about Basel's neophytes or Zirkel's night light ecosystems. The methods themselves serve not only to query the appropriateness of the problem definition but also to provide hints to redefine the orientation of the questioning.

The last typology of impact is the capacity to originate possible speculative scenarios. While they are usually formulated as a question starting with *"what if…?"*, the path to reach the final formulation can vary from case to case. After the analysis of the ten exercises, three different approaches are detected. The first one uses computational methods to set the thematical axis of the proposal, as discussed in the previous paragraphs. Secondly, the geographical location of the speculative scenario may be identified through these methodologies, too. Thus, similarly to de Monchaux's *"Local code"*, rather than seeking a single point to place a building, locating a myriad of places for a distributed impact can be a powerful asset. Lastly, the strategy or the action that triggers the scenario can be found through the computational enquires portrayed with GIS technology. Beyond *'what'* and *'where'*, it is possible to identify *'how'* the speculative scenario may develop over time, fully incorporating process over time as a key design subject.

Finally, the courses had multiple goals beyond the described Learning Outcomes. One is to put them in contact with helpful mapping methods. Besides, it was essential to arouse curiosity about computational spatial data and a world of possibilities for their practice. Finally, it was key to stimulate their imagination to promote novel approaches, different from the ones learnt –and those hegemonically imposed by the Smart Cities paradigm. It is now possible to look at the three course formats as three situations that designers may encounter when deciding to gain digital mapping skills. Seminars showed how their design thinking shifted from having no knowledge to deepening into a specific mapping feature. The Seminar students felt empowered: they could master and adapt one mapping technique to their precise scientific and *'designerly'* imagination. Designers may profit from a learning experience delving into the use of one mapping feature without having to apply it in a design process directly. This way, they can really explore the tool's possibilities and imagine how to really appropriate it, even conceiving *'detournements'* to its standard application. However, it is difficult to identify if they know how the learnt methods could help them within a design process where they had to produce a proposal. On the other hand, Design Studios showed how just a couple of GIS workshops impact design duties. The Studio students used more straightforward tools than the Seminar students, but they succeeded in employing them to imagine a possible future scenario or produce a design proposal. These students had certain difficulties, though. Without more established GIS knowledge, they did not feel completely assured of the path they were undertaking. While their results and design process responded to the Studio's goals, it is possible that they may not adhere to these computational methods if they do not gain more GIS knowledge. Lastly, the *'Stegreif'* students represent a paradigmatic example, where at least one of the students in the team of two could make good use of GIS, as they had pursued a Seminar before. These students had to produce a mapping that could trigger a speculative scenario or an explorative design. In this case, the students felt more confident, using the learnt methods differently and even adapting them to their specific needs. In this case, the students felt more confident thanks to a more robust GIS proficiency, which empowered them to feel free to experiment towards design and speculative scenarios. It is possible to imagine these students continuing their use of mapping methods in the future. These hypotheses can be tested with the qualitative analysis.

5.11.3 Consolidating the extracted insights

This chapter captures the impact of elementary GIS operations on design exercises within an academic setting. Other design tools and methods, such as sketching, interviewing relevant urban stakeholders, site visits or any other *'traditional'* design method, have not been part of the exercise. Whereas the repercussions of digital mapping on the design process are demonstrated, it is not intended to imply the complete replacement of any other design methodologies with them. On the contrary, profitable symbiosis may and should emerge from the simultaneous setting up of miscellaneous practices. How to foster these symbioses, particularly in professional practice, could be an interesting path to continue the investigations started here.

Similarly, the introduction of statistical and mathematical analysis in the first steps of the design process endeavours to merge science and design from the very beginning of the design reflection. External feedback from other disciplines often appears late in the design process, trying to *'inform'* design decisions, often artificially shaping them once the design has already crystallised. This operation often becomes a prosthetic compromise that does not satisfy the whole team. However, having integrated GIS-analysis methods as the origin of the design speculation, even late feedback from a botanist or an ecologist may have the opportunity to truly impact the core of the design, generating other possible futures.

Software availability –QGIS is free and open source, which considerably impacts simple GIS methods and the quick learning curve to use them. Online repositories and user video guides make it a feasible option for almost every designer wishing to use the methods compiled here. What is still a niche practice today has the potential to become a standard, at least for designers aiming to get closer to data analysis. Nevertheless, the methods described in these pages may not be as suitable for all design tasks. However, these ten exercises have proven the appropriateness of innovative and speculative designs in urban nature. The complete findings extracted from these analyses are presented in Chapter 7, so they can be balanced and confronted with the qualitative analysis that captures the following chapter.

6 Qualitative analysis

While the previous chapter analysed the design processes of a series of exercises, this one questions the development of the students from that starting point to their current moment in their studies, or, in some cases, to their incipient professional life. Which competences do they think they developed and how have they been using them in the following years? How did their design practice change? Which competences do they think they may need in their professional futures? This and the previous chapter –and both methodologies– are oriented toward the inquiry into the evolution of design process through the introduction of computational tools –Research question 1 and 2. The combination of both methodologies constitutes a form of '*Research for Design'* approach, focusing on a theoretical and analytical understanding of the possibilities to improve the design process.

This chapter provides insights that go beyond what has been explored so far. Qualitative analysis allows to explore the students' perspectives on how the learnt technology influenced their design thinking and skills development. This complementary study aims to enrich the perspectives from which the main subject of the thesis is assessed. Moreover, it offers a more nuanced and comprehensive understanding of the impact of technology on design practices, giving light and context to its possible causes and implications. First, the methodology is presented, leading to a series of findings, that are then discussed critically. The last section unfolds limitations, bias and possible further qualitative enquiries.

6.1 Methodology

This qualitative analysis is based on two events: a focus group with seven students, and six in-depth interviews. The invitation to the focus group was sent to the former students of the GIS-oriented courses –91 in total–, and all the positive responses were accepted. Those who could not attend on the proposed focus group date were invited to one-to-one interviews. Discussing with 13 students out of 91 makes a statistical sample of 14%. Although there was no further active selection, the final grades of the different courses also represent the average of those typically attained by the students in the faculty. Besides, there was a good mix of students who followed the courses during Bachelor or Master's. They have followed Seminars, Studios or 'Stegreifs', covering all course formats, although the Seminar is the most represented. There are six male participants and seven females, and the overall age oscillates between 23 and 30 years old. All students but two have pursued their Bachelor studies at KIT.

Sample selection

There were seven participants in the focus groups and six in the interviews, all former students of one or more GIS-oriented subject in their Bachelor and/or Master's training. The participants are coded *"f"* if they participated in the focus group and *"i"* if they participated in the interviews. Furthermore, three different characteristics are identified. First, their status during discussion, which could be Bachelor or Master student, or Master's Graduate. Then, the number and type of GIS-related courses they have followed, in order of attendance. There are three formats: 'Stegreif', Seminar and Studio –see section 4.4. for further detail. The last code captures the students' mastery of GIS and urban data analysis tools at the time of the focus group by evaluating the work they delivered in the courses. With these three codes, the students can be classified in table 6.1.

Participants and coding

The discussions were held in the Chair of Landscape Architecture. The focus group took almost two hours, and each interview was around one. These discussions were organised following semi-structured question guides. The same questions were always posed to them while encouraging the students to go beyond the pure answers and explore the participants' particular experiences, needs, causes, and consequences in depth.

ST. Nr.	CURRENT STATUS Bachelor / Master / Graduated FUP - Focus in urban Planning	COURSES FOLLOWED *'Stegreif'* / Seminar / Studio (in order of attendance)	MASTERY OF GIS
f1	Graduated	MA Seminar	Intermediate
f2	Master 4th sem. F.U.P.	MA Seminar / MA Studio / MA Stegreif	Intermediate
f3	Master 2nd sem.	MA Studio	Lower
f4	Master 4th sem.	MA Studio / MA Stegreif	Lower
f5	Master 5th sem.	BA Seminar / MA Studio / MA Stegreif x2	Higher
f6	Master 3rd sem.	MA Seminar	Intermediate
f7	Graduated F.U.P.	BA Seminar / MA Studio	Intermediate
i8	Master 3rd sem. F.U.P.	MA Stegreif x2	Lower
i9	Master 3rd sem.	BA Seminar	Lower
i10	Master 3rd sem. F.U.P.	BA Seminar	Intermediate
i11	Master 4th sem. F.U.P.	MA Seminar / MA Stegreif	Higher
i12	Master 4th sem.	MA Seminar / MA Stegreif	Intermediate
i13	Master 3rd sem.	MA Seminar	Intermediate

Table 6.1: Codes of the participants in the focus group

To ensure comprehensive and insightful responses, the focus group's guide and interview's questions are produced considering Sociotechnical Integration Theory and different Cognitive Psychology Theories (Bijker et al. 2012, Gubrium et al 2012) for mental models and decision-making. The questions are designed to ensure that the participants recall relevant information and provide in-depth reflections. Some questions are broken into smaller, more manageable parts, so they can explore each part's different aspects, applying principles of Cognitive Load Theory (Sweller et al. 2011). Furthermore, a sense of storytelling is fostered, so they can remember more information when the discourse takes a narrative form, as learnt from Narrative Theory (Herman 2009). They are also asked to recall the context of the situations they narrate, as a richer context allows them to explain their point better. The interviewer asks them to connect new information to their experiences, which encourages elaborating their ideas more precisely. The focus group organisation follows the recommendations of Krueger (1998).

Social science's theoretical framework of the qualitative analysis

The focus group begins with guidelines for respectful discussion, followed by an icebreaker on students' first experiences with GIS. The core discussion examines whether they continued using GIS, how it influenced their design process, and its relevance for speculative and nature-integrated design. The session ends by questioning GIS's role in education, including whether it should be prioritized and, if so, how. The interviews also follow a structured approach, assessing how participants integrated GIS into their practice. They then examine concrete examples of its use in speculative scenarios, followed by challenges faced after the course. The final section explores future needs such as skill development, tool accessibility, and potential improvements in academic support. This process ensures a critical reflection on GIS education and its impact on design workflows. The complete focus group and interview guide can be found in Annex C.

The goal of the qualitative analysis is to understand their current practices with GIS; they had their introduction to it between four and one year before the interview. This methodology allows for exploring the nuances of how the students integrated computational methods into their spatial inquiries –or even if they did at all. How did they see GIS as helpful for them? How did they incorporate it into their workflow? Their feedback on subjects such as integration of statistical analysis in the design process shed light on the operability and future potential of these methods for design professionals.

The findings and the discussion refer to both events, the focus groups and the interviews, as the intention of the questions and the goal of the events were similar. Due to a longer discussion time, interviews allow more detailed and nuanced answers. However, there is no reason to present the results of interviews and focus group separately. In this chapter, the indefinite pronoun *'they'* is used for all the students to protect the requested anonymity. Besides, gender is considered irrelevant in this study. The interviews were conducted in the most comfortable language for the students, mostly German and Spanish, with certain passages or moments in English or French. The interviews are compiled in their original language in Annex C. For a better understanding, the author has translated the quotes of the students in this section into English.

6.2 Findings and analysis

The competencies described in chapter 4 provide a robust framework to understand better the impact of digital geospatial analysis on the participants' practices. The outcome of the qualitative analysis is structured in three different sections. The first one explores the perceived impact of spatial computational data analysis in their competency development. The second one identifies changes they introduced in their design practice. The third one evokes challenges and opportunities they encountered when using these methods, which were identified during the discussions. It also investigates the causes of the frequency of these techniques being used. At the end, a discussion inquires into the reasons and consequences of the identified insights, and the limitations and possible biases of the study are identified.

6.2.1 Former student's perceived impact of GIS on competency development

All the students confirmed being the only students in their following Studios who could perform GIS analysis. Most of their colleagues at KIT had not even heard about any GIS software –neither QGIS nor ESRI's ArcGIS. The former is freeware, and the latter has an agreement with KIT to provide specific free licenses for it to its students: it is not a question of software availability. None of their colleagues could perform simple actions, such as opening files or exporting relevant information to a CAD software. Paradoxically, a third of the interviewed students attended a Seminar where GIS was required the following semester. However, they were offered no more than a quick presentation of one hour, which hindered an actual use of it. This situation shows the remarkably limited use of this tool within KIT's Architecture Department, similar to many other architecture schools worldwide (Monsur & Islam 2014). The following sections capture the student's impressions of GIS-related competences development. They are organised following the competence structure provided in section 4.3. The first are the seven key competences corresponding to *"operation"*, keystone of James Corner's *"Terra fluxus"*.

6.2.1.1 Enhanced data acquisition

Integrating remote sensing techniques and GIS tools significantly improved data procurement, as evidenced by its widespread use among the students. All of them plan to use GIS for their Master's thesis, and those who have finished their studies, have already used it. Regarding the impact on information gathering, it is remarkable that the extension of the area to gather data increases considerably; for the same task, students using traditional methods covered less than 5% of the area studied through remote sensing.

"Yes, it is really fast for the time invested. The difficult thing sometimes is to search for the necessary data, because I think at first you just download the data you find, and it takes longer to filter". Student i9

The improvement is also reflected in the completeness and fine grain of the datasets and their quantity. After the courses, they developed their skills to import data and got more comprehensive information about the context in a much more detailed way than before. They did not only look at the same sources as in the courses but also got datasets that were not treated in their respective courses, such as topography. All the students also highlight the rapidity of the compilation process and its interoperability; nonetheless, it requires a longer time to check possible omissions and filter and process such a vast amount of information. Moreover, only after that process may they realise that it is not the right dataset.

"But I have to say that the time I spared using QGIS, I invested it into data mining". Student i12

The information most looked for by the students concerns the built realm: streets, buildings, urban infrastructures. However, they realise that the learnt methods have let them gather very detailed information about nature that they had no access before: exact position of fauna and flora, soil conditions, atmospheric parameters, to name some. Two students managed to find the migration routes and urban trajectories of many animals in Amsterdam, what was in the origin of the proposal they produced, guiding even many of the final formal decisions of the design scheme.

Students who have joined the professional world expressed frustration and disappointment towards the limited implementation of advanced remote sensing techniques in professional offices. This is also flagrant in urban planning departments, as evidenced by one student, who started an internship for the garden department of Karlsruhe thanks to the acquired GIS-experience. However, the real duty required no use of digital tools: an inventory of trees, locating them by hand on a printed map, roughly estimating height, crown width and tree species. This is similar to the work portrayed by the Design Studio *'Urban Gaia' students*, but without geolocation and the digital tools that automatically create a precise database of trees in private plots, enriched with various digital metadata.

"They wanted to hire a student with GIS proficiency, but I have not used it a single time. I just compile data on an Excel spreadsheet". Student i12

6.2.1.2 More than raw data: augmenting the acquired information

All students confirm they use the overlay method, following Ian McHarg's principles. However, that is a standard method that architects and urban planners use to start their analysis. Remarkably, none of the augmenting methods –datasets crossing, spreadsheet joins, etc.– used in the courses seem to have been further mobilised by any of them. Reflecting on the possible reasons for this, it is possible to infer that after the sensing phase, they may have felt that they had enough information to launch the analysis phase with the methods they employed in previous years. Investing time in augmenting the datasets to make new insights emerge may be perceived as a time-consuming task, of which they feel unsure what they will gain.

"We wanted to create a proper map or a plan of Boka Bay and the Adriatic Sea. And there, we actually collected the data together. Everyone had a topic, worked on it individually, and then we put everything together" Student i11

6.2.1.3 Shift towards data-rich analysis

Despite the agreement on the radical shift for data collection, the subsequent analysis performed by the students remains mostly traditional. They rather mirrored their manual approach, applied to the remotely sensed material. Almost no student pursued a complete data-driven analysis, incorporating the statistical methods learnt in the GIS courses, such as spatial calculations of diversity index. Some of the students tried, though, but they were explicitly instructed to abandon these digital methods, and adhere to conventional urban analysis techniques by the directors of the Studio. This reflects a reluctance within some academic settings to embrace data-driven approaches.

" Yes, I think in general, I'm no longer so afraid of this analysis part. Or rather, I don't find it as big of a challenge as I used to back then". Student i10

On the other hand, they perceive that they can portray more complex spatial analysis thanks to GIS: they consider their investigations broader, considering and crossing more factors,

"I think the entire analytical part is much better. Much more advanced and meaningful than before. And it also works faster as a result". Student i11 while reducing the time to perform them. More interactions and patterns are identified due to the simple and pregnant graphical interface; they feel they move beyond simple data visualisation to using GIS for more detailed and finer analysis. Moreover, it is not only considered a technocratic and machinistic quantitative enquiry, as many of them feel that they must interpret the gathered data carefully. In this sense, they are not just guided by numbers and abstract datasets, but an active part of the deciphering process, deciding how to interpret each data event. This is particularly fostered when merging databases of the built realm and the natural ecosystems that inhabit the city.

"I did not want to do further data analysis, as the teaching assistants wanted quite a standard analysis". Student f7

Although their further Studios did not have nature as one of the key points, they mostly agreed that they were constantly gathering and analysing data about waterbodies, peri-urban forests or urban biotopes they did not have access to. As mentioned before, these analyses were done traditionally, by hand, or by simple overlaying. However, in some cases, there was an explicit interest in urban nature in the brief of the Studio. In these cases, the students excelled in gathering and analysing unusual datasets for the architectural Studios. These analyses originated many of the design actions proposed in the design scheme. This capacity to map not only visible elements, but also invisible aspects of reality is highlighted by two students explaining how, in another Seminar, they used GIS to map urban stress, in a sophisticated form of urban analysis.

"I believe that since I got to know this, I have realized that it allows me to find a meaningful approach for a concept, rather than just thinking and wild guessing. Instead, I can truly perform a meaningful analysis, which lets me justify everything and also simplify, to find the concept". Student i11

6.2.1.4 Synthesise and move towards design proposal

Some students refer to a certain *'subjectivity'* when interpreting the datasets. This can be considered the first steps of a synthesis, where designers must start making crucial choices. Some students acknowledge that the previous data gathering and analysis lead to a coherent definition of critical design parameters or constraints. They could begin to generate ideas and develop design concepts with them, moving beyond basic analysis. The data analysis performed by the students helped them in several cases to localise their design and define the specific topic that the design scheme responded to. These concepts may emerge from reformulating the design problematic – *"design the right thing"*– through the data synthesis.

The Seminars focused on GIS use without having to synthesise towards a design scheme, while in Studios and *'Stegreifs'* the students were asked to link GIS use to a design concept. This task is considered challenging, and a few students who followed either of these two formats expressed that they felt *'lost'* or did not have the required competences at this stage. On the other hand, many students explained how GIS tools helped them see the bigger picture, allowing them to go beyond what is immediately visible. Synthesising or making decisions in these conditions contributes to better anchoring the proposals in broader cultural and ecological contexts. However, most students recognise that their workflow has not substantially changed, apart from the enriched data-gathering. A couple of students see that it could change, if they could perform more sophisticated GIS operations, and only one student expresses a complete turnover in their practice. He explains how the tool has opened a new form of practice for them, where they can now find solid foundations for design decisions. GIS helps to understand political and social aspects of cities, beyond formal questions such as building alignments and street continuities. The enthusiast testimony of this student, describing in detail the many facets that the tool has affected, contrasts with a larger group of them, who communicate a different situation. Data gathering has radically changed for them, but the following steps of their design workflow remain relatively unaltered.

"In all Bachelor Urban Studios I have done before learning GIS, I would make an initial design decision and worked further, but I could not justify it anyhow. [...] Now I can make grounded reasonable decisions. [...] It is the GIS Seminar what made me interested in urban planning. It has completely changed my motivation in Design Studios. I was before not even very enthusiastic about the metier of architect" Student i11

6.2.1.5 GIS proficiency, enabler of novel practices

The hands-on approach of the courses, and the students' capacity to troubleshoot software issues and problems empowered them towards forms of practice that were impossible before. For instance, some effectively collaborated with traffic engineers in a design Studio at KIT. More than twenty architecture students participated, and only three had prior knowledge of GIS software. The multidisciplinary teams could work together better if they could use the same software to exchange and discuss information. All other students had trouble sharing and merging information.

Each student's expertise level influenced the research perspectives they were adopting, particularly when the methods were used within a design Studio. In this sense, many of the most experimental approaches came from students with the most solid experience, and exceptionally, from a couple of those who got in contact with GIS-methods for the first time. Some students found motivation when it was understood that the explorative method was expected, as creating their methods is perceived rewarding but very challenging.

"We as architects can also somehow verify the impact of our actions at a later stage [...] For example, you have three scenarios, and you can determine which of these scenarios best meets the goals you set beforehand". Student i13

One student explained how the gained GIS proficiency has led them to imagine new forms of testing their design actions, imagining how they will evolve in a later step. For example, from three scenarios, it is possible to determine which of them will first fulfil the goals set beforehand. This was not taught during the course they followed, but they imagined a possible use that they even deployed in their next design Studio. Weighting different speculative scenarios is a powerful method facilitated by computational analysis in this case.

6.2.1.6 Bridging the gap between analysis and design

During the GIS courses, it is encouraged to blur the limits between analysis and proposal, considering that every analysis is already a form of design, even in its germinal form. However, most students experience a pivotal moment between what they perceive as two distinctive phases. In some cases, the perceived gap between them is considerable. The discussion with the students evidences an unequal reaction to the introduction of digital data analysis. A small group of students stresses their paralysis after mobilising the learnt methods and felt incapable of using the results in a design process, despite their acknowledgement of the methods' quality and pertinence. The gap felt definitely bigger because of the increased complexity of the datasets, the unfamiliar methods, and the requirement to work with nature. Besides, the fear of not fulfilling the design purpose of the Studio pushed them to abandon the data-rich analysis and pursue a design that lacked good foundations but achieved at least the goal of producing a complete proposal. These students could not build strategies to chain the analysis work with a consistent design scheme.

"Since I got to know GIS, I realized that it offers a meaningful way to approach design—not just by wild conjecturing, but by actually conducting a sensible analysis. This allows you to really justify and simplify the concept, because when you gather this information, things naturally fall into place. You start finding spots that make sense here and there. So through the work of gathering information and having some idea of where you want to go, these spots just reveal themselves". Student i11

On the other hand, a small group of students explain how the learnt tools and methods have changed their design workflow, feeling empowered to perform a data-informed design process. They fully incorporated classic and unusual datasets about urban nature, allowing them to make data-informed decisions driving the design process in a manner that they describe as founded and coherent. The resulting process, while not always speculative, mobilises explorative approaches and reinforces critical assessment of the datasets, bridging towards design decisions.

"...to reach the concept plan, it was quire important because we identified that in this part, outside, there are commercial areas or student dormitories, there are many students going inside, many students living in dorms, and the connection depends on the user. From there, the concept for this part of the ring emerged in our project." Student i9

Between both extremes, several students managed to produce profound data-informed reflections, becoming the foundations of a design scheme; however, the Seminar format did not allow for a full detailed design proposal. Some students joined a design Studio after the Seminar to be able to apply these methods in a design scheme. The learnt tools stimulate a design process that encourages statistical data analysis and critical thinking, leveraging creative approaches to design. The potential for change in their design practice is considered high. Still, many have not fully fulfilled it, due to time management reasons and the lack of opportunities where these methods were explicitly requested.

"The final product [of the Seminar] is not really a final product; it's more like the starting point for deeper research or a more in-depth analysis. I think it's more like an interesting finding. It's a starting point". Student f06

6.2.1.7 Human-nature-Technology alliances

The students explained how, during the GIS courses, they discovered how to use technology as a medium to explore nature: they found robust datasets to track aspects of nature in the urban realm and understand the impact of human actions on nature. However, when the perspective of the Ecocene was not in the briefs of their next Studios anymore, they did not use such sources. Only a couple of them did, because biodiversity enhancement was the main goal of the Studio brief. They imagined forms of working with nature, data and mapping in ways that were not explained in the courses. Similarly, their capacity to use mapping technology to develop speculative scenarios with urban nature definitely increased during the GIS courses, and they were even able to model human and non-human interactions through digital datasets. A couple of students convey that they see the possibility of expanding this knowledge further. Still, it has not happened yet: the pressure to deliver outcomes at the end of the semester seems to hinder such exploratory approaches.

"Sometimes I think 'this must be possible with GIS', and then I ask [in Chat GPT] 'I want to do this and that, how do I do it, or how do I get there? And it [ChatGPT] just gives a very simply described, step-by-step guide on how to do it'". Student i11

Finally, it is key to mention how a reduced group of students explain that AI and LLM have impacted their practice. These four students use AI tools like ChatGPT to overcome technical challenges and improve efficiency in the use of the software. This form of continuous self-learning has empowered them to master GIS tools far beyond what was learnt in the courses. Moreover, none of them could write code before the GIS courses, and even if they still cannot do it independently, they use AI and LLM to help them write the code they need. They felt empowered. But why did only a limited number of them use AI to write the required code? Probably, because coding still feels like an *'alien'* tool for most design professionals.

"I felt like a professional, it was so cool. Working in Python and the the code would not run, and I had to try a different code. It was quite cool". Student i10

6.2.1.8 Representation

The capacity to communicate through graphic documents is highly impacted, as recognised by the students. They all use GIS to efficiently create base maps, layering and overlaying information from different sources. They could visualise diverse data types, from vegetation and animal habitats to building uses or sociocultural aspects. With them, they could create thematic maps, which, beyond basic information display, were used to identify spatial relationships by exploring data richness. This gave a better understanding of the broader context and served to analyse urban and territorial issues. Most insist that it should be learnt before or during Bachelor, to improve their graphic competences before starting their first urban Studio.

"The proposal we developed is about the use of different areas in the city. We defined very precisely what type of use exists where in the city and how these uses relate to each other". Student i8

Architecture students –and designers– reflect visually, and the mobilised graphic techniques became a form of critical thinking beyond sheer data display: the students could challenge preconceived notions, connecting quantitative data to the quality of the spaces. Some of them explain how the produced mappings help to reason, discover *"sense"* in their designs, and provide logic behind their concepts. Moreover, their graphic expressivity fostered good interdisciplinary communication and collaboration, sharing data and mappings flawlessly. However, from the wide range of possibilities presented in the courses, most students have mainly used the simplest ones during the following months and years. While GIS representation's experimental and explorative character is acknowledged, they do not often take this path. Technical difficulties, high time investment and feeling overwhelmed by data seem to be some of the factors that influenced this trend: they master the easiest representation methods, but they avoid risk at the first stages of the design process. They, in fact, recognise that they should continuously learn after the courses to refine their GIS skills for representation.

6.2.1.9 Speculative thinking

The impact of the learnt techniques and tools on speculative design can be demonstrated through one example. The discussions with the students revealed that almost none considered having worked with speculative design after the GIS courses: it was not required in the

"So, with the gathered data, we went on with the design, and at a certain point we took decisions based on our speculations. [...] It is quite hard to come up to a design scheme from speculation". Student i9

forthcoming design Studios, or their professional work. However, two students worked together designing the refurbishment of a massive parking building that had to be designed for 50% human and 50% non-human occupation. These two students managed to formulate a proposal that was distinctive in their Studio, due to their appropriate use of vast number of datasets about fauna movements: migration movements over the city, small animal observations and other information about geolocated urban biodiversity guided the carving of the parking volume to host multispecies cavities that cohabitated with the residential use of the other half of the space. Imagining the building as an urban stepping stone for interspecies encounters was also proposed by other students. Still, these students could firmly anchor the proposal in the natural context, guiding decisions about the exact position of each space following the interpretation of fauna flows, and adapting them to each species' necessities. Data-informed speculations can therefore become more contextual, anchoring design in site-specific conditions. It may not be a coincidence that the natural and the speculative go hand in hand in this case.

"I think QGIS is very helpful, especially for getting started, finding an approach or performing analyses. But I still find it difficult to make the connections [towards an speculative scenario and a design scheme]". Student i8

"I definitely feel more comfortable bow because you view and perceive the city differently ". Student f7

However, some students consider using GIS to explore urban scenarios for their Master's Thesis, for instance, to imagine the future development of cities' building culture. Most of them also express some kind of doubt about how they could really do so, though. They understand the tool's potential but do not know how to use it effectively for their purposes. They want something from the tool but do not know how to extract it from what they have learnt.

"I find it interesting to maybe explore or think about a scenario of how cities could develop over the next 5 or 10 years while still preserving their traditional character. And maybe I could use QGIS for that". Student i8

6.2.1.10 Naturecultures

The capacity to formulate an urban natureculture is fostered in the previous example of parking by using a vast number of datasets capturing aspects of urban biodiversity. Unfortunately, most students have worked with urban nature less intensely in their following projects, and mainly within a framework that is not as ambitious as the Ecocene in aspects as non-human agency or cohabitation. This reveals that, despite the awakening conscience of urban ecology, many architecture students still leave the integration of natural ecosystems in their design projects as anecdotal. Even those students who were interested enough to attend two or three courses at the Chair of Landscape Architecture. The interpretation that can be extracted of this situation is that a framework where a natureculture is expected stimulates the use of GIS techniques. At the same time, the other way around is not always true.

"The proposal involved repurposing a garage with a focus on biodiversity. We found a lot of geodata about animals and plants, and the movement patterns of the animals. This helped us in the design process to determine, for example, what are the flight paths of the bats? Where to place their nests or what is the exact location where certain plants can be placed". Student i9

6.2.1.11 Process: systemic and temporal approaches

The students inquired about time from different perspectives, for example, observing how landscape and human activities change due to rising water levels, impacting fishing and animal habitats. Thanks to the metadata capturing dates of ecological events, they could also observe seasonal changes. Some students expressed their desire to use it to inquire about future projections. However, they did not have the right datasets to go further. The time dimension of their work is certainly not an aspect they highlight.

"For me, a design is always very context-sensitive. And speculative scenarios with data, when you know the data, are not very 'space out'. For me, this brings together these two extreme sides a little bit". Student i5

While the time approach is not discussed in detail, the students communicate how they perceive that their systemic thinking has evolved thanks to GIS tools. They see this change particularly regarding urban built elements, but they also acknowledge that they have now enhanced their competences to incorporate natural elements such as rivers and waterbodies or even more complex phenomena, such as biodiversity distribution. They also express having gained a holistic view of cities, analysed broader contexts, and understood the systematic in those contexts.

6.2.1.12 Field: impact on scales and infrastructurality

The students admit they frequently moved between different scales of analysis: their ability to scale up from detail to the city level is a recurrent theme. Also, the other way around, they explored regional contexts impacting certain ecosystems, such as how the mountain region dynamics around Boka Bay in Montenegro impacted seaweed in the bay. Without explicitly using this expression, they reckon that they have worked with nested systems, for example, considering smaller scale elements, such as parks, operating within larger scale contexts, such as cities. Moreover, the object of study at each scale may be diverse, merging nature with the built realm. One student explains how the use of large-scale data about the whole city shaped the limits of their intervention. Such inter-scalar exchanges are repeatedly mentioned – *"look at the whole city"*– evincing the tool's impact on their competences to manage multiscalarity. While this is not a new approach at all, it is common practice that many students do not look beyond the perimeter of the plot to intervene. They repeatedly mention how the tool has helped to understand the big scale and tie it to their small-scale intervention. While this understanding of scale seems to have impacted the student's practice profoundly, it is less evident that the idea of infrastructurality of the proposals has been taken forward. It is perhaps required that a reflective vision of each student's work be created, which they cannot portray because of their lack of experience in the field of design.

6.2.2 Perceived evolution of their design practices

The shift in the students' competences –research question 1– is accompanied by a series of impacts on the overall practice of design, which is related to the second research question. In the following sections, this new form of practice is described in detail, as extracted from the discussions with the students.

Those showing rapid and solid development in GIS-use understood that the course's goal was not to learn one tool but to learn a new relationship with technology that enables multiple tools, actions, and approaches. Those who just tried to apply exactly the same three steps in their further career got disappointed by various reasons: they did not find suitable datasets, they encountered technical challenges, they found resistance to these methods in the faculties, or they just did not know how to apply this knowledge again.

6.2.2.1 Distinctive data-informed position

The students recognise that before working with GIS, they could observe a tendency for all students' analysis to converge towards similar outcomes. Such homogeneity stemmed from established datasets and methods and a lack of tools to engage with the urban and natural complexity deeply. All of them acknowledge a better data acquisition, but not all defend that it has empowered them considerably in their design thinking. Only four students see a profound change of position in their practice thanks to the learnt GIS tools and methods. The acquired data literacy has enabled a form of practice that produces different outcomes and incorporates greater urban complexity into the process, and well-founded factors drive design decisions.

"I wouldn't call it creative, nor objective. I would rather call it a way to do subjective analysis ". Student f3

Conscious of the lack of neutrality of data and data selection, the students embrace a process that navigates between certain data objectivity and professional tacit knowledge. Acknowledging this situation, some students could explain how the data acquisition and analysis allowed them to steer many decisions during the design process. They came to a solution that they knew was not purely objective, but that emerged from the datasets –from geological layers and soil composition to images from social media–, giving them enough hints to identify opportunities and challenges of their design proposal. Moreover, it was consistent with their perspective and differentiated from the others. This leveraging of subjectivities as a product of a data-informed position is a valuable asset for designers, sharpening their distinctive position while rooting it in spatial analysis. The introduction of bias is also a key aspect, discussed in detail in section 6.2.2.3.

These methods can also be used for architectural purposes, linking them appropriately and generating entirely situated proposals. This is illustrated by the work of one student, who wanted to design a firm's facilities specialising in building circularity. The geographic analysis of the territory did not only determine the final location of the building but even defined how the firm had to operate: which infrastructures to connect to, which alliances to build with other surrounding companies, which natural resources were available in the region, how to structure its business plan. The ability to successfully connect the production of only one building with a territory is fostered using digital mapping. This building somehow becomes a territorial figure thanks to the lecture of the regional context. This exemplifies a clever use of the learnt methods, applied to a single building. Unfortunately, no example was provided where nature had a key design role.

"I think, however, […] that you should never trust the data hundred percent, because there is always some bias involved, and you should not rely on it completely". Student i13

The students reckon that they almost exclusively use GIS during the first stages of the design process. They do not know how to integrate it in more advanced stages of the design process. A holistic integration of data analysis could foster more substantial design schemes, but it definitely requires a shift in how they currently design. Specific training for this GIS use is manifestly lacking.

6.2.2.2 Dealing with complexity

The conversations with the students reveal how the learned tools significantly impacted their design thinking by enabling them to engage strategically with urban and natural complexities. Several observations exemplify this shift. First, by broadening the context, both spatially and thematically: they can inquire into more significant areas of influence, crossing them with a more substantial number of studied parameters, such as the fauna biodiversity or geolocated social media interactions about nature. Besides, GIS facilitates more profound understanding of the multiple relationships across scales. This multiscalar approach allows them to develop a more holistic, nuanced, and informed perspective. This is particularly acute in the few cases where they were actively working within the paradigm of Ecocene, such as the Amsterdam parking building.

Working with datasets from other disciplines enriches the reflection perspective, but it is also recognised that they lacked the transdisciplinary knowledge to interpret them correctly, occasionally feeling *'lost'* and overwhelmed. However, using GIS allowed some of them to discuss with other disciplines in a format that could be shared and easily discussed, which brought depth and better foundations for their thinking.

"So, it makes it easier to visualize where the qualities and potentials are […] where the potentials in the city are, or where diversity is already high and no intervention is needed". Student i12

6.2.2.3 Bias identification

Digital datasets are often perceived as not transparent, as they are hardly checkable by the human eye. This can quickly introduce biases and perturb the results. An integral part of the courses was to identify and address the bias that each method implied. Many students insist on the importance of questioning the datasets' pertinence, quality, and possible bias they may carry with them. They recognise that they started questioning biases only after the GIS courses. Before, even if they were also analysing data –from Google Maps, for example– they were not really critical of the source of the information or its possible bias. Almost none of them even knew the meaning of the word *'bias'* before discussing it during the courses, as it is a term more present in the scientific curricula but less engrained in the design disciplines.

"Yes, as we already discussed in the seminar, data often has a built-in bias, as it is collected from a specific perspective, which is not always reflected in the dataset itself". Student i13

The development of a critical position towards bias is clear, although they do not always feel capable of finding the best way to assess this issue. They affirm the sharpening of their critical view towards the acquired and processed information, also if it is not a digital dataset. The shift towards a more critical approach to the information basis of their proposals is unequivocal. However, it is remarkable how absolute beginners immediately and uncritically accept the validity of the acquired data. After this first moment of *"honeymoon objectivity"* (Ha Hong 2013), the further work with the datasets encouraged their development of a critical view to this topic.

6.2.2.4 Soft skills

Beyond the technical and design competences identified, it was possible to envisage during the interviews that other skills were developed, particularly those known as *'soft skills'*. They are personal attributes and interpersonal abilities that enable effective communication, collaboration and problem-solving in professional environments. They complement technical skills by enhancing adaptability, emotional intelligence and teamwork, making individuals more effective in their roles. One of the key soft skills identified as emerging from using GIS tools is creative thinking, generating innovative solutions. Being confronted with an approach that they do not entirely master seems to have boosted their creativity, gaining adaptability and flexibility. Besides, their communication and presentation skills have been particularly sharpened, stimulating more profound and richer interdisciplinary exchanges. Finally, the heavy management tasks that data processing implies seem to have enhanced management and organisation skills.

6.2.3 Challenges and opportunities

Despite the students' minimal current use of GIS tools, they all insist that they should be taught to all students as soon as possible, and in any case before the first urban Studio, during the 4th Bachelor's semester. They identify GIS as an excellent opportunity for them as designers, but it brings some associated challenges.

6.2.3.1 Data availability and quality

Although all students acknowledge how data acquisition has dramatically improved thanks to digital datasets, they all paradoxically insist on the complicated path to high quality datasets, *"the right datasets"*. There are multiple reasons why the acquired data does not seem satisfactory. Some insist on the lack of data: it may not be enough to cover the investigated territory, or only partially complete. Others think it is never the dataset they would need or imagined, or define the obtained one as irrelevant or not good enough. This can refer to its thematic pertinence but also to the granularity of the data: it may seem too bulky and not refined enough. Its lack of geographical references makes it challenging to use in a spatial design scheme. This experience of quality data scarcity is accentuated by the perception of a profusion of useless datasets for their purposes. After weeks of looking for relevant information, many students seem overwhelmed with idle facts and struggle to structure a narrative that can help them start the project. However, the students convey their excitement when getting to know GIS; the pedagogical approach should take advantage of such motivation to imagine formats fostering higher adherence to GIS methods.

6.2.3.2 Operability and data preparation

During the discussion, there are multiple references to the usability of the found datasets. From basic problems like finding the correct geographic projection that allows flawless data insertion, to complicated operations to merge, compile and intertwine different datasets. The explanation of this reaction is simple: data preparation is laborious and takes time. Some of the guest lecturers in the courses informed the students that they estimated the preparation of the data up to 80% of the total time of an urban analysis, so the students should be prepared for this challenge. On the other hand, during the GIS introductory workshops, they had to carry out several small tasks, for which they received prepared datasets, which functioned without unexpected problems. Thus, almost no data preparation is required, but that is not the case when the students look for the datasets themselves. They report the challenges they faced with datasets in raw formats, sometimes generated for other purposes, incomplete, and isolated from other information. Specific training on data preparation should be implemented.

6.2.3.3 Time constraints

One of the most recurrent issues during the focus group was the considerable time that many of these methodologies required from them. This refers to three different aspects: the time devoted to produce data-driven cartographies, the timeframe of the courses, and the time to investigate further methods. Firstly, due to the abovementioned issues, the time to look for, prepare, analyse and critically work with urban datasets is longer than a classic urban analysis for a design Studio. It is fair to compare the time and effort that each approach demands and the range of information, reflection, and creativity involved. Nevertheless, the students struggle to adapt to the new methods, requiring more time to produce their design documents.

The second aspect of time regards the timeframe of the courses. The Seminars, with weekly or quarterly workshops and homework, work best to keep rhythm, interest and quality of results, boosting confidence to keep working with these methods. The design Studios, though, incorporate intensive workshops at the beginning of the semester, but there are no specific GIS tasks to accomplish. They are welcome to use them within the design process, but they often do not feel confident enough or fear that a new approach will ruin the design scheme. The goal of the course is the design itself, not just the data-rich approach. The limited time of a semester, usually 11 to 13 weeks, makes it challenging to learn and apply the learnt methodologies and deliver a consistent design proposal. Moreover, the students identified GIS methods and tools with the first analysis. They felt more confident treating digital information in the middle of the semester. Still, they think that they have *'accomplished'* the analysis phase and should concentrate by then on the definition of their proposal. Implementing a design process such as the one explained by Carl Steintz –Geodesign, see chapter 3– would be interesting: the three iterations he proposes imply that the data analysis only occurs around the middle of the process. That would give the students more time to learn GIS and be more confident.

The timeframes in which any *'Stegreif'* takes place is also a matter of discussion. It is perceived as too short; it barely allows the students to think critically about it. For this kind of intensive workshops, all datasets are provided, so they do not have to go through the trouble of acquiring or preparing data. However, understanding the whole dataset takes a very long time, so some students expressed that they could not perform the operations they wanted to do, so they felt urged to produce results immediately. One of the students identified this as a high risk of working in such a timeframe. Perhaps, converting this format into a 'Hackathon' could deliver better results: more intense, tech-centred, and collaborative.

In the conversation, the proposal of having a two-semester Studio, one to learn the tools and put them in practice, is welcomed as interesting, and probably as operative. Still, they mostly doubt that many students would like to commit to two semesters, in a master that takes three semesters plus one for the final master thesis. Even more difficult, as these methods are not communicated enough, the students do not really know what they are before enrolling. They feel that the time needed to learn the tool and apply it in a Design Studio does not correspond to the timeframe of one semester.

The required time to learn these methods and tools is agreed to be significantly above the average for any other university course. Nevertheless, the coherent structure of the instruction, with limited tasks and homework every week, is highly appreciated and allows them to progress properly. They all insist that continuity is key: this cannot be learnt quickly at the end; it demands progressive incremental complexity over time.

6.2.3.4 Integration into existing workflows and professional practice

There is a relevant difference between the students, depending on which courses they have followed. Three groups can be considered: those who only attended a Seminar or a Design Studio, and those who attended several courses through several semesters. The first ones had a very demanding experience, where they had to learn a new software and novel urban analysis methods, and had to put them into use for a design scheme. All of it in less than four months. These students are sure of the difference it would have made if they had mastered the tools better or beforehand. They are very optimistic about the learn curve they experienced, but they have not successfully implemented it further afterwards. They also fail to communicate clearly how they would imagine using these methods more precisely, although they feel generally attracted to every use of them. On the other hand, those who only followed a Seminar feel more confident about their use of the learnt methods. They used the same period of time as the previous group of students, but only to understand and experiment with the tool itself, without having to produce a design proposal –only a future speculative scenario. They experimented with only one specific tool, which they decided on or that was given, delving into. Indeed, this limited the range of applications they worked with.

Nevertheless, they communicate more confidently and clearly explain the specific goals they imagine for these methods in their own practices. They may not convey such broader interest towards the manifold possibilities that the first group expressed, but they were more confident about their specific methods. The thematic axes they use them for are, nevertheless, very architecture-centred: finding building types, uses, amenities... The thematic axis of the proposed courses, centred on urban nature, is not necessarily pursued any further.

It is remarkable how many soft skills are also further developed thanks to computational analysis. It is observed that the better and more frequent use of GIS tools, the higher development of soft skills. Several students feel empowered to address the lack of specific data better while still advancing, incorporating uncertainty and ambiguity. However, the technical and methodological requirements alienated and overwhelmed other students. Even accepting the possible gain of using GIS, they do not know how to proceed further. Imagining pedagogical environments and experiences that facilitate the adoption of these students' GIS tools is key, which is discussed in detail in Chapter 8. As an introduction to this theme, here are some notes about how the benefits of computational data analysis can become key in the faculty's curricula. First, the students clearly convey their wish to incorporate GIS tools before their Bachelor's studies. During the last months of writing this thesis, one chair decided to introduce very briefly the use of QGIS to all the bachelor students of the faculty, precisely at the beginning of their first urban Studio –4th Bachelor semester. Although the only goal of the training is to acquire the contour of the buildings and an aerial image of a specific area, this one-hour training has become a tipping point, as all students are at least introduced to the tool. However, without a continuous experience with GIS tools over several years, a single experience is useless. A certain continuity during the following semesters is essential, whether as further training, or at least as expected knowledge they must acquire independently.

Finally, the students who followed two or three courses showed not only the evident confidence of having worked longer with the learnt methods but also, in alliance with AI and LLMs, were able to imagine applications that were not taught in any of the courses. These experiences exemplify the pedagogical approach of the courses, where the students were encouraged to create their own methods. It seems to be easier once the mastery of the learnt methods is settled and consolidated.

6.2.3.5 Multidisciplinary and collaboration

Future practices are described as multidisciplinary by the students. Preparing them for this situation does not only imply creating pedagogical experiences where transdisciplinary collaboration is requested. It is also key to accompany them with the technical and methodological knowledge that makes such collaborations thrive. Depriving designers of such skills has disastrous consequences, as they become less capable of holding interdisciplinary discussions. Having acquired a form of digital literacy empowers designers to become active participants in shaping ideas with colleagues from other disciplines.

Several students participated in Design Studios at KIT in collaboration with the Department for Mobility planning. The project was developed in teams with students from both schools. While architecture students could use several design software, mobility engineers could only use QGIS. Most of them had to switch to hand sketching, which hindered detailed planning and handicapped fluent collaboration. Only some architecture students could use GIS, which definitely ballasted the team's work. It was also evident that mobility students could perform better analysis and could work better with geographical data: they did not only use GIS to gather data but to perform statistical spatial analysis. This student also had the experience of asking information from the local authorities about the city they selected as the place of their Master's Thesis. The only common software was QGIS, and they could only explore the datasets because of their previous experiences in these courses.

6.2.3.6 Learning and the role of AI

The first *"Data-driven urban nature"* Seminar took place before the official launch of ChatGPT. Some students, who lacked coding expertise but wanted to use it, voluntarily learnt it from GIS forums and open repositories. The arrival of AI and LLMs has enormously impacted students wanting to use code in their designs, allowing them to approach it independently. The way students have integrated AI and LLM in their workflow has been very different from one case to another. In the last year, more and more students have used AI as co-pilot, making GIS tools more accessible and expanding its possibilities. In AI apps, they would find a knowledge base that helped some of them have a new self-learning approach, gaining confidence to manage their skills learning more independently. They do not universally adopt AI, it is noted that those students participating in the last courses use it more than those who learnt GIS without AI help. A common and frequent use of LLM while working with GIS is observed as a catalyst for more frequent and more elaborated use of geoinformation tools and methods, beyond what was learnt in the courses. What support can Academia propose to students willing to approach such a self-learning path?

6.3 Discussion of the qualitative analysis

Once the findings are presented, the following reflections look for the reasons, motivations and circumstances at the origin of those findings and their consequences. First, it is essential to state that the students insist on the value of GIS for their practice, wishing to know it more so that they can use it better. They consider GIS a powerful tool, and some could explain how helpful it was in several situations. During the GIS courses, they received good feedback from their teachers and Jurys, praising their approaches and big scale ambitions, supported by robust mappings. While all of them appreciate the great possibilities opened by the GIS courses, they also acknowledge that they had very limited use in the following years. All students admit to using GIS for better spatial data gathering, probably because they estimate the ratio between time invested and the resulting outcome to be very favourable. They feel they have a better and broader basis to start their work. While this first step reassures them, further deepening in a problematised design situation through computational spatial analysis is not happening. Why is the adherence to all GIS-competences –apart from dataset-acquisition– so remarkably low?

First, it can be argued that the students were rarely asked to use GIS after the courses. Is it because the focus of the Department of Architecture lies on the scale of the building? In the exercises presented in Chapter 5, as well as in some of the experiences learnt in the interviews and focus group, it was possible to demonstrate how GIS impacted small-scale interventions. However, such a strategic and whole-city approach may not have been considered key in developing a simple building. If the expected outcome of the following courses was a well-limited design object rather than a transformation process or a more significant urban area, the students may have felt unnecessary to use GIS. They indeed acknowledge computational spatial analysis's value, but they may perceive that using it requires a too demanding investment. Instead, they mobilise other competences that are easier for them, even if that means missing a design opportunity. Furthermore, do other lecturers know how to use GIS and how to make it worthwhile for the students' design process? The author's experience reveals that only a minimal number of them know how to use GIS. Without further encouragement or requirement to use computational spatial analysis, the students may have felt it was unnecessary, leaving behind what was learnt.

However, all students insist on their will to use GIS for their Master's Thesis, and some of them already have. A key difference in this case is that almost all Design Studios propose a site to work at, while every student must look for and propose their own site for the Master thesis. Finding the right place to build is a task that requires them to take advantage of GIS tools. Spatial computational analysis is, in this case, perceived as an explorative tool to navigate between certainties and uncertainties, useful for rethinking *'what has to be designed'*, that is, defining the design problem. However, they all *'wish'* they could find datasets that fit their purposes, without being realistic about which datasets are available. It is possible to imagine that, after looking for a specific dataset, they do not find it, they abandon this path, frustrated and discouraged. This situation could change if they got specific data mining training, where they learn what kind of information may be available. In this case, it is key to alert them about the risks of data opportunism.

Another possible reason for the low adherence to the learnt methods may be that they do not feel they master GIS enough to use it again without technical supervision. On one hand, the explorative approach of the courses may have felt scary for students looking for learning experiences that assure their learning process. While the proposed pedagogy can be very stimulating for people who enjoy being challenged, it may feel discouraging for those who need to build certainties step by step. Moreover, the GIS courses encouraged the students to create and customise their own design path. Again, this approach is inconsistently received: certain students can enjoy this experience and learn a lot from it, while others may not feel assured enough, leading to abandoning these techniques. The revealed tension between encouraging creativity and struggling with ambiguity and uncertainty should be considered by pedagogies and academic settings, reassuring and awarding students who pursue explorative and speculative paths. A pedagogy supporting those students requiring more guidance could encourage all of them to continue using GIS. In Chapter 8, some pedagogical ideas in this direction are presented.

Another factor impacting low adherence can be the student's feeling that the GIS courses were a one-time experience in their career. They may require assistance in the coming years, should they want to keep experimenting with GIS. Although informal support for the following semesters was always offered at the end of each GIS course, only a few students took that opportunity. It could be beneficial to implement well-established infrastructures to which they can refer when technical support is required, or when they do not know how to use their GIS competences in their new Design Studios. To foster long-term engagement, how GIS is presented and integrated in other courses can also make a difference. Instead of proposing it as an optional tool, making it an integral part of a design methodology is key. Academic institutions must demonstrate GIS potential as an integrated design instrument. Besides, it could be beneficial to communicate more the results of design proposals using GIS tools, like exhibitions and publications. They may contribute to creating a data analysis culture, raising awareness about the opportunities of GIS, and encouraging them to pursue its use. Passing the message of the missed opportunity for architects to engage with spatial complexity through GIS is pivotal to open new avenues for students to imagine how to incorporate GIS into their toolbox.

Disciplinary barriers

However, architecture studies still prioritise CAD, BIM or 3D modelling, relegating GIS to an additional, optional or collateral tool. This stems from traditional disciplinary boundaries, reinforcing divisions and marginalising GIS from regular practice. Do architects consider GIS to belong to a different disciplinary logic? An affirmative answer would stem from understanding GIS as an analysis tool, not a creative tool, which is greatly useful for architects in their design process. Presenting and framing GIS as a design tool fostering creative processes could encourage architects to use. Insisting on the expressive graphic quality of the produced mappings, and how such spatial data visualisation is a powerful boost for the creative process –also for architects– may encourage the students to continue using these methods.

It is also key to raise a question regarding student design experience. They are still learning how to produce a design proposal; in the process, they are shaping their own approaches, mobilising specific techniques and tools. Would a more robust design experience be favourable to the adoption of GIS tools? For instance, would a professional architect's practice be impacted more consistently by the adoption of computational spatial analysis? On the one hand, it is certainly possible that solid design experience can help professionals fully and easily integrate GIS into their workflow. On the other hand, explorative approaches in the professional world have economic consequences, and not all offices can afford to take that path. However, the question remains crucial and could be a possible idea for further research.

Finally, two aspects must be highlighted: the relationship between speculative design and naturecultures and the lack of adherence. The previous discussion applies to all forms of practice, because most students did not work with speculation or hybrid forms of urban nature. However, whenever the students worked with speculation or with nature, the intensity and the integration of the GIS use increased remarkably. Regardless of the scale, design proposals can become active participants in urban ecological systems, beyond mere human shelters. When the students imagine their buildings as porous and permeable entities allowing flows of air, water, and living organisms to pass through, interwoven ecosystems are created. Taking it beyond and looking for forms to co-design with non-human species is a fascinating challenge, for what the traditional tools of the designer seem to be insufficient. Foreseeing temporalities beyond human lifespans encourages designers to plan transformations rather than forms, for which the alliance of speculative design and mapping can be a powerful asset.

The conversations identified two main aspects that have beneficial effects in speculative design. The first one is the capacity to better found and sustain the hypothesis through data analysis, avoiding speculation as a form of escapism from reality, but instead looking into the future, tiding it up firmly to a robust description of the present –see fig. 2.2 for the future cone. The second aspect is to situate and successfully contextualise the enunciated future visions in a broader cultural, social, and environmental framework: they become situated speculations. Using GIS, they feel more entitled to propose data-informed speculative scenarios, while raising their bias awareness. Parallelly, cultural, environmental and ethical awareness is raised. The interaction of ecological actors, social initiatives and site-specific knowledge is better understood through spatial analysis. A considerable impact is identified in handling the multiscalar interrelations of different forms of nature. Why were the learnt methods key when the biosphere or biodiversity was central to their next Studio's brief? GIS approaches may have seemed best suited to acquire, augment and analyse complex datasets of the biosphere: they were probably unable to work with this information otherwise. The ethical implications of data production, acquisition and use are often a matter of discussion. At the beginning of the process of this thesis, one of the main ideas was how technology may help to imagine new naturecultures. However, the students' discussions evince that the shift in the conceptual framework of nature unleashes novel uses of technology such as mapping. Furthermore, it encourages designers to take broader ethical considerations into using technology in the design process.

The students who explained that they are involved in self-learning dynamics are paradigmatic for this thesis. They embody a professional committed to continuously exploring and learning techniques and methods, who can best take advantage of what is discussed in these pages. Self-learning was not a safety measure to fill in insufficient pedagogical support, but a good complement: all students were encouraged to pursue self-learning dynamics. However, few put them into practice, creating a divide between quickly improving and those who could only progress with external help. Introducing courses where self-learning is one of the core methods may encourage more than leaving it as an option for those who want to excel. Besides, the students must be adequately supported in their self-learning process to make it an educational strength. This could be beneficial in responding to the needs of the different kinds of students and their relationship with this form of learning. The psychological impact of self-learning is to be considered, not to hinder confidence and motivation, and to avoid discomfort or feeling overwhelmed.

In the conversations with the students, the number of approaches emerging from the intersection of naturecultures, speculative design, and GIS mapping is extremely limited. It is possible, though, to state that such design processes have a considerable impact on designers' practice—in this case, students' practice. Certain competences blossom, shaping a different form of design practice. The next three chapters delve into this idea, gathering all findings and proposing a series of manoeuvres towards future design practice.

6.4 Methodology's bias and limitations

First, the size of the sample studied has to be acknowledged. A bigger group could reveal further insights, as these students may not represent the broader population of design students. Moreover, other perspectives are lacking here, as they are exclusively architecture students; other disciplines working with urban nature such as landscape architecture or urban planning may have different uses of GIS and diverse attachments to computational data analysis. Input from other perspectives such as professors, employers or participants could also be beneficial to triangulate visions. Further research incorporating them should be conducted.

A longer and continuous follow-up monitoring of engagement with GIS after graduation may bring a valuable longitudinal perspective. The ability to assess long-term impacts is limited by conducting the study shortly after the coursework. Comparing these results with similar research about the people who participated in this study, but at least five years after their Master's thesis, could be an interesting counterpoint. Likewise, broadening the spectrum of tools beyond computational GIS and looking for fruitful alliances with alternative ways of engaging with spatial complexity could avoid technological bias, as it may seem that not all design approaches that rely on computation are considered valuable.

The analysis is based on students' self-reports, which personal biases may influence: they could downplay their struggles or overestimate their understanding. Besides, the person conducting the interviews and the focus group was the former teacher of GIS methods. Possible biases can be introduced here: the students may want to *'please'*, over appreciating the courses and the pedagogical approach. Besides, the Department has a broad selection of design Studios, Seminars, and *'Stegreifs'*. Their choice to attend these courses indicates that they are interested in designing with nature and learning digital mapping methods. It is key to address the possible bias creeping in through their availability: it could be argued that the students who joined the discussions were those prone to employ these methods. The exchange revealed that, although they all consider it a highly valuable tool, a substantial majority of them only used what they learnt in a considerably reduced manner.

Finally, bringing this thesis's *laboratory* to a professional level could reveal different insights. The setting of a professional office has remarkable differences from the academic setting: the designers have more design experience and their own established methods, and they are obliged to constantly collaborate interdisciplinarily. On the other hand, their practice is constricted by market dynamics and economic efficiency. How would their practice be effectively modified?

Part three

Findings, discussion, outlook

The last three chapters of this thesis present a comprehensive exploration of the empirical findings, critical discussions, and future prospects arising from the laboratory experiments conducted in Part Two. This last section is conceived as an exploratory inquiry into how emerging design methodologies—rooted in the interplay of urban naturecultures, speculative design, and digital mapping through spatial data and computational analysis—can transform design practice and competence development. The empirical analysis and reflective discussion presented herein are underpinned by a combined methodological approach, merging 'research by design' with qualitative investigations, which together provide a robust framework for examining the multifaceted impacts of integrating GIS-based tools into design processes.

The originality of this research resides in its commitment to exploring novel design methods that are predicated on the dynamic interaction between a thematic focus on urban naturecultures, the method of speculative design, and the technological instrument of digital mapping. By engaging with a series of design exercises undertaken by a cohort of students, the study unveils two significant transformations in the practice of design. First, an epistemological shift is observed: students evolve in their approach to GIS usage, moving from a view of spatial data as merely objective representations to perceiving it as a medium that fosters reflective inquiry and the generation of alternative spatial imaginaries. Second, a methodological shift is identified within the design workflows, where traditional linear processes are supplanted by non-linear, explorative practices that more effectively accommodate the complexity inherent in urban nature scenarios.

In detailing these transformations, the empirical analysis draws attention to the dual impact of digital mapping on both the acquisition of technical competencies and the development of critical, speculative capacities. The findings reveal that the use of GIS-based tools does not simply serve as an ancillary technical skill; rather, it acts as a catalyst that reconfigures the entire design process. Students demonstrated a progressive shift in their ability to integrate analytical rigor with creative speculation, thereby enhancing their capacity to envision and articulate new forms of urban naturecultures. This exploratory thesis, therefore, posits that the introduction of computational spatial analysis into design education contributes not only to a refinement of technical proficiency but also to a broader, more reflective design mindset that is capable of engaging with future uncertainties.

The structure of this part is organized around two main thematic groups. The first group of findings focuses on the epistemological transformation that occurs when designers engage with GIS tools. It documents how the act of mapping, far from being a mere technical exercise, becomes a generative process that stimulates inquiry into the underlying assumptions of spatial representation and data interpretation. This process involves a critical interrogation of the objectivity traditionally attributed to digital data, thereby uncovering latent biases and promoting a more nuanced understanding of how design interventions can emerge from the interplay between data and human interpretation.

The second group of findings examines the transformation of design workflows. Here, the analysis underscores the shift from a conventional, sequential design process to one that is more iterative and open-ended. This transformation is characterized by a reconfiguration of tasks and responsibilities within the design process, where analytical data gathering, visual synthesis, and speculative ideation converge in non-linear, dynamic ways. The exploratory nature of this thesis is evident in how it documents the evolution of these workflows over time, highlighting the emergent practices that arise when digital mapping is integrated into the fabric of design education and professional practice.

Following the presentation of empirical findings, the discussion chapter critically engages with a series of proposals aimed at translating these insights into actionable strategies for future design practice. In this discussion, the thesis moves beyond a mere description of observed phenomena and delves into the implications of these shifts for the broader field of design. The proposals outlined in this chapter are based on the empirical evidence gathered from the student exercises, qualitative interviews, and reflective practice of the researcher. They suggest pathways for developing new operational paradigms that prioritize data literacy, methodological flexibility, and a heightened sensitivity to the socio-ecological dimensions of urban design.

One of the central arguments advanced in this discussion is that design practice must evolve to accommodate a more integrative approach, one that dissolves the traditional boundaries between technical analysis and creative speculation. By doing so, it becomes possible to envision a future where the competences necessary for addressing complex urban challenges are not solely defined by technical mastery but are equally informed by critical reflection and imaginative reconfiguration. In this regard, the thesis contributes to an ongoing rethinking of the role of design in mediating between data and the creation of transformative urban environments. The findings and proposals articulated here underscore the potential of digital mapping not merely as a tool for representation but as a dynamic medium that enables designers to engage with and reshape the built environment in innovative ways.

The final chapter of this part provides an outlook that synthesizes the limitations of the current research and delineates prospective avenues for future inquiry. It emphasizes the necessity for continued exploration into the real-world application and transfer of these methods and tools, arguing that such an evolution is critical to narrowing the gap between design research and practice. By critically assessing the constraints and challenges encountered during the study, this section sets the stage for subsequent investigations aimed at refining and expanding the methodological framework developed herein.

In sum, Part Three encapsulates an exploratory journey into the possibilities offered by integrating computational mapping into speculative design practices. It offers a critical reflection on the epistemological and methodological shifts triggered by this integration and provides a forward-looking perspective on how these developments can inform and transform design education and practices. The results presented in this part highlight the transformative potential of *Mapping Exploring Speculative Scenarios with Urban Nature* as both a conceptual and operative framework for reimagining the future of urban naturecultures.

7 Findings and tensions: a tool reshaping its user?

This chapter examines how GIS methodologies evolve beyond technical learning towards declinations of generative instruments that reshape students' competences, workflows and conceptual approaches. In **Part two**, two methodologies are combined: a *'research by design'* analysis of the students' exercises, and a qualitative analysis of the associated interviews and focus group. The goal now is to illustrate how these complementary methodologies are suitable for exploring research question 1: *When imagining new urban naturecultures, how does incorporating GIS-based methods influence professional competences necessary for merging computational analysis with design practice?* This goal can be understood as *'research for design'*, a methodology aiming to improve design practices. As Klaus Krippendorff (2006) states: *"A science for design must nurture ways that enlarge the design space within which designers act"*. The proposed courses, together with this thesis, aim to contribute to that enlargement of the design territory, identifying how design practices are affected by the incorporation of GIS methods and tools that foster novel approaches. As a form of *'research for design'*, this thesis is proactive (ibid.). Besides technical tools, it seeks to provide the intellectual and operative frameworks required to change how to imagine what does not exist yet.

First transformation, epistemological

The following sections engage critically with the tensions introduced by GIS beyond a mere list of impacts. The resulting implications are investigated; contradictions and paradoxes are considered; and possible motivations and patterns are explored. Two profound transformations are captured, one epistemological and one operational. The first corresponds to the shift from Cartesian logic and –allegedly– objectivity towards a grounded, contextual and relational exploration of critical and speculative methods. This new epistemology expands the territories of design inquiries, rather than limiting their boundaries through simple data analysis. It must be acknowledged that such a transformation brings with it a weighty political responsibility for the students, since their mappings construct ideological visions of reality. However, within this epistemological framework of GIS, new design opportunities unfold.

Second transformation, operational

The second transformation, the operational, encompasses the impacts of GIS on the students' workflows, demonstrating the potential for GIS as an active design instrument beyond a passive analytical tool. The possibilities it opens up not only affect how the students fulfil design tasks, but also require different attitudes and approaches towards the act of design. These implications are critically assessed, considering what they mean for design pedagogy and future practice. It is crucial to recall at this point that the environment in which the *laboratory* took place is the academic context; further implications for professional designers will be discussed in the following chapters.

Overreaching paradigms: Ecocene and data-rich speculative inquiries

Both transformations are fundamentally shaped by two overreaching paradigms: data-rich speculative inquires and post-human theories guiding the Ecocene. GIS mediates between quantifiable data and speculative inquiries, fostering new ways of structuring design hypotheses. Bridging data and speculation advocates for entirely situated design visions, exploiting the possibilities of both approaches. At this stage, the Ecocene reveals itself not only as the theme or goal to attain, as initially imagined and presented in Chapter 1. The analysis of the exercises reveals the Ecocene's double role as the germ of transformations and design horizon. As captured in Chapters 5 and 6, those students adopting post-human approaches from the earliest stages of their exercises had a more acute need for computational methods and took the best advantage of them.

7.1 The expansion of the design inquiry: from analysis to speculative exploration

GIS skills were introduced in the courses, not only enabling analytic approaches but also enlarging the possibilities of the learned tools to construct new understandings of the environment and the multiple forms of nature being mapped by the students. The key parameters to understanding this shift are the competences described in Chapter 4: those skills, abilities and behaviours learned by the students and then mobilised to perform the exercises successfully. The impacted competency development implies more than technical mastery: it acts as a catalyst for the conceptual and epistemological transformation of digital mapping technologies.

7.1.1 Beyond analysis: GIS and the epistemologies of objectivity and possibility in explorative design

There is an evident epistemological tension between GIS as a cartesian, logical tool for structuring knowledge and GIS as a tool for expanding creative design inquiries. While there is widespread use of GIS for performing computational spatial analysis, what new strategies could be imagined to take best advantage of GIS in the explorative phases of design? Were there invisible epistemological constraints of GIS limiting the students' speculative capacities? The *laboratory* reveals GIS as a knowledge system that can unlock certain regions of the students' creative and *'designerly'* imaginations.

At this point in the dissertation, it is clear that GIS is not just a tool but a way of gaining knowledge through assumptions about space, order and rationality. Its structural logic, which is fundamentally Cartesian, grasps space and geographic information as quantifiable and modellable. Its users, in this case, the students, had to convert their ideas, aspirations and intuitions into a language and a series of parameters, which could be interpreted correctly by computers and GIS software. This transformation towards comparable metrics obliged the students to meet high standards of rigour and precision, looking for aspects that could be faithfully captured in the datasets. Such actions are understood as steps approaching scientific knowledge, consolidating a form of practice they are not necessarily used to, where significant amounts of quantifiable data are gathered, processed, filtered and analysed. The students gained competences to perform those tasks, improving their analytic skills. It is undeniable that such a quick adoption of scientific methods, mathematics and statistics is fostered by graphic representation, a discipline in which the students excel. Drawing spatial distribution of complex constructs is particularly easy for them. After the courses, they successfully demonstrated how to incorporate scientific rigour and measurable parameters into their spatial explorations. Indeed, design is a discipline that strongly relies on drawing, fostering spatial and graphical thinking. Creating allowances between representation and scientific analysis is a very attractive feature for students who are learning to use GIS software: they quickly realise that they can use it to think, reflect and imagine transformations.

While the students felt confident with this new approach to acquiring and producing urban and natural knowledge, the risk of restricting the world to those scientific parameters was also identified. They discovered that GIS lacked mechanisms to incorporate other aspects, such as the history of cities, human emotions or psychological well-being. These not easily parameterisable aspects are key for their everyday practice as architect students. The datafication of non-human agencies also represents a complex challenge they just started tackling. Moreover, the positivist reality that GIS contributed to describing is undoubtedly insufficient to fulfil their daily task completely: design. So, having found a way to approach the cartesian epistemology of GIS, a second trip must be taken: using the software to move towards the next stage, explorative design. The students had to imagine strategies that merged quantifiable GIS data analysis with their own *'designerly'* ways of knowing, avoiding quantifiable reductionism. Such endeavour is here identified as challenging but rewarding. The articulation between urban science and design proposal may well be the most critical issue: students must test for themselves how digital mapping can best work in their design workflows.

The students learned basic GIS techniques in the workshops, and could follow innumerable online tutorials online to discover how to perform a specific data analysis. However, the exact procedure for incorporating their data explorations into their design processes had to be chosen by themselves and learned through hands-on experience. The first step taken by many of them was to abandon a certain notion of control: accepting that taking technical determinism to its last consequences did not bring them to the essence of their design task. Uninterpreted information remained unfertile and required their *'designerly'* thinking to make knowledge out of it. Some students even began to question the mechanisms behind the positivist procedure that they followed. Such a self-reflective process allowed them to deeply understand the theme they were inquiring into, revealing the invisible structures that computation had concealed from them –fig. 5.28.

Moreover, working with elusive aspects of nature within post-human theories, they quickly understood that pursuing forms of total control was not a realistic approach: how would they control non-humans anyway? Thus, the students had to imagine subversive strategies that reconciled GIS and speculation. Rather than proposing closed, controlled design schemes, they started speculating about the impacts of different possibilities through *"what if…?"* questions. Such enquiries could engage with the quantifiable realities they had drawn, as well as the soft and ill-defined implications, merging scientific spatial analyses with possible futures. In this way, speculative design not only embodies an act of resistance to data absolutism but also becomes a valuable ally in critically assessing the performed data analyses, rooting them in broader, more meaningful context. The students' GIS mappings ignited and fuelled a reflection founded on quantifiable data, something that could only be achieved through speculative and critical methods.

7.1.2 Fictional objectivity and political posture

At the beginning of the courses, many students admitted that their interest in GIS lay in their intention to learn how to support their designs and decisions objectively. It is now crucial to investigate the politics of GIS knowledge production: who controls it, who benefits from it, and how it constructs sense—it would be controversial to say that GIS builds *'truth'*. Bypassing naïf *"honeymoon objectivities"* (Hong 2020), the students engaged actively with the politics of mapping through the learnt methods and tools.

At first glance, students saw GIS-based mapping as a neutral practice, based on technique and objectivity. However, making their own mappings revealed itself as a process requiring many conscious choices: the preparation of the map became an ideological act, constructing political narratives about middle-sized Central European cities and nature. Deciding what to map, selecting the key parameters, and establishing rules to measure and compare them are actions that construct a reality through mapping. But could the students' exercises not be political anyway, if they were operating within the framework of the Ecocene? A critical engagement with GIS as a tool of power therefore urged responsible action.

Working with GIS undeniably raised the students' awareness of the political power of their work. First, they understood the complex responsibility of the map maker. At the beginning of the courses, they thought that the map maker's task was simply to graphically represent *'the* *truth'* of objective datasets. However, they gradually accepted their role as narrative developers, and were able to reflect on the impact of their mappings. The perspective of the Ecocene also contributed to this shift, as they could move from fixed and seemingly reliable anthropocentric precepts towards more complex visions that acknowledged non-human agency. GIS and Ecocene, in this case, go hand in hand in developing the political awareness of the students.

They discovered it was crucial to ask themselves who ultimately benefited from their mappings. Were they accepting an established Capitalocenic status quo or challenging hegemonic views? Architecture has had human well-being in its centre for centuries. Still, mapping for architecture during an emergent Ecocene shifts the focus towards novel symbiotic forms of cohabitation and hybridisation. By mobilising diverse spatial analysis practices, the students were able to question how their mappings obscured certain realities and highlighted others. Again, the graphical clarity that architecture students can deliver is key to producing documents that foster deeper discussions about the capacity of oppression of minorities or the biosphere. Exercise 5.6 is a good example. The students highlighted the spaces and dynamics of oppression suffered by night ecosystems graphically.

The hegemonic use of GIS embodies forms of political power. This was discussed in Chapter 3 using the example of the Smart Cities or the Digital Twins paradigms. Inviting the students to not only use classic forms of GIS operations but to imagine possible *'detournements'* to them represents a pedagogical approach that aims to enhance the critical use of a technological tool. Of course, time is short in the GIS courses of the *laboratory*, and it is necessary to first learn the *'classic'* uses of GIS before attempting to turn them upside down. This means not necessarily thinking out of the box but perhaps bending the box differently; orienting the tool's use towards new directions. Thus, the key question here is: how are architecture students trained to question their own map production? The students of these courses heard, at least once a week, *"Never trust your maps"*, a warning inviting them to engage with their own production in a critical way. More than environmental activists for the Ecocene, the students were asked to become mapping activists, exploring hidden power structures in their practice, and working for more just uses of GIS. Institutions that truly seek a profound impact on mapping culture should adapt their curricula, shifting from basic software learning towards a critical understanding of the underlying mechanisms of the tools. This is particularly key for digital tools, whose functioning is often hidden from the designer's eye.

7.1.3 Data literacy and complexity, unresolved tension

Data literacy was observed to be a pivotal competency; the starting point of all design investigations and the enabler of further competences. A crucial step towards critical *'designing the right thing'*, it enables students to avoid design automatisms and preconceived ideas. This is particularly relevant when incorporating nature as one of the key elements of the design. The following aspects made evident the relevance of data literacy as a context and enabler for action, while highlighting its tension and complexity.

First, it is crucial to understand the data landscape. Data availability was a recurrent concern for the students; they constantly felt they did not have enough datasets to fulfil the required task. Of course, working with cities that provide solid public data infrastructure is an undeniable advantage: the available datasets are anchored in the territory and profit from local knowledge. However, the exercises that focused on smaller cities –or rural areas, such as the shown study on Reunion Island– demonstrate how less available datasets can be a base for ground-breaking speculative explorations. Easily accessible information from collaborative platforms such as iNaturalist or the analysis of social media networks may provide geographical information with sufficient granularity and quality to formulate speculative hypothesis for a place with, apparently, less open data. However, working with small areas –like Karlsruhe's Zirkel, for instance– requires a minimum data granularity to work with. Considering the datasets used by the students, the mobilised methods and tools seem to fit best for whole middle-sized cities and their immediate surroundings. The search for alternative datasets is crucial for proposals considering very small areas, such as squares or a small street.

Secondly, working with large datasets sometimes produced two opposing reactions: on the one hand, a false sense of control, on the other, the impression of being drowned in data. Both relate to the new position gained by the students to address complexity. The ability to rapidly incorporate novel sources of input information into their initial mappings encouraged them to face the subject of the exercises in a more nuanced, rich and elaborated manner. Ultimately, they grasped the higher levels of complexity needed to fully inquire into the nature of urban, social and ecological systems. While it is appropriate and logical to take advantage of such an enhanced position, a critical eye is also required to avoid the potential pitfalls of oversimplifying reality through its datafication. A balance between simplifying and addressing complexity must be found. Are the intricate threads of eco-social urban tissue so easily identifiable, though? Is it possible to properly sort them out in adequate categories and to equitably set the scale to measure them? Which further impacts should be considered that were not captured in the numeric data?

Where data alone could not advance their inquiries, the students found they could utilise speculation as an instrument to critically assess the broader implications of data acquisition, selection, grading and combination. Critical thinking and speculative design methods revealed themselves as a symbiotic instrument for data gathering and spatial analysis. The combination empowered students to actively engage with complexity, navigating between the risks of oversimplifying or ignoring it. This gave rise to situated, contextual and well-founded reflection about their own data collection.

Moreover, picking up from the students' reactions, it is important to understand what lies behind the impression of data overload. Not seeing the forest for the trees is a common pitfall for designers who lack experience with handling data. Diving into a sea of data, far larger than anything that could be reviewed manually, requires a shift in the students' modus operandi. Undeniably, the students' lack of design experience magnified the sensation of loss of control, leaving them feeling at times clueless among stacks of undecipherable datasets. They searched for methods to build certainties as, in many cases, this was the first time they had been confronted with studying a whole city. Moreover, they were working with forms of data they had never seen before, such as social media posts or biodiversity indicators. The goals for which the datasets had to be gathered were also new, as the Ecocene represented a different framework to their previous courses.

Two challenging tasks are understanding the data landscape and critically curating the selection with which to work. Experienced partners are vital: in academia, researchers and lecturers; later in professional life, experts and engineers can provide guidance. Multidisciplinary collaboration at an early stage would no doubt promote deeper understanding and avoid commonplaces, prejudices and data-opportunism (Ortner 2019). Raising timely awareness of this much-needed collaboration is key.

By the end of the GIS courses, the students could actively engage with complexity through data literacy. The diverse and ever-growing landscape of urban data is considered an asset beyond a simple source to *'inform'* design with science. In this environment, data-literate students can incorporate information-rich inputs into their workflow. They observe unexpected interactions between datasets that are not often crossed with one another: introducing contradiction awakens complexity, making it possible to understand it better. Their mappings are then enriched with dynamic and multiscalar relationships, merging built and biosphere. The immediate physical context and other relevant factors and indicators captured in the sensed datasets become the starting point of their data-informed spatial enquiries.

In science, bias is typically addressed through rigorous methodological controls. Design, even data-informed design, remains inherently subjective, making bias more pervasive and less scrutinised. Having integrated computational analysis technologies into their process, the students became more aware of the introduced biases. This awareness applies to the data science process they undertook and also to their overall design process. This was repeatedly stated during the interviews and focus groups, highlighting the magnitude of the impact on their self-reflection. The specific case described in exercise 5.5, *"Diversity in the urban commons"*, is paradigmatic. While the course used the Shannon Index as a trojan horse to enable students to immerse themselves in spatial data analysis, one student questioned the nature of the index, investigating its suitability to inquire into certain urban features. The articulated final presentation showed how the student's critical capacity to question the results and the process dramatically increased during the course. The acquired data literacy empowered him to engage in discussions that affected not only technical aspects, but also complex epistemological understandings about the analysed data and the mobilised computational analysis method.

Thus, the iterative and dynamic workflow of the students revealed that their awareness of possible bias was extensively increased and, in some cases, was introduced into their workflow for the first time. This is one of many soft skills whose development was also observed in the students' evolution. Soft skills are essential for effective collaboration, as well as innovation and adaptability in the design process. Two key areas emerge for the designer's continuous training: communication and adaptability. The first one shows up in graphical communication, but also extends to interpersonal communication. It is important to be able to articulate ideas clearly, overcoming possible barriers due to differing multidisciplinary terminologies and methodologies. Concerning adaptability, it is crucial to gain a high degree of flexibility when working with data-rich and often unpredictable environments. Exercises that require iterative attempts demand students to frequently adjust their approaches according to new data or feedback loops. Adaptability becomes critical when navigating uncertainty and seizing opportunities for innovation. Understanding the requirements of the learned methods stimulated these soft skills, allowing them to embrace ambiguity as a mindset that fosters experimentation. These soft skills are particularly relevant when the students change their workflows.

7.2 GIS and the transformation of design workflows

The benefits of learning GIS went beyond competency development. It also encouraged students to shape the way they approach design tasks differently. Beyond using GIS to perform static analysis, and then carry on with their traditional workflows, it is possible to identify key changes in their approaches. Unfortunately, as discussed in the qualitative analysis, many students did not really adhere to most of these transformations in the following months and years. However, a thorough critical investigation of these impacts may help to decipher the reasons behind this situation. With this, it may be possible to propose measures that allow students –and designers– to take advantage of the positive impacts explained below.

7.2.1 GIS proficiency fostering non-linear workflows

The design process of architectural students could be summarised as compiling some site information, doing some analysis sketches, and moving on quickly to designing a form to react to the brief. While clearly reductionist, this description reflects the linear workflow in the heads of many students participating in Design Studios. A certain mastery of GIS methods and tools can effectively impact this linearity, introducing paths and approaches that not only unlock common paralysing situations but also incorporate richer, more complex forms of proceeding.

A linear workflow for a problem-solving practice would typically move from analysis to synthesis, and from there towards a design proposal. This assumes that an objective analysis leads to clear design solutions, reinforcing a deterministic approach. Merging systems thinking and critical thinking, two complementary frameworks identified in the students' work, contributes to breaking this inertia. First, systems thinking is considered a flexible analytical approach for structuring complexity, making GIS a powerful tool to achieve such a goal.

The exercises display diverse methodologies; from layering, classification, model prediction or pattern identification. With them, it is possible to map interconnections between different urban and natural systems and reveal spatial patterns. Urban nature is intrinsically and continually evolving and mutating, which requires working with dynamic patterns across scales. But does this framework ensure that the implications and motivations of such patterns are well understood? Some of these aspects are not datafiable, requiring a disruptive method that breaks the continuous line of thought in system thinking. Critical thinking questions whether data speaks for itself, inviting students to imagine scenarios that disrupt the assumed objectivity of the GIS-based analysis. Paraphrasing James Bridle (2018), further forms of reflection beyond computational thinking and technical solutionism are to be fostered. The learned methods act as a springboard towards knowledge structures embracing complexity and multiplicity. This layered knowledge organisation is stratified rather than linear, with interconnections between the different layers that stimulate new insights (de Landa, 1997). In the context of GIS mastery, designers construct multiscalar and interdisciplinary frameworks, integrating systems thinking together with speculation and effective design strategies. All those superposed and intricated stratus catalyse an operative approach, navigating and articulating urban ecological landscapes.

The successive non-linear loops described above were focused on defining the problem, which design then responds to. Here it is pertinent to look back at the diagram explained in Chapter 2 –fig. 2.4– to understand just how clarity of problem definition is achieved through such iterative loops. While it may be perceived that GIS limits the students' agency to define what is important, the introduction of speculative design generated a powerful alliance to construct new problematics. Iterating between both diamonds and the cone, many final design proposals were refined through the feedback from testing each successive design scheme. The Basel neophytes exercise is a good example. This approach becomes a considerable asset in overcoming the gap between the first spatial inquiries and the design formulation some exercises lacked.

Such an iterative process fosters a shift from defining fixed problems towards a posture where it is key to outline dynamic questions. In this sense, the combination of GIS and speculative design expands the type of questions that students must react to. The following design steps should not respond to static, limited and immutable problematics but to conflict-rich questions in motion. Such a challenge cannot be solved by simply proposing concluded forms. This encourages students to focus less on object design and more on the relationships established between existing systems. In fact, the students in the exercises talked less about *"the object they were designing"* and instead began to reflect on the implications over time and space that emerged from their mappings. This enables process-based thinking, focusing on flows and evolving scenarios rather than on stationary forms. Formulating precise but open and dynamic problem definitions fosters forms of design that embody transformation flows. This approach, again, is aligned with the ideas of nature in the Ecocene, where dynamic balances and evolving alliances are sought. However, processes also depend on elements and systems with form and spatiality. GIS is, for this application, a powerful asset: while not the right tool for sketching, drawing or designing, it provides robust spatial information to redefine the research question and contribute to its geographic localisation.

Furthermore, it is essential to mention that neither GIS nor speculative design is presented here as a replacement for other methods to reflect on problem definition. The combination of diverse approaches and perspectives can create a better and richer understanding of the problems of a particular site. Practices include site visits, situationist *'dérives'*, interviews with the local users, and any other form of physical approach to the territory. These are complementary to digital mapping and were not included in the proposed courses due to the limited time available. In fact, looking back at the courses, it must be acknowledged that the combination of GIS investigations with other methods is manifestly lacking. Several activities that encouraged the use of multiple methodologies beyond the digital were unfortunately cancelled: site visits, photographic surveys, interviews with the neighbours… The development of pedagogical environments to promote crossover tools should be considered in the future.

As explained in section 1.5, different perspectives contribute to better tackling ecological questions. In this sense, it is key to note that the distance created by GIS –and somehow also by speculative design–can take great advantage of on-site classic observation, qualitative analysis of interviews with local stakeholders, or gathering of local knowledge. An exclusively remote sensing approach clearly lacks the relevant forms of information that must be taken into account.

Finally, interpreting significant amounts of data through computational means requires robust strategies that focus discussions and avoid drowning in anecdotal data. Buhigas and Solá-Morales (2022) propose *"rigour, ethics and honesty"* when combining raw data with intuition derived from experience. Both are valuable assets for the designer but require a profound ethos to identify and avoid bias –from data or the designer's experience– and avoid data mirages. However, it is not only in data handling that rigour must reign. The formation of each designer's inquiry method –the workflow– is a task in itself. The use of GIS obscures processes that only happen in the motherboard of computers, the *'black box effect'*. The students overcame this situation by carefully representing each step of the process graphically, by being able to discuss each of step in a critical way, and by modifying them accordingly if necessary. Drawing the result of each methodological step is identified as very good practice for dealing with the hidden mechanisms of computational processes. It not only fosters design transparency and logical thought but also enables designers to use graphic representations of each step during the following design process.

7.2.2 Impact of graphic representation on workflows

The students' exercises have been exhibited in various forums, from international conferences on data and nature to open public small-town hall shows. The first recurrent commentary from any audience is the celebration of visual clarity, graphic language, outstanding quality and creativity. This competence aims beyond simple representation, and is instead used as a research tool beyond pure analysis. Students' graphic expressivity finds in GIS a powerful alliance empowering them to shape their work steps in new ways. The students' personal and distinctive use of GIS demonstrates that they not only learned how to apply the tool, they also learned new a new way to produce knowledge, stretching the possibilities of GIS to achieve their design goals.

The challenge of representing urban nature through digital data becomes an opportunity to bring the biosphere to the center of speculative design—not as dry statistical values, but by leveraging non-human agencies to better incorporate the biosphere as a key topic in research-based design proposals. Breaking silos of urban and biological studies, both nature and cities –and their hybridisation– can be represented in an interconnected graphic language, fostering synergies and challenges. Such a task requires tools that allow designers to produce proposals, which emerge not only from *'designerly'* ways of knowing but are also informed by the analysis from external researchers. Mapping becomes a research-based design tool: the opportunity lies in the graphic skills of the students to represent research-rooted ideas, producing elaborated forms of knowledge. This approach breaks linear workflows and infuses the students' production with a scientific perspective, hijacking conventional GIS workflows and proposing data-informed narratives of urban nature.

Maps, plans, sketches and many other graphic documents help to grasp a particular idea or to form an impression that conveys a specific story within it. The students' representation of data becomes a material force shaping viewers' understanding of urban nature. Their mappings communicate ideas beyond analysis: they construct realities. What happens when such constructs are confronted with a *"what if…?"* question? Take the example of the exercise discussed in section 5.5 working with Zürich's diversity of the commons. A map displays the city's areas with the highest and lowest diversity of green zones. This information is superposed with the distribution of the surface of green zones and street parking places in square meters per 200 square meters. Such statistical data comes to life when asking the question *"What if all street parking spaces were transformed into diverse green spaces?"*. The map reader's imagination starts envisioning local and distributed transformations in different forms, evolving dynamically over time. The interaction of the map with the speculative question creates an open narrative for which every map viewer has a different development.

Forms of storytelling through mapping are a powerful catalyst for transformation, mainly due to their capacity to make people engage with them. People understand the striking graphic displays and reflect on the question from their own perspective, which is influenced by their individual personal background, social environment, political engagement, etc. Thus, these forms of storytelling are not only valuable for designers to continue their design work, but they may also become a tool for participation. In this sense, such a process completely breaks the designers' professional silo, allowing them to incorporate early into their design workflow the reflections of local communities, other experts, or municipal authorities. This opportunity will be further explored in the discussion, Chapter 8.

7.3 Critical findings for further competency development

As it has been unfolded in this chapter, GIS impacted the students' technical skills, expanding its epistemology towards a situated, political approach. In addition, the effect on the design workflow is also documented, showcasing novel forms of mapping operability. The tensions between nature, design, and technology emerging from the analysis of the exercises are explored in the following sections. Considering how each one dynamically shaped the other two helps to initiate a reflection about the pedagogical environment where students' competences thrive.

7.3.1 GIS and Ecocene, drivers of transformation

The original hypothesis of the courses, along with the early parts of this dissertation, was to explore how GIS mapping techniques could support the imagination of speculative scenarios with urban nature. The courses aimed not only at generating new forms of naturecultures in a formal sense, but also at imagining them conceptually, aligning with Bernard Cache's vision of philosophy emerging from the means of production. Chapter 5 presents a multitude of examples illustrating this approach. However, a closer examination of the design processes also revealed a reciprocal dynamic: while GIS facilitated speculative exploration into urban nature, the compelling imaginary of the Ecocene also played a formative role, actively shaping the technical and methodological evolution of GIS use. The combination of both unleashes synchronous drivers of design practice's transformations.

The students' work fostered visions of nature that avoided platitudes and moved towards targeted interventions that recognise unique ecosystem dynamics and agency. As the Ecocene is still a future vision, a goal to achieve, it embodies a concept preceding its own methodologies. Engaging with the principles of the Ecocene required an expansion of GIS methodologies beyond conventional digital mapping, creating a feedback loop between concept and tool. What started as an exploration of GIS as a technical aid for students evolved into a more profound epistemological shift: GIS was no longer just a representation instrument but a medium for questioning, interpreting and reimagining urban nature. The double role of the Ecocene as both a distant objective and an immediate driver of methodological development has revealed itself as a key feature for future GIS development.

Gernot Böhme warns about the danger of parametrising society (Böhme 2012). A similar risk lies in the digital parametrising of nature as a form of control or dominance, which echoes the Scientific Revolution of the 17th century. Is there a form of characterising natural processes that is operative for designers and, at the same time, respects non-human agency and the precepts of the Ecocene? The introduced tools not only brought new perspectives to look at nature but also encouraged forms of parametrising different aspects of nature to work with, avoiding overcoming clichés of the romanticism of nature. The radical change that the sensing of urban nature datasets introduced into the projects has an ambivalent force. Understanding data about aspects such as plant growth cycles, soil health, or seasonal variations contributes to gaining insights into nature's rhythms, interdependences and ecosystem services. Design proposals could be better integrated and symbiotically work with these conditions. Reducing the expression of datasets of nature or built environment to similar graphic language fosters hybrid visions of naturecultures. However, this abstract video game aesthetic can misguide designers, creating an artificial distance with something treated as raw data. However, it is living beings that are considered here, with their own stories and their own agency. The question that arises is how to gain a non-human perspective through computational data, coming back to consider each actor's agency.

The evident tension between systems thinking and non-human agency is pivotal here. While one tends to optimise holistically, aiming for efficient impact, the other escapes these control measurements rather than pursuing ethical coexistence and symbiotic regeneration of the ecosystem. While both processes can occur simultaneously, they emerge from different understandings of nature, and it is the designer's work to incorporate them. There is still a long path to walk for this activity, and the combined actions of GIS mapping and speculative design have proven to be an operative approach in this quest.

7.3.2 The need for a new design pedagogical approach

A critical look at the pedagogical environment created for the courses reveals tensions and challenges that academia should face by reorienting design curricula. First of all, learning the techniques of GIS software must go beyond the mere mechanical repetition of a series of commands. It is key that students apprehend the epistemology of GIS if they are expected to use it as a critical design methodology and not just a technical tool. Such an approach may flatten the learning curve. The experience with more than a hundred students in the courses shows that students applying only the few learned methods find these reflections somewhat unmanageable. On the other hand, for students who obtain a deep understanding of the underlying logic of the software and tools early on, rapid and robust development of competence is seen consistently. This encourages students to self-learn other techniques and even to repurpose and subvert official uses, adapting these to their design investigations and goals. The required supervision, support and mentorship to accompany approaches that are practical and experimental at the same time is discussed in detail in Chapter 8.

Universal access to AI and LLM has only been available for two years now, so its role in GIS use of self-learning is still evolving. However, it has already impacted the students dynamics: some of those who wisely used GIS and computational spatial analysis during the courses have, since then, completely integrated AI and LLM into the way they solve bugging problems and continue to learn to use further GIS techniques. These human-machine alliances for self-learning seem to have facilitated powerful results and, clearly, will be a key learning instrument in the near future. While they will require constant support for standard features, as well as correct implementation, they may be useful for those students trying to subvert how tools are initially conceived. Opening new application paths can be accompanied by LLM and AI, easing the students' explorative moves. However, not even half of the students used AI in their exercises or afterwards. This may reveal that it is not a method that is suitable for all profiles, or that additional efforts are required to help them learn how AI can support their work.

For the studied courses, it was key to use methodological doubt to spark curiosity in the students. Finding resources to increase self-motivation and initiative is here key: they will need much more than a simple course to incorporate solid GIS use in the future. The pedagogical approach of the analysed courses provided learning experiences designed to enable students to co-create their path to knowledge. While a small group of students continued with this approach, it must be acknowledged that it was not sufficient for most of them. Possible explanations for this, along with the resulting tensions, are explored in detail in section 6.3. The question of the required time and rhythm is considered key to gaining higher adherence to GIS methods. One semester spanning thirteen weeks is considered a very limited time to learn not only the mechanics of the software and its application, but also give the students tools for further experimentation through self-learning. This framework manifests the need for innovative pedagogical formats that prepare students for a professional life where they will look for resources to adapt to novel tools and methods. At the same time, it may be pertinent to inquire into formats that would perform best when bringing these techniques outside academia and training independent designers who are willing to use them. A training proposal considering both options is outlined in section 8.3.

7.4 Synthesis of findings: a new operative epistemology for GIS speculative mapping

The *laboratory* was designed to investigate how GIS computational mapping, often claiming objectivity and data-driven rationality, could be transformed into an engine for speculative design. The findings across Chapters 5, 6 and 7 reveal a transformation beyond operational adjustment, embodying a profound epistemological shift: an evolution towards a new operative epistemology that reconceptualises the role of mapping within design education and practice.

Central to this shift is acknowledging that GIS is not a neutral tool. It is a knowledge system embedded with assumptions about space, power and control. While students initially approached GIS with the aim of objectify spatial data to obtain factual certainties that inevitably guided the proposals towards a univocal solution, they discovered a different use. Through iterative engagements in speculative exercises, their technological awareness was raised, revealing GIS's inherent subjectivities: it could reflect, reinforce or contest narratives depending on how it was mobilised. This realisation dissolves the binary opposition between analysis and imagination, data and design, science and speculation. This new perspective, far from discouraging them from using GIS, fostered novel forms of practice merging statistic rigour with *'designerly'*, tacit knowledge.

Crucially, the paradigm of the Ecocene –initially introduced as an anchor– evolved, revealing itself as a methodological driver. The Ecocene's emphasis on multispecies entanglement prompted students to transcend anthropocentric or utilitarian logic embedded in the conventional use of GIS. It urged them to question datasets and the systemic relationships they revealed. In this sense, the Ecocene did not merely set the thematical frame for the mappings, but also fostered an active restructuration of the students' thoughts through and with GIS.

A reciprocal relationship between GIS influencing speculative practices and speculative practices reshaping GIS created a continuous formative loop. In it, the students progressively reconfigured their technical workflows and their cognitive habits in parallel. This unlocked the potential for GIS to operate as a speculative dispositive: a platform for assembling situated knowledge, designing with uncertainty and crafting open-ended futures. Speculative design does not simply deal with imagining futures: it actively reshapes the instruments used to construct them.

Equipped with foundational critical literacy, students began to employ counter-mapping strategies, deploying GIS to destabilise dominant narratives, imagine alternatives, and evaluate the impacts of those possible futures. These practices of dissent implied a reconfiguration of design workflows. Decoupling GIS proficiency from strict problem-solving dynamics fosters non-linear, iterative processes. Thus, mapping becomes more than a preparatory step preceding design; instead, it can be dynamically integrated throughout the design cycle. This allows navigating complex datasets without succumbing to reductionism, revealing tensions between systematisation and complexity.

Moreover, visual representation emerges not just as a medium of communication but as a conceptual tool. The graphic language of GIS is leveraged to make visible the hidden interdependencies between human and non-human actors, ecological systems and urban infrastructures. The students' mappings function as speculative storytelling devices, vehicles engaging with the map viewer to continue a conversation about more just, resilient and transspecies futures.

However, this transformation also reveals some frictions and limitations. The courses enabled a shift in GIS applications, but their impact on long-term professional practice remains uncertain. The lack of adherence to the students' GIS methods requires pedagogic implementation measures, easing the gap in the transition between academic learning and professional life. In addition, the academic setting provides the *laboratory* with an interesting perspective, but its translation towards the professional sphere remains unproven.

Taken together, these insights point towards a new GIS operative epistemology of design: one that blurs the rigid boundaries between science and design, data and speculation, nature and cities, academia and professional work, research and practice. *Mapping Exploring Speculative Scenarios with Urban Nature* becomes an ethical, political, and creative practice that shapes knowledge as much as it shapes space. Future pedagogies must embrace this expanded vision, encouraging students to both master and subvert computational tools in pursuit of more even-handed transspecies urban futures.

8 Discussion: three manoeuvres towards future forms of practice

The previous chapter gathered the main findings that the proposed double methodology allowed to identify, engaging critically with their revealed tensions and contradictions. The impacts on the students' skills, competences and workflows put into perspective the considerations needed to imagine the evolution of design disciplines dealing with urban nature. However, this thesis does not intend to put up a theory just at an intellectual and conceptual level, but also and, mainly, to reflect on actual practice. However, what exactly does *'practice'* mean, and to which form of *'practice'* does this text refer? Undoubtedly, it encompasses diverse tasks, actions and duties, but *Mappings Exploring Speculative Scenarios with Urban Nature*, MESSUN, occupy a key role. These professional designers and *'data-aficionados'* use diverse forms of knowledge to produce cartographies, enunciate possible futures, and design proposals. This complete chapter outlines the contours of this future practice, and the *laboratory*'s modalities of transfer towards such *'practice'* are discussed in section 9.3.

It is crucial to highlight at this point that no specific solutions are proposed here, though; paraphrasing James Bridle in his vision of what is required regarding the technology to come, *"solutions are the problem. Solutionism makes things worse. Instead, we need manoeuvres to cope with our situation"* (Bridle 2019). Thus, the following sections take the form of three manoeuvres emerging from the exercises' empirical analysis, the discussions with the students, the *laboratory*'s extracted findings and knowledge, and the didactic experience of the author during the last five years. With them, it is possible to inquire into the implications for design professions, the biosphere, and the future-coming tools. These three manoeuvres are a call to action. They emerge from problematic situations, proposing paths for a desirable evolution. Finally, the required academic, institutional, professional, societal and ecological changes, distortions and challenges to conduct these manoeuvres outside academia are inquired into.

8.1 Manoeuvre 1. Expanding the possible: redefining designers' agency

The functions of design professionals are circumstantial and contextual: they are subjected to the evolution of the societies they engage with. It is futile to define the profession of the designer statically; it is more accurate to articulate it in continuous evolution. The exercises' analysis highlighted a series of findings about how different competences are learnt and deployed, interacting closely between them. This helps to outline a specific form of future practice for designers using the available technology but producing radically different outcomes. This practice is conducted by a professional using digital GIS, focussing on critical zones (Latour, 2020), and mobilising methods of speculation. Each of the following sections identifies a characteristic challenge emerging from the findings in Chapter 7, proposes a demarche to face it, and critically discusses the feasibility of its implementation.

8.1.1 Future designers' acquired data-literacy

The first aspect of these new professionals is their capacity to extract, structure, manage, interact, and interpret digital datasets. This enables new forms of practising, not without challenging withstand and inevitable consequences. Nowadays, most designers are *'illiterate' in* handling and analysing big digital data in their everyday practice. This adjective reflects their inability to incorporate GIS computational processes in their daily work. However, as seen in the student's interviews, it is not only an incapacitation or lack of access to datasets, but a conscious choice refusing to engage with the available data critically. Such reluctant designers may argue that data is not their expertise, or even that their practice does not require its mastery. This can be described as data *'aliteracy'* instead, highlighting the resistance and refusal to engage with advanced computational spatial tools. This obdurate posture entails harmful risks.

First, because *'data-aliterate'* designers become passive consumers of spatial information. Engineers and other planning supporting disciplines provide designers with initial datasets, certainly. However, this data has then been processed, refined and selected as per their own professional view, interests and biases. Designers must regain contact with initial data, being cautious and critical of pre-digested data interpretations. If no designer would ever refuse to visit the building site before starting a project, why do they ignore the value of this first-hand contact with the digital data describing the urban reality they want to contribute to change? If data defines reality, engaging actively with it becomes an ethical, political, and strategic necessity.

The second risk is to consider GIS and data just as an effective spatial decision support system, provided *a posteriori* by some external third party to confirm the validity of a design. Designers working like this trust their experience and *'designerly'* knowledge to produce a proposal that is *'fine-tuned'* by the recommendations of other disciplines' spatial data experts. Such an approach risks becoming a technocratic confirmation bias for design, where external GIS analytics approve or refuse design approaches through supposed data objectivity. *'Data-aliterate'* designers do not have enough digital competences to engage in real conversations about the use of data shaping their design.

A robust approach to avoid this situation while leveraging the full potential of digital tools and methods is to educate designers as *'data-literate'* critical thinkers. They must evolve to become professional designers and, at least, *'data amateurs'*, lending from Leadbeater and Miller's *"pro-am"* terminology (2014). Data literacy and mastery of digital technology are, in this context, considered as a key to accessing certain parts of the designers' imagination. Thus, there is no contradiction in merging designers' visionary skills with data management skills, as the latter acts as an enabler for the former. Beyond *'using GIS'*, designers producing *Mappings Exploring Speculative Scenarios with Urban Nature* must actively weaponise it as a design force. Certain particular uses of GIS may not exist yet as such: designers must question themselves what GIS can do for them; the tool must be shaped to their needs. From the early stages of the design, selecting data that may impact most *"reflection-in-action"*, to every key stage of the design process. This can be laborious and arduous but provides designers with unique research foundations, as demonstrated by the students' exercises. Of course, this does not mean that designers must undertake the work of engineers, biologists or urban ecologists. The designers' data inquiries do not replace other disciplines' spatial investigations but contribute to the initial pathfinding with their own data production. The most relevant aspect of this production is not its scientific exactitude, but its rooted entanglement of tacit and *'designerly'* know-how with all other forms of knowledge. Therein lies its most valuable strength. Moreover, data literacy empowers designers to communicate with experts from different disciplines on the same footing during a key phase of design, aiming to define the design problem precisely.

This kind of practice is certainly not suitable for all tasks, commissions, and jobs undertaken by design professionals. In a similar position to parametric design for architecture, these advanced digital approaches are not required for all proposals. However, designers aiming not to respond to urban reality but to truly contribute to its transformation towards the Ecocene find digital data literacy an asset in facing such a challenge. It is legitimate to gain such literacy to investigate the impacts it unleashes on both technical and epistemological levels. In this sense, the practice emerging from *Mappings Exploring Speculative Scenarios with Urban Nature* may correspond to approaches that question given design briefs. They may come up with precise proposals, but most importantly, they become instruments of profoundly situated discussion, leveraging transformation possibilities. In a hyper-accelerated productive discipline requiring immediate solutions, it provides instruments to imagine radical futures, slowing the pace to really discuss the origin of the actions to undertake.

A shift in certain contour conditions is required for designers to acquire the desired data literacy. Education in and outside academia is key –section 8.3. covers this aspect thoroughly. However, many other changes must be undergone to allow the disciplinary evolution towards *'data-literate'* designers' practice. First, designers must understand and acknowledge their loss of agency, should they continue avoiding data-rich approaches. Besides, they must be exposed to the benefits of using such approaches; they must understand the multifaceted potential of GIS for their design tasks. Furthermore, they must experience such potential in their practice; as observed with KIT students, *Mappings Exploring Speculative Scenarios with Urban Nature* can be truly transformative when they allow themselves to test their own experimental approaches.

Moreover, coding should not be considered an optional knowledge; it should be taught as a core skill, just as mathematics or physics. Preferably from an early age, so that they can use it freely and with ease when they become professionals in their discipline. This change has already started in some schools, but it would need to be extended and, most importantly, critically taught so that every learner is aware of the ethics behind invisible computational processes. Designers must overcome the fear of coding; when they remark and experience the benefits of the simplest code for their daily duties, they may understand that it is not required to be a digital geek to take advantage of programming.

Parallelly, to face the *'black box'* risk, institutions should start asking for demonstrations of the algorithmic structure behind design processes. Engineers will be able to provide them, but designers will have to be able to do their part, too. Finally, it is key to acknowledge that some resistance may appear in academia and the professional world, claiming the lack of scientific basis of *'designerly'* use of data analysis. Engaging with them in honest discussions about the possibilities of such methods is a first step towards tool refinement. The gain is not assured, and designers must understand they are engaging here on an uncertain path. A very limited number of designers work already with *Mappings Exploring Speculative Scenarios with Urban Nature*, mobilising the required data literacy. Pioneer cases such as Nicholas de Monchaux or 300'000km/s are setting the bases of future practices, occupying the gaps between research and practice, data and design, nature and urban, commission and questioning the brief. More and more professionals should contribute to fill this gap, shaping the form of practice yet to fulfil its full potential.

8.1.2 Designers imagining naturecultures

"Our understanding of nature is increasingly mediated, demanding a re-evaluation of our role in the ecological narrative" (Cinti 2024). This statement sets the focus on the necessary reflection of design professionals' role aiming to shape futures towards Ecocene. What does this challenge precisely mean and how to face it? First, it is necessary to come up with new paths to imagining nature in spatial practices. The lecture of this thesis, to this point, evinces the opportunities for a systemic entanglement of design disciplines and urban biotopes. However, in most cases, design still treats the biosphere and the built environment as separate entities. Ecology

and environmental sciences cannot be reduced to metrics and their optimisation; design cannot just create forms out of tacit experience. Two complementary forms of knowledge production are key to mediating with this datafication of nature: critical thinking and design practices. With them, it is possible to imagine environmental strategies fully integrated into the design process as a fundamental actor. The Ecocene paradigm requires radically restructuring designers' engagement with natural and non-human systems at all levels and scales. Merging critical thinking with digital mapping allows to imagine naturecultures outside the status quo. Besides, it contributes to evaluating the impacts, allowing refining proposals through iterative critical questioning.

The findings emerging from the analysis of the student's exercises reveal GIS and computational systems as tools opening new opportunities, but they also are technologies generating certain barriers and biases. Designers should redefine their engagement with GIS to take advantage of its Cartesian framework but escape its classic use towards extractivism of real estate. GIS hacking, moving towards a subverted and repurposed use of it, has proven in the students' exercises how ecological thriving in complexity can be fostered and not hindered. This technological reappropriation questions blind trust in computation and grows within a reflective posture. In it, Ecocene should guide how designers redefine their role as active mediators between technology and non-human entities.

Building on the findings extracted from the *laboratory* in **Part two**, it is possible to propose strategies for bridging the gap between nature and design. This implies that designers must radically change some of their practices, reorienting them towards new goals to achieve. Designing with thriving ecosystems requires a new spatial ontology, in which Ecocene functions as an ethical compass to navigate in this reorientation of designers producing *Mappings Exploring Speculative Scenarios with Urban Nature*. The speculative power of GIS must also be questioned by key ethical dimensions. The ability to create speculative scenarios through opaque algorithms raises questions about accountability, inclusivity, and representation. Critical design using GIS should consider how speculative scenarios impact diverse populations and ecosystems, even addressing power imbalances in urban spaces. Ethical speculation involves recognizing that speculative scenarios are not neutral. The use of GIS to imagine future possibilities must be critically examined for its potential to reinforce or challenge existing power structures (Kitchin & Dodge 2011). Designers are required to observe their methods and their use of technology, critically addressing their design process to incorporate the values of the Ecocene successfully.

Abandoning anthropocentric perspectives entails considering humans at the same design level as bacteria, animals or fungi. Observing non-human life goes beyond capturing fauna and flora occurrences in the urban realm; it means mapping non-human intelligence and behaviours, understanding them and making them an integral part of design practices. This will redefine what is understood as urban intelligence, still considered human-made and optimised by the technological intelligence of the Smart Cities paradigm –not forgetting that technology is also non-human for Donna Haraway. Orchestrating all these agencies simultaneously shifts design practice towards distributed, ecological intelligence networks. An authentic search for multispecies symbiosis should replace preservation paradigms minimising environmental damage. Imagining possible naturecultures fostering interspecies cohabitation should be supported by nature-technological hybrids that recognise the agency of non-human entities. The most difficult, unresolved task is finding instruments and methodologies to understand and give voice to non-human agency. Moreover, nowadays' actors designing the city, designers, urban ecologists, or policymakers still operate in silos, leading to fragmented ecological interventions. Can the joint formulation of speculative futures for naturecultures be the key towards more integrated proposals?

As discussed in the exercises' analysis, a key aspect of abandoning object-centric design is to move towards process-based thinking. Designers must produce the pathway of transformative processes with urban nature; imagining such dynamic, evolving natureculture systems requires a mindset shift where designers do not produce *'finished'* spaces. Instead, they come up with open-ended spatial strategies co-evolving with the surrounding and embedded ecosystems over time. For such a task, formulating speculative environmental scenarios provides a powerful methodology. In it, data is not just analysed but understood in context and bent it toward transformative spatial futures. Instead of reacting with mitigation strategies, designers can prototype alternative natureculture evolutive futures.

The discussed technologies and design methodologies aim to update many ideas of urban metabolism: the last paragraphs advocate for climate justice, biodiversity sovereignty, regenerative symbiosis, habitat resilience and multispecies cohabitation, all in temporal and spatial interdependence. *'Data-literate'* designers' mastery of digital technologies to achieve the Ecocene's goals echoes the seminal ideas of the European Union about *twin transition*. There is no doubt that this new professional must be a key stakeholder in the definition of what this emerging term means, but mostly in how this term is implemented in real-world scenarios in the near future.

Such repurposing of the goals and focus of designers requires, first and foremost, to reflect on its implementation feasibility: institutional, academic, professional and societal transformations easing or hindering this shift. Starting with academia, nature cannot be a background condition of Design Studios, but an active agent. That is a suitable starting point to let students learn dynamic planning, aiming to design transformation processes encompassing urban and natural elements. An appropriate academic format would be creating multidisciplinary *Natureculture Design Labs*, where designers collaborate with biologists, climate scientists and data analysts. New interdisciplinary tasks such as biodata strategical planning, climate-fiction cartography, or multispecies negotiations will require designers to take an active role in their shaping. Armed with the methods and tools explored in Chapter 5 –and many more–, they will be able to face the planning of bio-digital and nature-driven infrastructures. In certain respects, *'data-literate'* designers gain a position as activists, influencing policies, and impacting societies' discussions.

Finally, institutions must introduce policies that promote the creation of urban naturecultures. Moreover, cities and environmental agencies must be guardians and facilitators of their desired evolution over time: urban governance will require adaptive environmental policies rather than fixed land-use laws. In this environment, citizens will interact with co-evolutive green infrastructures rather than using human-controlled parks. How should policy writing be affected by this new set of practices? This could be an interesting follow-up topic for future research.

8.1.3 Designers exploring alternative futures

After discussing how design practices may evolve thanks to data literacy and the framework of the Ecocene, the next sections explore how speculation effectively shapes a future-oriented form of practice. This thesis builds on Dunne & Raby's concept of speculative design but pushes it further by introducing computational data analysis as the enabler of future urban scenarios with naturecultures. The students' exercises' analysis demonstrates how speculative design can be an active agent for spatial transformation. The new professional described in these last pages actively mobilises speculative methodologies, unleashing potentials and challenges.

The proposed shift in practice propels professionals beyond solution-oriented practices. They use computational mapping to provoke new design questions and construct new problematics, aligning with the principles of the Ecocene. This approach pursues to regain agency for designers: they are not asked to predict futures but to orient their practices towards transformative future-making. Here, two interrelated forms of speculative mapping are proposed as actionable strategies: counter-mapping and critical storytelling.

As seen in several examples in Chapter 5, mapping can challenge power structures and hegemonic views of urban nature. Counter-mapping becomes a key practice of *'data-literate'* designers towards Ecocene: they can support their contestation to established narratives on data analysis and challenge prevalent concepts about urban naturecultures. Future speculative scenarios may look very shiny and positive in their initial formulation. However, the goal is not its formulation but to reflect on the –often hidden– values that those scenarios generate and promote. Again, the Ecocene should be the compass to navigate the interpretation of those values.

Besides, storytelling through mapping is a key finding, as described in section 7.2.2. Beyond its use as a communication tool of the personal line of thoughts of the map maker, its potential as an enabler for professional collaboration and citizen participation must be highlighted. Designers can create maps, converting abstract spatial data into compelling, relatable stories. A correct use of GIS can make complex spatial issues accessible to communities, and the implementation of storytelling contextualises the data, making it understandable and emotionally resonant. Creating environments where the mappings are shown and people's reactions are gathered can be a form of enhanced governance. This dispositive can function as an echo chamber to amplify marginalised voices, allowing them to react and engage in public co-creation. This approach bridges local knowledge and institutional decision-making, and could be taken even a step further, if mapmakers could create new narratives with mapping from the singular experiences of people and communities who have not had access to address their spatial concerns. This would become a form of storytelling from co-created counter-mapping.

Again, adjusting university curricula is crucial to implement this manoeuvre effectively. GIS education must expand beyond technical skills to include critical data literacy and speculative mapping. The professional world still remains risk-averse and favours short-term, market-driven strategies over radical speculation. Integrating speculative design into environmental policy will bring this practice outside of conceptual design firms and academic think tanks. Perhaps the capacity of speculative mapping to enable and foster public participation can bring this situation further. A last relevant consideration concerns the material and instrumental development that may allow the evolution of designers producing *Mappings Exploring Speculative Scenarios with Urban Nature*, as described in this first manoeuvre. Software, plug-ins and apps need to evolve to foster these practices. The shaping of these tools, as well as their impact on the design workflow, is the keystone of the next manoeuvre.

8.2 Manoeuvre 2. Beyond the given: designers crafting tools and mediating methods

The previous manoeuvre explores how certain tools change design practices, outlining future forms of practice. But how will these forthcoming practices shape the tools to arrive? Which technical extensions will the future data-literate designer require? More user-friendly interfaces, better integration with manual drafting tools or incorporation of recurring procedures (Brechtold 2016) are reasonable and useful demands to software developers. The overall usability would be enhanced with such improvements, while facilitating new users to approach GIS software. However, apart from the technologies developed by a third party, probably steered by giant tech corporations such as ESRI, this thesis explores designers' capacity to self-customise their own tools. The first step is the *'detournement'* of the existing GIS technological environment: using the naïve approach of the novice to use well-established tools and methods in unexplored forms, stimulating new paths to generate knowledge through data representation. The following step to support *"practices of dissent"* (Paredes Maldonado 2020) is to become an active figure in shaping one's own design processes and methods. This second manoeuvre proposes calls to action to *'data-literate'* designers, who can actively shape their practice through their own tools and methodologies. Building on the findings from Chapter 7, demonstrating the necessity of a new design agency beyond pre-cooked tools and conventional workflows, this manoeuvre empowers designers as *own-design-tool prototypers*.

8.2.1 DIY tool development for speculative mapping

This is an era of profound conventionalisation of the graphical expression through software that acts as a compilation of standardised parts. The capacity of designers to define their own design process is going to be key, particularly when envisioning out-of-the-box proposals. Chapter 5 shows how the students reshaped their relationship between technology and speculation within a design education framework. GIS is a tool mostly analytically used by geographers, engineers or big-scale planning agencies. The students' needs from GIS are undoubtedly different, as they primarily deal with design, more particularly in these courses, with exploratory and speculative design. Such a starting point encouraged them to move beyond data consumption and use GIS as a site of creative agency. They were not only using standard GIS tools somehow differently from their original purpose, but they were also creating their own tools to achieve their goals.

Pre-built tools, also in GIS software, contribute to the fast adherence of inexperienced users to a new way of doing. However, they reinforce passive relationships with technology, endangering knowledge production: embedded biases and black box effect may remain invisible to the designer's eye. Findings from the *laboratory* of **Part two** evince how using standard computational processes differently, or creating custom-made tools oblige designers to question black box effect and possible biases. This, in turn, fosters a deeper understanding of broader implications. The students' exercises also demonstrate how such practice expands what can be mapped: they looked for other spatial orders and mapped subjective appreciations through social media imaginary, for instance. Moreover, crafting GIS tools facilitates counter-mapping practices, by challenging not only hegemonic views, but even questioning the research tool to inquire into each topic. Even when some mapping results were not the finest or proved not completely accurate, the students could acknowledge this fact. This is a logical consequence of having gone through critical engagement with their use of computational tools. The value of such a reflective attitude is discussed extensively in the findings section, where it is also demonstrated that no total mastery of GIS is required to benefit from the self-crafting of its tools. Designers producing *Mappings Exploring Speculative Scenarios with Urban Nature* are not skilled computer scientists building complex digital twins. They are professional designers and computational knowledge amateurs who feel empowered to repurpose specific GIS tools fitting their design and speculative goals.

This second manoeuvre takes off with the idea of designers becoming active shapers of their own GIS toolkit to imagine the transformation of urban naturecultures. This implies a profound shift from user to toolmaker, which, in the case of architects and other designers, is common practice: they customise how to use software and digital tools to achieve a task that does not really have a single path to carry it out. They have probably done experimental toolmaking with CAD in the past and are still doing it with BIM. Of course, generative software such as

Grasshopper is the perfect example of this tool self-crafting.

In this sense, GIS should not be understood as a finished product, but as an open-ended medium. GIS pre-packed tools are primarily oriented for other disciplines, such as geography, engineering or real estate business. The most common goal is site analysis, but not necessarily a design proposal. On the other hand, designers must make GIS adaptable to their practice; two different approaches are proposed for them. The first one uses standard GIS tools differently, repurposing their mechanisms to match their speculative design needs. Secondly, they should create their own bespoke GIS routines, imagining a possible evolution of the software that hosts the tools. Both strategies try to bend-the-box-differently, opening perspectives for different kinds of GIS users, rather than just thinking out of the box or escaping reality. But how can designers face such a challenge? They should use FOSS –free and open-source software– and avoid close-code software products. Options here are endless, from QGIS, the software used in the courses, to other not specifically spatial but computationally powerful such as R or Python programming. They can also use open-source GIS libraries to help them produce speculative cartographies, and they should use AI and LLM to refine their code writing. Keeping in mind the aim for algorithmic transparency, coding abilities and experience can be here a barrier for some designers to advance at the expected pace.

By adopting this position, designers can incorporate other forms of data, allowing the emergence of spatial ontologies aligned with the Ecocene. The disruption sought with these *"practices of dissent"* (Paredes Maldonado 2020) contests the hegemonic posture of Smart Cities using the same technological environment. However, this *'detourned'* use of GIS is no standalone instrument; it takes great advantage when combined with other methods, both traditional –analogic– or fully digital, generative tools such as Grasshopper. The real shift that this second manoeuvre initiates can only be achieved with the designers' technological and epistemological endeavour to shape their own tools and processes. Therefore, the use of FOSS must be favoured and promoted both in academia and in professional practice. Moreover, academic encouragement of experimental toolmaking would contribute to creating a culture where designers are not passive users of technology but active shapers of their toolkits. Two complementary educational formats may have a positive impact towards this direction. First, courses where the gain of very simple GIS tool repurposing is made evident for students through hands-on exercises. These pedagogical experiences aim to encourage students to further practice of this kind. Parallelly, other time-intensive workshops over several days –similar to hackathons–should be proposed for those students willing to really deepen their use of GIS. The experience of the courses demonstrates that these formats have a profound impact on the learning curve, taking the participants to a completely different level, not only in the technical use of it, but also in the epistemological understanding of the tool. The resulting professionals will invest in cultural capital by accumulating knowledge, skills and connections with other similar profiles in their field. Their impact is significant on innovation, introducing new ideas and perspectives while contributing to more engaged and active practitioners.

The universal access to open-source LLM granted by Deepseek in 2025 sets a new framework for using AI to support coding. Rather than reading a set of instructions, designers can engage in oral conversation with the LLM to adjust and sharpen its tools. The interface listens to the user's voice, answers it, and can access the screen and interpret what it displays. The user engages in a conversation with the LLM, showing the screen, just as everybody has done when they needed software assistance from an experienced colleague. Upcoming forms of coding based on LLM may soon not require any coding competence. This could lead to designers creating their own self-tailored complex computational tools and fulfilling their needs without coding mastery. This, of course, opens up questions about the lack of algorithmic transparency, which will have to be further addressed differently.

8.2.2 Designers' cultural mediation of their mapping workflows

Stating that designers decide their own workflow to produce a particular piece of work could be considered a tautology. However, many accepted GIS uses and computational processes tend to be seen as objective and unmistakable, risking standardising design workflows and outcomes of those using them unreflectingly. Fully understanding that design is a cultural and political act and not just a suite of technical processes means that designers producing *Mappings Exploring Speculative Scenarios with Urban Nature* must feel empowered to consciously decide which processes of knowledge generation suit each case best. As evinced from the students' exercises, bespoke design workflows fostered outcomes merging design, speculation and computational analysis.

Carefully curating the mapping workflow in each situation fosters situatedness. Thoughtfully undertaking this task means that *'data-aficionados'* professional designers should introduce the principles of Ecocene at early stages, considering non-human agency and gaining multispecies perspectives. Avoiding capitalocentristic approaches encourages them to construct a design path that must be situated and distinct for each case. Designers must mediate between data, *'designerly'* intuition and speculation methodologies, integrating multiple epistemologies:

– GIS and algorithmic operations: spatial-computational knowledge

– Critical thinking, fiction-futures, counter-mapping: speculative knowledge

– Embodied and tacit design experience: *'designerly'* knowledge

These forms of knowledge must be enriched with situated local knowledge such as interviews, site visits or *'dérives'*. Together, they assemble a form of knowledge that can be reflected in the mapping, whose creative process must be adaptive and negotiated every time. Instead of having a one-size-fits-all step-by-step process, these designers must iterate fluidly between research, speculation and design rather than treating them as separate stages. Shifting from following standard workflows to authoring them, inviting different stakeholders to the process helps redefine design priorities.

The pedagogical shift required to contribute to this change is major: learning not only to produce a reasonable outcome but to mediate the processes in which students simultaneously engage with multiple forms of knowledge. Engaging with this approach's complexity and uncertainty is certainly a challenge that will require gradually shaping new pedagogical formats. Training to read, interpret and navigate conflicting spatial narratives stemming from diverse methodologies is key to shifting from problem-solving dynamics to a process-making culture. Finally, as stated in the last sections, the first two manoeuvres require a shift in the pedagogy of speculative mapping. The last manoeuvre explores this scenario.

8.3 Manoeuvre 3. Restructuring design education for mapping naturecultures' speculative futures

This thesis does not focus on pedagogy but on the impact of GIS use on competency development and the future evolution of design professions. However, the academic setting of the *laboratory* and the implications of the two first manoeuvres lead to a necessary reflection on the pedagogical approaches of mapping in design education. Academic institutions aiming to shape future planning forms can take advantage of these considerations.

Regardless of this thesis's specific approach and perspective, countless references argue the growing demand for GIS expertise and the resulting importance of its reinforcement in academic curricula. This is crucial for Landscape Architecture and Urban Planning studies and is also increasingly important for Architecture (Saha 2017, Monsur 2014), as shown in Chapter 5. It is argued that students should not deal with complex tasks at the beginning of their training, which is supposed to lead to overload and discontent (Brechtold 2016). The author's pedagogical experience, however, proves that exigent and complex challenges, ordered as per certain reasonable incremental difficulty, encourage faster and more profound knowledge and engagement with the tool. Moreover, plain basic skills do not contribute enough to structural changes in systems and critical thinking. Beyond technical mastery of the software, it is key to understanding the logic behind the software and using it to its own advantage –or even *'detournate'* it. Remarkably, at least one or two students every semester managed to mobilise tools and procedures that were, not only not taught during the courses, but also unknown to the faculties. This illustrates that, in these cases, the driver for learning is curiosity, particularly for those designers willing to explore new technological territories.

As discussed along these pages, mapping is neither a neutral nor a technical practice. Mapping is an active design asset blending diverse key knowledges of the designers: scientific, spatial, speculative, narrative, critical, situated, *'designerly'*. This makes mapping a crucial practice in academia, particularly in design institutions trying to break silos between research and practice, between science and design, and between computation and speculation. Embedding mapping as core competence in university curricula fosters student learning to:

– decode and manipulate spatial data, rather than passively using GIS,

– construct speculative spatial narratives based on geospatial insights,

– merge cartographic experimentation with design synthesis.

To achieve this, GIS has to gain status as a design generative tool with full speculative capacity. New ways of learning it beyond pure technical mastery must be proposed, bridging between computational knowledge, critical reflection and speculative practice.

8.3.1 New pedagogical approaches for *MESSUN* designers

The students aiming to gain experience as designers producing *Mappings Exploring Speculative Scenarios with Urban Nature* should curate their own learning trajectories, experimenting with diverse complementary methodologies. These should be merged with computational methods based on free and open-source software that they can adapt to their needs, developing their own DIY toolkits. The following three proposals encompass different needs and opportunities emerging from the findings of this thesis' double methodology to develop a new critical mapping technosensibility. While the thematical angle can be completely open, it is possible to learn from the *laboratory*: working within the paradigm of Ecocene enables different ways of thinking that are beneficial to the experience.

The speculative cartography design Studio. One-semester hybrid Studio merging all forms of applied knowledge in a hands-on design experience. In it, students collect, interpret and work with spatial data to construct critical cartographies. The focus lies on counter-mapping, encouraging the students to develop new ontologies of space, and not only document existing ones. The publication and exhibition of the results contribute to communicating the value of the approach, gaining visibility among the other students. Finally, the possibility of proposing a double-semester design Studio could be an opportunity for students to have enough time to incorporate all methodologies within their design workflow truly. However, this is difficult with the current Master structure, where students only follow three Studios, diminishing the opportunities to learn from the knowledge offered by other chairs. A considerable cultural change must happen to encourage students towards a more significant specialisation within a general Master's Programme.

Spatial algorithms for urban futures. Intensive workshops. The creation of hackathon-based workshops aims to boost technical mastery while still orienting them towards experimental practice and speculative design. Two- or three-day intensive workshops allow students to deepen their knowledge of the technical aspects of GIS. However, the goal encompasses more than learning software functioning. It is the opportunity for students to reflect critically on the technology itself, considering embedded biases, possible impacts and dangers that its use unleashes. This is the place to imagine new ontologies related to each technique, and the moment to imagine different applications to standard uses, and detournements of GIS tools –*'fold-the-box-differently'*. The workshops should take place right before the semester or during the first weeks, allowing students to apply the knowledge they have gained in all their courses.

Narrative mappings. Hop-on, hop-off atelier. While both previous formats provide intensive punctual learning environments, a third one offers students the opportunity to pursue a continuous learning experience in critical cartographies, which is key. The proposal is to create an atelier with regular frequency –weekly or fortnightly–to which students can experiment with GIS and apply it in their design Studios and Seminars. This permanent format allows them to join and step out freely, accompanying their whole Bachelor and Master studies with adapted answers to their specific wished applications. Such availability encourages the development of bespoke strategies for each student's project, in contrast to the more directed and thematically limited two previous formats. The overreaching goal is to ensure adherence to speculative mapping methods –identified in the qualitative analysis as one of the main challenges–and their infiltration into all other courses.

What challenges may face the implementation of such courses? First, the three proposed formats cover different time investments and several paces, each contributing to better developing certain competences. The time required for the Bachelor and Master Programmes is certainly limited and must integrate widely diverse subjects. Negotiating the time investment for each training may be arduous, and resistance to change from institutions can appear. However, early adoption and continuous support are two key aspects to take care of when implementing the changes this manoeuvre encompasses. Moreover, the difficulty of putting new computational mapping methods into practice should be faced from learning-centred education, focusing on how the students learn. While enough support must be provided for the students to feel assured and motivated, self-learning is key. The students' best results in several years of courses correspond to those who firmly took their education into their own hands. The support of AI and LLM for self-learning is key, not only as a troubleshooter but also as a discussion partner to explore the paths designers wish to take.

8.3.2 Role of research

Finally, research plays a key role in establishing and further developing these GIS methods in Academia. Two complementary and simultaneous formats become valuable assets bridging research and design practices: *'Research for Design' –RfD–* and *'Research-Based Design'* –RBD. The former can contribute to design practice by testing new forms of applying GIS methods for the planning of urban nature. There is a myriad of studies that develop applications that are far too complicated for independent designers to use in their designs. However, there is less research work on the *'detournement'* of simpler methods that are tightly bound to a design practice. A closer collaboration between designers and researchers, fostering exchange about these methods, will benefit the former and allow the latter to root technological development in design use. This would undoubtedly contribute to breaking silos between imagining the tools and the use of them. Parallelly, the gradual implementation of GIS-informed research as a form of design practice is key. Professionals performing *'Research-Based Design'* managing to mobilise GIS methods become early adopters, contributing to spreading the advantages of such a methodology. This is valid for any urban or architectural project, but it is particularly acute when incorporating robust strategies that merge nature with the urban. Institutional support for this research approach is highly encouraged.

8.3.3 Continuous self-learning beyond academia: building a life-long education on computational mapping

The rapid evolution of computational tools and GIS techniques requires educational measures to ensure the adoption of speculative mapping methodologies by design professionals. Realising the relatively low adherence of the students to these methods after the courses, it is key to propose formats that:

- bridge academia with continuous professional learning,
- support professionals willing to apply these methods,
- enhances the visibility of the results of speculative mapping.

Creating online learning platforms with repositories sharing techniques, scripts and their resulting cartographies is a first step, decentralising peer-to-peer learning models. Universities could offer workshops and fellowships for mid-career *'data-literate'* designers. In them, professionals can develop and test new spatial ontologies. Again, the goal is not to instruct code-writing experts, but to empower professional designers who can take great advantage when introducing some simple computational mapping techniques.

8.4 Conclusion

The restructuring of the practice for future designers is not just about technical skill-building; it is a political, epistemological and cultural shift. Designers must claim ownership over their tools, workflows and learning processes. They must ensure that speculative mapping becomes a radical transformative force for imagining and constructing alternative spatial futures. Combining these three manoeuvres has the agency to transform the design metier, outlining a future where speculative design practices with urban nature are well data-founded. The combined transformative strength of these three manoeuvres draws a group of professionals taking active care of reinforcing and enhancing their digital literacy. Professionals do not only learn how urban sciences analyse cities; they also invest time and energy in imagining how certain of those digital skills guarantee them access to something much more than knowledge. Those simple GIS tools empower them to approach the mechanics of design differently: more situated, closer to the territory, and more open, avoiding previous automatisms and final, fixed outputs. When they look at the mappings they produce, those documents, even on paper, don't seem ecstatic anymore: in their eyes and their imagination, regions, limits, distributions, and connections are permanently mutating with the pulses of city life. Just as all urban ecosystems do. And new visions for the co-evolution of these hybrid ecosystems urge!

The required restructuration of academic curricula provides upcoming generations of designers producing *Mappings Exploring Speculative Scenarios with Urban Nature* with an adaptive toolkit that will evolve over time as they continue their professional careers. Alternative approaches are not only presented, but the required environment to implement them is also discussed. Despite the speculative nature of this chapter's discussion, it also acknowledges its role as a roadmap for action beyond the intellectual dissertation. These pages capture a series of actionable strategies that can shape future developments of design disciplines.

9 Outlook

This thesis emerged and evolved between different research cultures, learning from the advanced and diverse approaches of French, German and Anglo-Saxon academic contexts. The viewpoints provided by these rich foundations are the germ of this chapter: problematising broader implications of the research findings and discussion, addressing the thesis's limitations, and exploring its possible transfer and applications. The perspectives this thesis opens are also presented, bringing diverse standpoints to face potential future research paths investigating *Mappings Exploring Speculative Scenarios with Urban Nature*.

9.1 Limitations of the research

Every research project presents limitations; acknowledging them enhances transparency and the validity of the results, providing valuable insights for future research. The first one identified here has already been announced. This thesis crystalises from the constant self-questioning of the author's methodological and pedagogical approaches developed in recent years. These approaches are tested in the *laboratory* with an honest interest in understanding their value better and exploring possible enhancements. However, being the instructor of the courses and analysing their results and mobilised methods could be interpreted as the author being a '*judge and party'*: a stakeholder directly involved in the courses and at the same time arbitrator judging the pertinence of the results. This may introduce a subjective bias in interpreting the outcomes and the process, overestimating the effectiveness of the pedagogical approach due to the author's investment in its successful implementation. The introduction of the qualitative interviews and focus group aims to counterbalance this bias, even when the same person conducts both. An external, independent evaluation could have added more objectivity. Unfortunately, time constraints did not allow this option.

The second methodological limitation concerns the design expertise of the students. The *laboratory*'s academic setting allowed high permeability of new methods with students eager to learn, while providing a privileged situation to observe impacts on competency development over time. However, the students' design proficiency level is not yet well established and solid, which may have influenced their ability to benefit fully from the GIS methods. The *laboratory* might differ consistently when observing professional practitioners armed with robust design competences. If tacit '*designerly'* knowledge is key in Schön's *"reflection-in-action"*, and students have not yet gained enough design experience, the results may be affected by this situation. This open question may be the perfect opportunity for future research: extending this *laboratory* to professional contexts would be interesting, testing its applicability beyond academia.

From several points of view, time is a key factor when considering the research's limitations. First, most students just followed one semester of training as part of their Architecture studies. This timeframe has proven extremely short, particularly for stimulating counter-practices and uses in '*detournement'*. An experience where a continuous learning experience over several semesters or years may have a different impact. Besides, the proposed setting did not allow long-term competency development and adherence testing. The research, focusing on immediate learning outcomes during the courses and the next few years, does not track whether students use GIS in their professional practice. A longitudinal study following graduates over several years could be more conclusive in assessing whether the pedagogical shifts translate into long-term professional changes.

In addition to the methodological limitations, certain data and tool limitations are also identified. First, concerning the phenomenon of *'data opportunism'*. Students may have prioritised readily available datasets over more relevant ones, which certainly impacts the outreach and pertinence of their outcomes. Steinitz faces this issue by leaving the data acquisition to the third iteration through his questions, leaving more time to reflect on the most suitable datasets. The use of opportunistic datasets affects the students' results and may also affect the findings of the thesis: would the students adhere more to the learnt methods and tools if they felt that the datasets were more relevant to their design proposals? This opens up an interesting research perspective: working with students and professional designers to structure data acquisition protocols guiding them towards what Ortel defines as *"design-driven data"*.

Another data and tool limitation of this research lies in its exclusive focus on a very restricted toolset: GIS. This allows to understand the direct links between one tool and competency development. However, the benefits of merging GIS with other traditional tools, as well as other advanced –but available and manageable– methods, such as parametric design or generative AI, would have a profound impact on the results; as stated in the findings, the assemblage of diverse tools and methods has a beneficial effect that this research is unable to capture. Studying which combinations produce the best results and most significant impacts could be interesting and more anchored in real-world practice, where professionals constantly mix several tools and techniques to ideate their proposals.

9.2 Transfer: from the *laboratory* to practice(s)

This research aims to contribute as a form of *Transformative research*; in this case, towards a shift in the practices of independent data-literate designers who find simple ways of *'detourner'* established GIS tools and methods to produce *Mappings Exploring Speculative Scenarios with Urban Nature*. However, certain challenges make it difficult to pass from the research stage to its application in real life. This is the place to identify these transfer challenges, implications, and key stakeholders, as well as explore the modalities of transfer and their possible risks and distortions. First and foremost, it is crucial to clarify which specific *'practice'* –or more precisely, diverse *'practices'*– the *laboratory* is intended to transition into.

First, it is a practice spanning throughout scales, as stated in the very first pages of this thesis. From architects and landscape architects working on small-scale proposals to urban planners imagining the future of middle-sized cities, all of them can take advantage of the discussed methods. The impact on architects and landscape architects may differ, as they usually have no previous experience with GIS. Urban planners, on the other hand, may be able to operate with GIS but have probably not tried the methods of the KIT courses. Different transfer modalities would be required for each case: architects and landscape architects may need more technical training, but they can be more open to experimenting with methods they do not know. Reversely, urban planners will require less technical adaption, but more resistance to changing existing working procedures may be found.

Secondly, the professional setting of the practices can also be diverse, for instance, as professional designers in big companies. In this case, the main challenge faced by the transfer may be the misalignment of goals. Designing for the Ecocene implies profound changes in a system driven by economic profitability. Setting the focus on non-human ecosystems in such a framework requires a shift that leading corporations are not ready to undertake unless a financial opportunity is detected. For instance, some insurance companies are modelling possible futures with urban nature, using GIS and digital twin technology. As a result, they are starting to invest in peri-urban forest management to reduce risks to human health, such as wildfires. With this depletion, they aim to reduce future costs of losses and premiums while creating a virtuous cycle of minimal risks for communities and healthier forest ecosystems. Such initiatives still have profit and human well-being as the primary goal and must be attentively monitored if an authentic positive impact on the biosphere is expected. Is the mindset change implying that investing in ecosystem well-being can be a profitable business activity and a pertinent first step towards Ecocene? Independent studies verifying the ecosystem gain of such operations may bring some light to that question. Positive results promote the legitimacy of Ecocene-oriented design approaches in political and economic spheres.

Smaller design firms may find it economically challenging to work with speculative futures and methods that require some testing time without assuring immediate return. Could they allow themselves to finance the trial of these different methods? How would be their client's reception of them? In this case, the biggest challenge is to adapt the fastest to their workflows to get results they can use as quickly as possible. Perhaps the most fitting practice would be those of small design offices looking to generate a significant impact or to initiate change. They may not only do this kind of work and mostly take regular commissions, but they keep part of their budget to run some projects that operate on a *'guerrilla'* mindset. Projects that may not be built in the short term or ever built at all; however, these proposals engender discussions with policymakers, local stakeholders or researchers. Proposals that question the given brief, that reframe the problem that design should react to. Such projects can become game changers, generating a more significant impact than others that may be planned and built following more traditional workflows. Nevertheless, this does not mean that *Mappings Exploring Speculative Scenarios with Urban Nature* are only valuable as a practice of dissent. Still, their use as trojan horses to, with time, impregnate other forms of practice of the office could be an efficient modality of transfer.

Time misalignment is also a considerable challenge, as many professional practices are driven by immediate results, both for planning phases, and also for implementation and construction. Not only because time is money but also because the impact of political actions is expected to be effective in very short timeframes so that policymakers may be re-elected. This drives to a certain institutional inertia, hindering the disruption of conventional workflows. Finding paths to integrate new methodologies, currently on the margins, into existing structures is a key challenge. Formulating future scenarios can be a strong force pushing towards structural change, but accepting that those changes will require time to be implemented and co-evolve is crucial.

This leads to the question of who the most relevant stakeholders of this transition are and what their roles are. First, municipalities and political decision-makers should abandon short-term goals, at least in some pilot projects encouraging alternative use of future-making to point towards the goals of Ecocene. They know how to organise competitions and tenders for green infrastructure design. However, they could reorient them towards formats where the co-evolution of urban and natural systems has to be defined. Future modelling encompasses not only computational calculi but also speculative methods; together, they can be a powerful asset for these competitions.

Many design professionals lack training in speculative and GIS-driven methodologies, which is a key challenge for the transfer. Their high-pressure environments discourage both experimental workflows and learning new methods. Such disconnection between academia and the pragmatics of project execution must be faced with continuous professional training and more frequent and closer collaboration with academia. Educational institutions can propose formats for professional environments and offer lifelong learning programs for professionals. Adult education is a growing market due to strong trends such as constant upskilling, for which companies and governments have invested increasingly in recent years. The shift in academia is what can produce the most substantial impact. Integrating GIS and speculative methodologies into mainstream design education is a first step. Promoting practice-based collaborations with professional environments could be a second one.

Students and young professionals can introduce cutting-edge methods into conventional and rigid professional environments. Their engagement is essential for the transfer. With them, both bigger and smaller design offices can decide to invest time and effort in a design process that looks for broader and deeper societal impacts. They can face these *'guerrilla'* approaches by merging design and research and creating new storytelling in the convergence of technology, nature and speculation.

Beyond understanding the actors involved in this shift, bridging the gap between this research and its application requires precise strategies for overcoming the abovementioned barriers. Two parallel formats could contribute to this goal. First, creating experimental labs in professional environments where design professionals and academic researchers could collaborate. These hybrid spaces could test and co-develop speculative GIS methodologies on real-world projects, sharing scientific and *'designerly'* knowledge. Second, municipalities should provide urban test sites for speculative GIS-driven interventions, where the benefits of these methods can be experimented with. Both actions require public funding mechanisms and policy integration, advocating to legitimate Ecocene-oriented principles. EU's initiative on *"Twin transition"*, coupling ecological and digital transformation, is the perfect existing funding framework where the methods proposed by this thesis could define its own agenda, mechanisms and expected outcomes. Parallel to funding search, knowledge diffusion through open-source platforms is key. It is possible to establish a repository of best practices and cross-disciplinary collaborations in them. They may encourage and promote professional networks by sharing their methodologies and case studies. Moreover, creating public awareness of the pertinence of these methods may increase public pressure on public institutions for early adoption.

Two main challenges are identified when anticipating potential failures in the transition process and considering how to mitigate them. First, there is the risk of dilution and oversimplification of the methods, just adopting their technical aspects, and losing critical depth if no critical reflection follows. This thesis highlights the importance of redefining the epistemologies of technology, but missing this aspect may lead to the pitfall of acritical technological solutionism. Applying any technological advancement without a profound critical reflection on its counterparts is useless. In the second place, it is essential to alert corporate interests to possible co-optation, as described by insurance companies' new approach towards peri-urban forests and wildfires. The absorption of speculative GIS methods by commercial agendas is certainly troubling, as it empties many of the core goals and ethics of Ecocene, substituting them with corporate profit while carefully maintaining a *'green'* surface.

Transitioning to real-world implementation of the findings and manoeuvres discussed in the previous two chapters requires profound institutional and professional shifts. A successful transfer depends highly on adaptability, interdisciplinary collaboration, and policy integration. A powerful strategy embeds experimental natureculture design within professional environments while keeping their speculative and critical dimensions intact. The mindset shift towards Ecocene is this shift's goal and motor. Applying the tools and methodologies described in these pages extensively aims to reduce the breach between research and design practice. It is a call to action for both disciplines: design should be able to adopt GIS-based research methods, and research activities should be more aware of the design challenges and requirements.

9.3 Future research directions

Building from the conclusions of this thesis, two possible paths to continue with the perspectives this study has opened are considered. The first corresponds to extending the *laboratory* to professional designers, and the last one aims to understand the potential of speculative mapping to promote participation. Starting with the first one, a similar *laboratory* could be imagined within professional design offices, extending the academic setting of this thesis towards the business sector. It would serve as a complementary bridge between theory and practice, translating the academic speculative and research-driven methodologies extracted from the academic setting into applied practice. Many different professional contexts could host this experience. Still, offices searching for new business opportunities, positioning themselves in emerging niches and promoting innovative, future-oriented design could be most interested in participating.

In this *laboratory*, the role of naturecultures towards the Ecocene should transcend the role of the theme, becoming a core principle of the setting. A precise thematic focus could be beneficial to explore the particular interrelations of all the factors. For instance, study how professional designers approach the configuration of peri-urban forests. Moreover, the possibility of fully integrating interdisciplinary collaboration would complement the findings of this thesis, breaking silos and better understanding the dynamics of good cooperation through speculative mapping production.

The second possible research direction faces critics of speculative scenarios generated with computational design, considering that they embody an utterly top-down approach. Although these scenarios can be produced by *'data literate'* professional designers and discussed transdisciplinaryly with other areas of study experts, they can still be considered a form of colonising the future. Counter-practices with digital mapping can become a suitable tool to incorporate bottom-up perspectives and initiatives. How can the methods described in this thesis be used to integrate civil society and foster participation and co-creation? Nowadays, there are many alibi experiences and superficial approaches where public participation is reduced to symbolic engagement, which fails to empower communities and produce meaningful design transformations. Such participation as an empty ritual could be shifted into valuable co-design experiences if the communities engage from the earliest stages. The use of inclusive and accessible methods seeking to involve a broad audience may find in speculative mapping an imaginative medium fostering the emergence of diverse perspectives. Using narrative techniques in critical mapping may encourage people to participate differently, sharing their specific local knowledge. An analysis of this kind of mapping in participative processes could assess its impact on community engagement.

In the following years, many developments in digital mapping, speculative design methods, or new visions of urban nature may fit into or expand the discussion captured in this thesis. The field of urban nature development will dynamically evolve, interacting with many of the aspects discussed here, and incorporating new issues. Researchers, but mostly designers, should actively regain their voice in shaping the future postures of the metier described in these pages, facing new challenges and speculating about the nature of their future design methodologies.

Annexes

French, graphics, interviews

These annexes bring together a set of complementary materials intended to support and document the main body of the thesis. It includes, first, a concise overview of the thesis in the French language, providing a brief synthesis of the research as a whole. In addition, the annexes contain a graphic section compiling the most relevant graphics of all students' exercises, in which visual materials are presented at a larger scale than in the thesis corpus in order to ensure clarity and legibility. The annexes also comprise the full transcriptions of the interviews and the focus group discussions, reproduced in the original languages in which they were conducted. Finally, they conclude with a comprehensive bibliography covering all sources cited and consulted throughout the thesis.

A French overview

As stated in the Cotutelle agreement, approximately 10% of the thesis's text is translated into French. However, this is just a summary of the whole work; for complete information and reference, please see the English version of the text. LLM has been used to correct the style.

A.1 Préface

Formé en tant qu'architecte, j'ai commencé à enseigner aux étudiants en architecture l'utilisation des systèmes d'information géographique, SIG, au semestre d'hiver 2020, peu après avoir rejoint la Chaire d'Architecture du Paysage à l'Institut de Technologie de Karlsruhe. Après plus de quinze années d'expérience professionnelle, principalement axées sur la phase de conception technique et de détail, ce nouveau rôle a marqué un tournant significatif dans ma carrière, m'orientant vers les études urbaines, et plus précisément vers l'architecture du paysage. Cette transition m'a conduit à une réflexion critique sur l'évolution de l'urbanisme depuis le début de mes études en 1996, ainsi que sur les moyens d'intégrer de nouvelles ontologies, concepts et technologies dans mes cours.

À l'Institut de Technologie de Karlsruhe, KIT, j'ai constaté que l'analyse des données géographiques n'était pas solidement ancrée dans le cursus architectural. Motivé par cette lacune, j'ai initié une série de cours qui reflétaient mon propre cheminement dans l'exploration des méthodes et outils que j'identifiais comme pertinents pour les professionnels du design travaillant avec la nature urbaine. Ces séminaires et cours de projet mettaient au centre des projets visant à encourager de nouveaux dialogues entre le domaine urbain et le monde naturel — des projets adoptant des approches post-anthropocentriques et couvrant des échelles allant du microscopique au régional. Je me suis notamment concentré sur des projets redéfinissant la relation entre les environnements bâtis et les systèmes écologiques.

Ces initiatives pédagogiques ont considérablement renforcé la littératie des étudiants en matière de données, recevant des retours enthousiastes : nombreux sont ceux ayant souligné l'utilité du SIG dans le développement de leur carrière. Cependant, malgré leur capacité accrue à collecter et gérer des ensembles de données détaillées, j'ai observé que les outils analytiques avancés étaient souvent sous-utilisés dans leurs travaux ultérieurs. Si les étudiants excellaient dans la collecte de données, ils recouraient rarement à des outils plus sophistiqués pour approfondir leurs analyses ou explorer des scénarios de design spéculatif. Cette observation a suscité une question critique : pourquoi les étudiants ne s'engageaient-ils pas plus profondément avec ces outils ? Cette interrogation constitue le point de départ de cette thèse.

Cette recherche s'attache à analyser les processus de conception diversifiés des étudiants utilisant le SIG, afin de démontrer la pertinence, l'efficacité et le potentiel opérationnel de ces méthodes tout en identifiant les obstacles à leur adoption plus large. Je soutiens qu'il est impératif de comprendre ces limitations pour combler le fossé existant entre la science des données urbaines et son application dans la pratique du design.

Les défis liés à la planification et au design urbains ont traditionnellement été abordés à travers des prismes historiques, environnementaux et socio-économiques. Ces dernières décennies, l'avènement de la computation et de l'analyse des données a donné naissance à la science des données urbaines, 'urban science'. Les praticiens de ce domaine se répartissent généralement en deux catégories : les chercheurs et les praticiens appliqués. Les chercheurs se concentrent sur des paramètres isolés ou des phénomènes urbains spécifiques, analysant leurs implications sur des indicateurs urbains plus larges. Par exemple, certaines études examinent la relation entre la largeur des rues et la qualité de l'air, produisant des connaissances académiques sous forme d'articles et de communications. En revanche, les praticiens appliqués s'efforcent de développer des outils permettant une prise de décision fondée sur les données. Ils construisent des modèles pour simuler des scénarios urbains et proposer des recommandations destinées à éclairer les politiques publiques et à guider les développements futurs. Toutefois, aucun de ces groupes ne participe directement à la conception de projets d'aménagement ou de design. Ils fournissent des cadres théoriques et des outils techniques aux concepteurs, lesquels possèdent souvent une maîtrise limitée des données.

Il en résulte un écart notable entre la science des données urbaines et le processus de design. Les urbanistes et concepteurs intègrent rarement des analyses de données avancées aux premières étapes de leur travail, notamment lorsqu'il s'agit de définir et d'explorer le problème à résoudre. Cette thèse défend l'idée que les données urbaines ne devraient pas être perçues uniquement comme des outils d'aide à la décision en phase finale, mais comme des catalyseurs potentiels pour le design spéculatif. Elle explore la manière dont les données urbaines peuvent constituer un point de départ pour des pratiques de conception créatives et exploratoires, en esquissant le rôle futur de concepteurs pleinement engagés avec la nature urbaine. Rejetant à la fois le déterminisme technocratique et une confiance aveugle dans les données, ce travail propose une série de stratégies visant à promouvoir la créativité dans le design par le biais de la littératie des données, positionnant la technologie comme un médium ouvrant de nouveaux horizons imaginatifs.

A.2 Ceci n'est pas un glossaire

Cette thèse est rédigée en cotutelle entre deux universités, l'une en Allemagne, et l'autre en France, discutée plusieurs fois en quatre langues différentes, et écrite en anglais par quelqu'un dont la langue maternelle est l'espagnol. La nécessité constante de traduction de terminologie spécifique n'a pas seulement enrichi le tournage autour certain concepts, mais aussi causé une confusion initiale chez les lecteurs, suscitant récurremment des discussions autour certain termes. Cherchant un consensus synthétique comme fondation, les prochains paragraphes servent à consolider certaines bases communes. Néanmoins, la thèse entière cherche à explorer les aspects caléidoscopiques de chacune de ces notions en plus grande profondeur.

D'abord, le mot le plus difficile et élusif : ***nature***. Les multiples aspects et facettes concernant cette notion sont exposés au long du chapitre 1, mais il est possible de le définir préalablement comme la biosphère : tous les êtres vivants, indépendamment de leur origine ou leur état plus ou moins sauvage –en comprenant aussi ceux plantés ou élevés par l'activité humaine. En français, l'expression 'le vivant' est aussi un équivalent approprié.

Cette thèse vise à contribuer à une forme de recherche et exercice qui favorise la gestion écologique, en répondant aux défis planétaires d'origine humaine. L'***Ecocène*** est présenté comme une époque où la génération de nouveaux futurs est guidée par des manières écologiquement informées de savoir, comprendre et orienter la conception des transitions durables. Le mot ***design*** lui-même évoque plusieurs interprétations, ce qui conduit à de nombreux malentendus lorsqu'il est inséré sans traduction dans différentes langues. Dans ces pages, il fait référence à une proposition spécifique en architecture, urbanisme ou aménagement paysager. Il est équivalent à *'projet'* en français ou *'Entwurf'* en allemand, signifiant une tâche accomplie par des ***professionnels de la conception*** ou ***professionnels du design***: un terme utilisé dans cette thèse pour englober toutes les disciplines qui interviennent à différentes échelles dans la planification de la nature en ville : architecture, architecture paysagère, conception paysagère, urbanisme, aménagement régional. Ils sont responsables des plus petites plantes qui poussent sur des toits verts fins jusquu'aux solutions ayant un impact sur les forêts périurbaines.

Finalement, certain termes liées à la technologie discutés dans cette thèse sont présentés. Le plus important est ***GIS*** –Geographic Information System–, qui sert de cadre de travail pour compiler, traiter et analyser des données. GIS est ancré et profusément utilisé par les sciences géographiques. La pratique du ***Geodesign*** est présentée comme une vision utilisant de la connaissance géographique pour faire le projet –design– activement et avec une charge de réflexion.

À travers ces nuances de langage et de sens, cette thèse invite les lecteurs à découvrir des distinctions subtiles et des interprétations plus profondes tissées tout au long de ses pages.

A.3 Introduction

Ceci est une carte. Elle a été créée par un cartographe et interprétée par un observateur. Elle présente des informations de manière spatiale, permettant une compréhension précise, intuitive et visuelle. Elle contient des données, des données statistiques pures distribuées spatialement. Il serait laborieux de la produire manuellement, en raison des coordonnées géographiques exactes associées à chaque occurrence représentée, ainsi que du volume d'informations traitées. Des opérateurs mathématiques, géométriques et topologiques sont appliqués dans un environnement computationnel, facilitant la tâche tout en assurant une application méthodologique cohérente. La science au service de la représentation spatiale.

Cependant, cette carte ne revendique aucune objectivité totale. Les paramètres sont soigneusement sélectionnés et mesurés selon des standards spécifiquement établis, ce qui introduit déjà un biais potentiellement contestable, tout comme la décision de les combiner selon cette disposition particulière. De plus, l'échelle, les choix graphiques et les couleurs retenus par le cartographe pour représenter chaque paramètre influencent la lecture de l'observateur. Cette carte médie culturellement les phénomènes qu'elle décrit, engageant le lecteur dans une relation bilatérale d'interprétation de ses significations possibles : l'observateur commence à interroger la carte, tentant de comprendre le message qu'elle véhicule. Dans ce processus interactif de compréhension, il ne s'agit pas uniquement de ce que la carte affiche explicitement : l'observateur est également invité à extraire du savoir à partir de ce qu'elle ne montre pas de manière manifeste. Des motifs, des tendances, des connexions, des menaces et des potentialités peuvent être perçus, interprétés et identifiés. L'invitation tacite à rechercher d'éventuelles causalités et corrélations enrichit la lecture attentive de la carte, qui n'a jamais été une simple réception passive d'une information objective. Cette carte ne représente pas la réalité ; elle la construit.

Progressivement, le regard du lecteur curieux ne se limite plus à ce qui est représenté, à ce que cela évoque ou à ce que ses omissions graphiques permettent de déduire. À un certain moment, la carte peut stimuler l'imagination de l'observateur, l'amenant à envisager activement des transformations possibles de la réalité qu'elle représente. Le lecteur commence alors à formuler des questions débutant par « et si… ? » : et si tel paramètre croissait suffisamment pour affecter la distribution homogène d'un autre ? Et si l'évolution d'un second paramètre dans le temps modifiait les relations entre d'autres paramètres ? Les couleurs, les dimensions et les formes diverses se transforment progressivement dans l'esprit du lecteur, selon les scénarios envisagés. Des futurs possibles émergent de l'interaction dynamique entre données, spatialité et imagination créative et scientifique du lecteur. Cette capacité à susciter l'imaginaire ne serait-elle pas plus précieuse que sa supposée objectivité ? Notamment à des fins de conception.

Bien sûr, toutes les cartes ne possèdent pas la même capacité à engager un tel processus stimulant. Cette thèse s'intéresse aux représentations spatiales des données scientifiques qui possèdent le potentiel d'encourager la formulation de futurs possibles, en proposant des orientations méthodologiques permettant aux cartographes et aux observateurs d'atteindre cet objectif avec succès. Des cartes capables d'engendrer des transformations. Le dessin présenté à la première pages de l'introduction en langue anglaise appartient à cette catégorie. Il fait partie d'un atlas sur la touristification de Madrid, explorant comment l'hébergement touristique transforme le paysage urbain et déclenche des processus de gentrification. Deux architectes en sont les auteurs : Mar Santamaría et Pablo Martínez, fondateurs du bureau barcelonais 300'000 km/s. Ils ont rassemblé des informations provenant des données ouvertes d'AirBnB, du portail de données ouvertes de Madrid, du Cadastre et de l'Institut National de Statistique d'Espagne. Ils ont préparé les jeux de données, les ont rendus comparables, ont organisé leur représentation et ont produit un ensemble de cartographies pour un événement auquel ils participaient. Selon leurs propres termes, cet atlas *"a servi de base à une conversation publique avec des experts et des citoyens afin de comprendre les causes et les conséquences de ces transformations et d'anticiper et répondre aux besoins des citoyens à travers l'aménagement urbain"* (300'000 km/s 2017). Par cette déclaration, ils affirment clairement que leurs cartes sont utilisées comme un médium pour engager d'autres spécialistes – ainsi que le grand public – dans une interprétation culturelle et contextuelle d'un phénomène complexe : la touristification. Des données numériques et tabulées sont subjectivement et intentionnellement sélectionnées, organisées et présentées sous une forme qui devient un savoir, transmis et discuté de manière intersubjective. Ces choix graphiques instaurent à la fois une certaine distance grâce à leur abstraction, et une certaine proximité en raison de leur précision.

Considérant l'invisibilité des processus computationnels, il est raisonnable de supposer que les cartographes n'étaient pas absolument certains du résultat graphique exact des représentations des données avant de commencer. En ce sens, ce document émerge d'une amalgame de certitudes et d'incertitudes. Il plonge dans l'hétérogénéité complexe du domaine urbain, capturant des occurrences contextuelles. L'imprévisibilité du résultat cartographique transforme le cartographe en premier lecteur de la carte. Les architectes de 300'000 km/s furent les premiers à évaluer les résultats et à interroger la carte. Ils s'engagent dans une enquête à travers le prisme des connaissances scientifiques, mais également par la pensée spatiale (Bednarz et Lee 2011) et par des modes de connaissance propres au design (Cross 2006), cette intuition du concepteur consolidée par de nombreuses années de pratique. Toutes ces formes de cognition humaine sont simultanément mobilisées pour réfléchir non seulement au contenu de la carte, mais également pour imaginer les possibilités futures qu'elle suggère.

Dans ce cas précis, l'engagement éthique de ces cartographes les pousse à mettre en lumière les risques futurs et les défis auxquels sont confrontés les groupes de population les plus vulnérables, subissant les effets du tourisme de masse. Cependant, les compétences en cartographie des données numériques sont bien plus fréquemment mobilisées pour des raisons moins bienveillantes, telles que des initiatives visant à accroître l'exploitation économique future par l'analyse de l'usage des sols et le développement immobilier, ou encore pour capter les comportements des consommateurs en vue de proposer des dispositifs commerciaux rentables. Ce savoir-faire statistique et cartographique est largement diffusé à ces fins, mais plus rarement en tant qu'outil de conception. Par ailleurs, l'objet de design complexe que cette thèse explore, la nature, nécessite un cadre théorique spécifique.

La conscience actuelle des enjeux de durabilité est nourrie par les théories écologiques posthumanistes contemporaines (Morton 2007, Latour 1993, Descola 2013, Haraway 2015), qui décentrent la perspective humaine au profit de visions relationnelles et interconnectées des écosystèmes, des technologies et des acteurs non-humains. Ces ontologies relationnelles de l'écologie offrent des cadres pour repenser la conception de la nature comme un acte symbiotique, collaboratif et interespèces. Reconnaître l'agence des non-humains implique de tenter de comprendre des perspectives multiespèces, d'imaginer des futurs urbains, et d'intégrer ces êtres et leurs relations avec leur environnement. Toutefois, toute action impliquant des êtres non-humains dans le contexte urbain relève d'une forme de conception, d'un mécanisme destiné à influer sur l'avenir des écosystèmes urbains. Ces actions produisent des *"naturecultures"* (Haraway 2003), un concept soulignant l'indissociabilité des humains, des non-humains, des technologies et des écologies. Leurs relations intriquées plaident pour l'impossibilité de séparer les processus biologiques, technologiques et culturels.

L'émergence de sensibilités écologiques contemporaines encourage un changement transformateur vers l'Écocène (Boehnert 2018), une ère régénératrice privilégiant l'alphabétisation écologique, la pensée systémique et des pratiques de design visant à restaurer et soutenir les systèmes vivants planétaires. Bien que cela puisse être perçu comme une utopie, il s'agit en réalité d'un exercice d'imagination profondément ancré et lié à la réalité. Envisager des scénarios futurs subversifs n'est ni une forme d'évasion ni une fin en soi. C'est au contraire une force motrice du changement : les concepteurs qui imaginent des futurs improbables réfléchissent en fait aux forces et défis qui façonnent notre présent. L'engagement ferme des designers envers la pensée critique constitue le moteur du changement structurel. Tel est le fonctionnement du design spéculatif (Dunne et Raby 2013) et la raison pour laquelle il est pertinent pour ouvrir des voies menant à l'Écocène.

La triade conceptuelle fondamentale de cette thèse est donc établie :

– la nature, et la création de naturecultures orientées vers l'Écocène constitue le thème ;

– le design spéculatif est la méthode permettant d'imaginer ces naturecultures ;

– le mapping est l'outil technologique utilisé par les designers pour déclencher ces futurs.

Cette triade opère simultanément à toutes les échelles, du détail constructif permettant aux toitures végétalisées de favoriser la biodiversité, jusqu'aux politiques transrégionales soutenant des écosystèmes équilibrés. C'est pourquoi le terme professionnels du design, ou simplement designers, employé dans ce texte, englobe toutes les disciplines intervenant à différentes échelles dans la planification de la nature : architecture, architecture du paysage, conception paysagère, urbanisme et aménagement régional. Tous interagissent avec les données, la cartographie numérique et la biosphère pour concevoir de meilleurs futurs. L'évidente tension entre la nature et sa mise en données implique une technosensibilité émergente mais encore en cours de développement, rapprochant nature et technologie. La révolution numérique des dernières décennies a considérablement influencé l'art et la pratique de l'architecture, transformant tant les processus de travail que les résultats. Toutefois, la pensée computationnelle n'a pas encore entraîné de changements manifestes dans la pratique de l'architecture paysagère et des autres disciplines de conception travaillant avec la nature (Picon 2013, Fricker 2021, M'Closkey et VanDerSys 2017). Ni leurs processus de conception, ni leurs propositions n'ont été transformés de manière substantielle jusqu'à présent. Pourquoi en est-il ainsi ?

Les outils génératifs tels que le design paramétrique ont été utilisés en architecture pour diverses applications. Par exemple, comme moyen d'exploration formelle à travers des géométries complexes, comme optimisation structurelle dans une approche performative du design, ou encore comme facilitateur de fabrication numérique et de personnalisation de masse. Comparé à l'urbanisme ou à l'architecture paysagère, le nombre de paramètres et de parties prenantes que l'architecture paramétrique peut intégrer est plus restreint. Plus important encore, l'architecture peut être conçue comme un produit fini, une forme, tandis que l'urbanisme s'attache davantage à façonner un processus de transformation en perpétuelle évolution. L'utilisation de logiciels paramétriques tels que Grasshopper dans cet objectif est certes possible, mais elle diffère fondamentalement de la simple recherche formelle. Existe-t-il d'autres instruments pertinents susceptibles d'aider les concepteurs à imaginer des processus de transformation des naturecultures vers l'Écocène ?

Cette thèse adopte une position claire et proactive en examinant le potentiel de la cartographie computationnelle critique comme moteur génératif du design. Les cartographies opératoires (Paez 2020) ne sont pas seulement des outils de représentation, mais un processus actif et génératif qui transforme la réalité spatiale. La cartographie opératoire est interventionniste : elle mobilise l'analyse spatiale et la spéculation pour imaginer de nouveaux futurs. Dans sa production, les concepteurs activent et assemblent diverses formes de production de connaissances : scientifique, spatiale, critique, spéculative et, bien sûr, propre au design. Les Systèmes d'Information Géographique constituent les fondements de cette pratique cartographique. L'hypothèse initiale peut désormais être formulée : la cartographie computationnelle peut constituer un outil de design précieux pour l'élaboration de scénarios spéculatifs liés à la nature urbaine. Cette perspective représente un apport original à cette recherche, en particulier dans sa connexion avec le renforcement des compétences professionnelles des concepteurs, explorée à travers des méthodologies de « recherche par le design ».

Cette approche trouve son origine dans l'observation de l'évolution des pratiques des étudiants de la chaire d'architecture paysagère à l'Institut de Technologie de Karlsruhe (KIT) après l'apprentissage de quelques outils cartographiques élémentaires. Parmi les technologies disponibles, ils n'ont appris que des méthodes analytiques basées sur les SIG, profitant de l'adoption croissante, de la convivialité et de la disponibilité généralisée de ces systèmes. Contrairement aux méthodes avancées nécessitant une maîtrise technique approfondie des outils computationnels, l'accès élargi aux technologies SIG aujourd'hui – ainsi qu'à leur formation – permet aux professionnels du design de s'engager dans des formes sophistiquées d'investigation susceptibles d'influencer de manière significative leurs processus de conception. Toutefois, face à l'utilisation encore limitée de l'analyse de données numériques comme outil exploratoire du design, il convient d'interroger les compétences que les concepteurs doivent acquérir pour produire efficacement des propositions spéculatives et critiques alignées sur les objectifs des théories écologiques posthumanistes contemporaines. Cette thèse explore ces idées, structurées autour d'un ensemble de questions de recherche. La première est la suivante :

Q.R. 1 : *En imaginant de nouvelles naturecultures urbaines, comment l'intégration de méthodes basées sur les SIG influence-t-elle les compétences professionnelles nécessaires pour fusionner l'analyse computationnelle avec la pratique du design ?*

Cette question permet d'examiner l'impact potentiel des outils SIG sur les compétences du concepteur spéculant sur les futurs liés à la nature urbaine. Cela se reflète dans deux processus simultanés : l'acquisition de compétences grâce à l'introduction des outils, et le développement d'aptitudes supplémentaires rendues possibles par l'utilisation de la cartographie numérique. L'attention ne se porte pas sur des méthodes avancées, exigeant une puissance de calcul importante et une expertise en codage – domaines déjà largement explorés par la recherche existante. Il s'agit plutôt d'analyser comment la pratique des concepteurs indépendants pourrait être enrichie par l'introduction d'outils techniques simples. Cette thèse se concentre sur ces pratiques appliquées à la conception de la nature et sur les bénéfices qu'elles offrent aux concepteurs. Ceux-ci poursuivront leur carrière en tant que professionnels du design et « amateurs de données ».

La pertinence des compétences identifiées ne se mesure pas seulement à l'adéquation des propositions résultantes, mais également à leur capacité à révéler des perspectives émergentes, de nouveaux points de vue et des futurs possibles. À ce stade, il convient de souligner que le mapping constitue une forme de réflexion intégrée au processus de conception, et non un simple instrument destiné à dessiner des propositions futures. Le mapping est ici envisagée comme une force mobilisatrice pour favoriser la réflexion spéculative et critique. Peut-il susciter des schémas de design ouvrant des chemins inédits et inexplorés ? Pouvons-nous mieux comprendre le processus de conception en intégrant ces outils, méthodes et pratiques ? Quels sont les avantages et opportunités qu'offre l'analyse des données urbaines pour formuler des scénarios spéculatifs liés à la nature urbaine ? Comment cette utilisation influence-t-elle le processus de design ?

Ces questions interrogent une nouvelle épistémologie opératoire du design fondée sur les SIG, inscrivant cette thèse dans le champ de la *'Recherche pour le Design'*, un type de recherche visant à soutenir et à informer directement le processus de conception (Roggema 2017). En explorant une réalité contextuelle du design, la Recherche pour le Design cherche à aligner les démarches de conception sur des facteurs sociétaux, culturels, technologiques et environnementaux. Les perspectives qui informent et guident le processus créatif sont ici recueillies et analysées. En comblant l'écart entre les concepteurs, leurs besoins et le contexte d'usage, cette thèse explicite son objectif principal : apporter une contribution méthodologique aux pratiques de design traitant de la nature urbaine, qu'il s'agisse d'architectes, d'architectes paysagistes, d'urbanistes ou de planificateurs régionaux. Cette contribution opère dans deux environnements simultanés. D'une part, elle propose une nouvelle épistémologie de la cartographie, enrichissant les perspectives qui façonnent le rôle des pratiques cartographiques dans l'élaboration des naturecultures urbaines et des imaginaires spatiaux. D'autre part, elle suggère une série de transformations opérationnelles de la praxis pour doter les concepteurs de méthodologies cartographiques adaptables, spéculatives et critiques, intégrant les dimensions computationnelle et socio-écologique.

La seconde question de recherche émerge logiquement de la première. Si l'introduction de l'analyse spatiale des données enrichit les compétences du concepteur, comment cela façonne-t-il une nouvelle posture dans la pratique du design ? À quoi pourrait ressembler le métier de concepteurs *'data-literate'* dans le futur ? En s'appuyant sur les idées du design spéculatif, la formulation de futurs possibles pour ces concepteurs pourrait-elle nous aider à discuter de manière critique de la situation actuelle ? Toutes ces interrogations sont explorées à travers la seconde question de recherche :

Q.R. 2 : *Comment les pratiques du design spéculatif réimaginant les interactions entre nature et urbanité pourraient-elles évoluer en interprétant des données computationnelles ?*

Cet exercice spéculatif esquisse une nouvelle posture pour les professionnels du design : des individus capables d'effectuer des analyses spatiales computationnelles à l'aide d'outils basés sur les SIG, et de créer des cartographies critiques pour déclencher des scénarios spéculatifs avec les naturecultures. Leur travail établit des ponts entre science et design, entre recherche et pratique, entre données et spéculation, entre nature et villes. Cette thèse fournit à ces professionnels du design un cadre théorique solide, tirant parti du développement des compétences observé chez un groupe d'étudiants et proposant des pistes sur l'évolution future de leur pratique.

La thèse est structurée en trois parties : le cadre théorique, l'expérience empirique et la conclusion. Dans la première partie, les questions de recherche sont contextualisées au sein du socle conceptuel que construisent trois axes entremêlés : nature, design et technique. La nature est l'un des thèmes que les concepteurs investiguent à travers la cartographie. Partant des théories écologiques posthumanistes contemporaines, le développement notionnel des idées de nature est suivi, fournissant ainsi les bases d'imaginaires futurs avec la nature urbaine. La méthodologie retenue pour produire ces nouvelles naturecultures est le design spéculatif, une approche transformatrice qui interroge les fondements mêmes de l'action du design, favorisant une réflexion critique sur les origines des problèmes à traiter ainsi que sur les impacts des propositions possibles. Enfin, l'outil technique proposé est la cartographie numérique. Reconnaissant la capacité des cartes à construire culturellement et de manière critique la réalité, cet outil permet de déclencher efficacement des scénarios futurs avec la nature urbaine à l'ère de l'Écocène. Cette pratique est ici définie sous l'acronyme MESSUN : *Mappings Exploring Speculative Scenarios with Urban Nature* –Mapplings explorant des scenarios spéculatifs avec natures urbaines–, une approche qui incarne ce cadre théorique.

Dans ce cadre théorique, la deuxième partie installe le « laboratoire », un dispositif empirique explorant la transformation des flux de travail des pratiques de design face aux changements écosociaux et technologiques. Ce laboratoire prend place dans le contexte académique, grâce à l'accès privilégié de l'auteur non seulement aux résultats cartographiques des étudiants, mais également à la possibilité d'observer l'ensemble du processus. Les paramètres nécessaires pour observer ce changement dans les pratiques de conception sont définis afin d'en permettre l'analyse. Une série de compétences professionnelles sont identifiées comme références cruciales pour suivre cette transformation. Grâce à elles, il est possible de proposer une analyse approfondie des exercices des étudiants en architecture, en découvrant comment les compétences se développent en lien avec les outils, les méthodes et les notions acquises. Les étudiants ont intégré des outils computationnels géospatiaux dans leurs processus de conception, les modifiant considérablement par rapport à leurs routines conventionnelles. Chaque exercice est examiné à la lumière des considérations développées dans le cadre théorique exposé dans les trois premiers chapitres. L'objectif n'est pas uniquement d'examiner la pertinence fonctionnelle des résultats des exercices, mais aussi d'interroger leurs processus de conception, en évaluant l'impact des méthodes employées sur le déroulement du design. Cette méthodologie s'inscrit dans des approches de *'recherche par le design'*, utilisant les propositions de design pour construire des connaissances de recherche.

Si l'enquête décrite ci-dessus permet de comprendre l'évolution de l'approche des étudiants pendant les cours, une démarche méthodologique complémentaire est nécessaire pour saisir l'effet de ces transformations sur leur carrière ultérieure. L'évolution des compétences des étudiants dans les années suivant le cours de design est investiguée par une analyse qualitative conduite à travers une série d'entretiens et un groupe de discussion, réalisés dans les mois et années suivant immédiatement le cours.

Enfin, la troisième partie compile et problématise les principaux résultats des méthodologies combinées, répondant directement à la première question de recherche, en offrant une meilleure compréhension du lien entre les méthodes basées sur les SIG et l'évolution des compétences professionnelles en design. Les défis et opportunités associés à ces compétences sont ensuite discutés de manière critique, rendant possible l'imagination d'une évolution spéculative de cette nouvelle catégorie de concepteurs professionnels, *'amateurs de données'*, produisant des *Mappings Exploring Speculative Scenarios with Urban Nature*. Cette transformation de la posture de la praxis est saisie en trois manœuvres, esquissant les contours d'une nouvelle forme de pratique du design *'data-literate'*, répondant ainsi à la seconde question de recherche. Finalement, le potentiel de transfert et d'application des postulats de cette thèse dans la pratique est discuté de manière critique, imaginant un avenir où ces méthodes ne seraient plus l'exception, mais intégrées dans la routine quotidienne des concepteurs.

Pour conclure cette introduction, les objectifs suivants décrivent l'orientation de la thèse à deux échelles simultanées, l'une générale, l'autre spécifique. Ils peuvent ainsi servir de corollaire intentionnel.

Objectifs généraux de la recherche

Générer un savoir systématique et un cadre théorique pour la pensée contemporaine et les techniques spéculant sur la nature urbaine.

Fournir une plateforme accessible aux concepteurs souhaitant intégrer l'analyse computationnelle des données dans leurs flux de travail en design.

Créer des passerelles entre disciplines du design et groupes de recherche travaillant sur les données computationnelles liées à la nature urbaine.

Objectifs spécifiques de la recherche

Enquêter sur une nouvelle épistémologie des SIG et de la cartographie au service du design spéculatif et des nature-cultures à l'ère de l'Écocène.

Analyser une série d'exercices de conception utilisant des outils de cartographie numérique afin d'explorer les compétences mobilisées et comprendre leur articulation.

Esquisser et proposer une série de manœuvres vers la posture professionnelle du concepteur géo-spéculatif.

A.4 Première partie. Nature, design, technique

Historiquement, la triade nature, design et technique a été à l'origine de nombreux développements civilisationnels. Léonard de Vinci en est une figure emblématique : ses observations de la nature, associées à des techniques de représentation avancées, ont permis des percées dans la connaissance anatomique et la conception d'outils médicaux ou mécaniques. Cette thèse inscrit cette triade dans une grille contemporaine de lecture où *la nature* constitue le thème, *le design* est la méthode, et *la technique*, l'outil, chacun exploré dans les trois chapitres de la première partie.

Nature urbaine. Le premier chapitre explore le concept changeant de *'nature'* et son rapport historique et contemporain avec la ville. L'évolution de cette notion est retracée en soulignant que la nature n'est ni figée ni universelle : elle varie selon les époques, les contextes culturels et les paradigmes scientifiques. La nature a été successivement considérée comme opposée à l'urbain, comme milieu de l'urbain, comme équilibre interconnecté, ou encore comme moteur de l'urbanité. Ces visions ont influencé les politiques urbaines, les formes de planification et les modèles écologiques associés.

La dichotomie ville/nature, longtemps perçue comme binaire, est ici déconstruite. Une compréhension relationnelle et dynamique de la nature est présentée, mettant en avant les approches *post-humanistes* qui décadrent l'humain du centre de la réflexion écologique. Ces théories soulignent l'importance de la cohabitation interspécifique et de l'agence non-humaine, soit la capacité des éléments naturels à influencer et structurer l'environnement urbain.

Dans cette optique, la notion d'Écocène est introduite comme alternative au paradigme de l'Anthropocène. L'Écocène ne se limite pas à constater les effets de l'action humaine sur la planète, mais propose un changement de posture : un avenir guidé par des connaissances écologiquement informées, propice à la conception de transitions durables. Quatre concepts clés montrant comment la pratique du design peut évoluer vers l'écocène. En premier lieu, l'agency: la reconnaissance de la capacité d'action des éléments non-humains dans la fabrique urbaine. La transformation du Rhin canalisé en Baden-Württemberg montre comment les fleuves ont perdu leur agence en faveur des hommes qui les modifient. En deuxième lieu, la cohabitation : la ville de demain doit permettre la cohabitation harmonieuse entre humains et non-humains. Cette cohabitation dépasse la simple tolérance ; elle implique la reconnaissance de l'altérité et l'adaptation des formes urbaines en hébergeant diverses formes de natures. En suite, l'hybridation : le paradigme de la séparation entre nature –Naturlandschaft– et culture –Kulturlandschaft– est remis en cause. Tout est déjà artificialisé, mais cette artificialisation n'est pas une fin en soi. Il s'agit désormais de naturaliser la ville, de créer ou batir une *'seconde nature'* intégrée aux systèmes urbains. Finalement, l'nterconnexion : le vivant est pensé comme un système imbriqué de réseaux et d'échanges. L'environnement urbain ne peut être compris qu'en prenant en compte ses multiples couches de relations écologiques, sociales et techniques.

Le concept de *'natureculture'*, issu de Donna Haraway, est mobilisé pour penser cette fusion et dépassement des dualismes. Les espaces urbains deviennent alors des lieux d'assemblage hybride, où s'articulent données, infrastructures, organismes vivants, flux d'énergie et information. Enfin, les outils et méthodes nécessaires pour concevoir l'Écocène dans les environnements urbains sont évoqués. Il faudrait mobiliser des pratiques de design capables d'intégrer ces dimensions complexes, en particulier celles fondées sur la cartographie numérique comme outil de compréhension et de transformation.

Méthodologies du design. Ce chapitre explore les épistémologies du design et ses méthodologies dans une perspective critique. Il s'agit de dépasser la vision du design comme simple résolution de problèmes pour le comprendre comme un champ de pensée propre, mobilisant des formes spécifiques de raisonnement, d'exploration et de projection. Trois approches principales du design sont analysées, le premier, le design comme résolution de problème. Héritée de l'approche scientifique et technique, cette vision voit le design comme un outil logique et rationnel, destiné à répondre à des besoins clairement identifiés. Le deuxième, le design comme réflexion dans l'action, *'reflection-in-action'*: inspirée des travaux de Donald Schön, cette approche considère que les designers développent des connaissances en agissant, que le savoir émerge du processus même de conception. Il s'agit d'un apprentissage itératif, où les idées se forment au fur et à mesure du travail. Et le troisième, le design comme discipline autonome. Selon Nigel Cross, le design possède ses propres logiques de pensée, distinctes de celles des sciences ou des arts; il mobilise une capacité à aborder l'incertitude, à naviguer dans la complexité, et à projeter des futurs possibles. Comme ça, le design devient le chemin vers la définition du problème: le design ne se contente pas de résoudre un problème donné, il participe à la formulation du problème lui-même. C'est un processus exploratoire qui permet de questionner les prémisses, de révéler des enjeux cachés, et d'élargir les champs d'action.

Cette posture critique est incarnée dans deux formes de design, le design critique et le design spéculatif. Le prémier remet en cause les modèles dominants, interroge les normes sociales et technologiques, et propose des objets ou scénarios qui perturbent les attentes. Le design spéculatif, développé notamment par Dunne & Raby, il consiste à concevoir des futurs alternatifs, non pas comme prédictions, mais comme provocations. Ces spéculations permettent d'interroger le présent à travers des récits situés dans d'autres temporalités. L'objectif n'est pas la faisabilité, mais la stimulation du débat et de la réflexion critique. Il n'y a pas seulement une méthode de spéculation; plusieurs outils et stratégies sont évoqués, fonctionnant comme les *'futurs cônes'* qui cartographient les futurs possibles, probables et préférables. L'imaginaire y devient un outil opérationnel de conception. La mise en opération des résultats du design spéculatif implique dépasser le simple exercice intellectuel pour inscrire ces scénarios dans des dispositifs pédagogiques, participatifs ou politiques, capables de produire des effets réels.

Le design urbain est un problème pervers, *'wicked problem'*, c'est-à-dire complexe, incertain, contradictoire, sans solution unique. Ce caractère impose une posture spéculative : on ne peut pas répondre de manière linéaire, mais il faut élaborer des dispositifs critiques et exploratoires, capables de rendre visible cette complexité. Face à la complexité des villes contemporaines — marquées par les crises environnementales, les inégalités sociales et les transformations technologiques — le design spéculatif devient une méthodologie pertinente. Il permet de naviguer dans la complexité sans prétendre la résoudre entièrement et poroduire des récits alternatifs et des images de futurs désirables ou inquiétants. En plus, il cée une distance critique avec les formes dominantes de planification. Plusieurs approches complémentaires du design spéculatif urbain sont présentés:

– Leitbild et scénarios : Images directrices ou visions qui guident la planification, mais en acceptant leur caractère grandes lignes.

– Top-down vs bottom-up : Spéculations élaborées depuis les institutions ou depuis les acteurs citoyens.

– Coloniser vs décoloniser le futur : D'un côté, la projection de futurs centrés sur la technologie et la croissance ; de l'autre, la construction de futurs ancrés dans la justice sociale, écologique et décoloniale.

Le géodesign articule la connaissance géographique –issues du SIG– avec le processus de conception spatiale. Le géodesign est présenté comme un pont entre science des données et pratiques de design, intégrant les variables écologiques, sociales et spatiales dès les premières phases du projet.

Le chapitre se conclut par une analyse des pratiques de design spéculatif appliquées à la nature urbaine. Il s'agit de comprendre comment les architectes, urbanistes, paysagistes peuvent utiliser ces approches pour imaginer des natures futures dans la ville : non pas une nature décorative, mais une nature actrice, hybride, cohabitante. Le design spéculatif devient alors un outil de recherche transformative, c'est-à-dire une démarche visant non seulement à comprendre le réel, mais à le transformer. Cette recherche par le design est également une recherche pour le design, dans la mesure où elle alimente la pratique en retour. À ce point le concept de transition jumelle, *'twin transition'* est introduit : une transformation simultanée écologique et numérique des sociétés. Cette transition nécessite des compétences nouvelles, à la fois techniques –maîtrise des outils numériques– et critiques –capacité à penser les enjeux écologiques. Le design spéculatif offre une grille d'analyse et une méthode d'intervention dans ce contexte.

Cartographie (mapping) computationnelle. Le dernier chapitre de cette première partie explore l'outil technique fondamental au cœur de cette thèse : la cartographie numérique ou computationnelle, principalement à travers l'usage des Systèmes d'Information Géographique. Une relecture critique de l'histoire des pratiques cartographiques à l'ère numérique est proposée, mettant en lumière leurs rôles dans la production de sens, d'imaginaires et d'alternatives.

Les mappings sont ici envisagées comme une technologie d'assemblage, de superposition et de révélation. Elle ne se limite pas à représenter un territoire : elle construit une lecture du réel, structurée par les données choisies, leur agencement, et la culture du cartographe. La carte est un dispositif médiateur, culturellement situé, qui peut territorialiser ou déterritorialiser les espaces, selon les objectifs poursuivis.

Une évolution historique critique identifie sept moments-clés dans l'évolution des pratiques de cartographie numérique, des pionniers pré-numériques jusqu'aux modèles contemporains comme les jumeaux numériques. Ces moments montrent l'évolution des cartes d'outils de pouvoir vers des instruments de participation, de contestation ou de spéculation, à voir:

– Cartographies analogiques, recherchant les villes spátialement avec des sciences statistiques.

– Premiers usages superposant des couches de données manuellement, suite à l'exemplede Ian McHarg et son ouvrage *"Design with nature"*.

– Numérisation des couches, avec l'introduction de logiciels de SIG permettant l'automatisation et l'objectivité apparente.

– Projet Cybersyn en Chili dans les années 1970s. Un usage politique du SIG pour gouverner un pays en temps réel: le nouveau paradigme du contrôle.

– Villes intelligentes, *'Smart Cities'*: deux paradigmes émergent, l'optimisation technocratique et le hacking civique.

– *'Digital Twins'*: modèles prédictifs et simulés du territoire, vecteurs de contrôle ou de spéculation.

– Le futur vers une cartographie opérative

Cette évolution critique permet d'introduire la notion de cartographie opérative : un usage de la cartographie non pas comme simple outil descriptif, mais comme vecteur de transformation. À travers les SIG, les designers peuvent activer des processus de réflexion spéculative : des cartes qui deviennent actes de design, non pas des représentations d'un état du monde, mais des projections possibles de son devenir.Cette approche est ilustré à travers le projet *Local Code* de Nicholas de Monchaux, qui propose plus de 3 000 interventions locales dans des interstices urbains de grandes métropoles américaines. À travers des cartes nourries par des données ouvertes, ce projet génère des micro-scénarios écologiques, révélant le potentiel transformateur des espaces négligés.

L'approche défendue ici, baptisée MESSUN *Mappings Exploring Speculative Scenarios with Urban Nature*, repose sur trois piliers méthodologiques :

– La cartographie comme contre-pratique : alternative aux narrations dominantes, elle révèle des dimensions cachées du territoire.

– La spéculation comme méthode : ouverture à des futurs incertains, narratifs, critiques, parfois utopiques.

– Les naturecultures vers l'Écocène : l'enjeu est de générer des imaginaires où humains, non-humains et technologies cohabitent en interdépendance.

Ainsi, la cartographie computationnelle devient une interface entre données et imagination, entre savoirs scientifiques et récits de transformation, entre technique et politique.

La première partie de cette thèse établit une charpente théorique solide fondée sur l'interaction dynamique de trois dimensions : le thème –nature–, la méthode –design spéculatif–, et l'outil –mapping digital. Elle met en lumière la nécessité de dépasser les dualismes traditionnels – nature/culture, humain/non-humain, données/projet – pour penser l'aménagement urbain à l'ère de l'Écocène.

Ce cadre conceptuel défend une posture critique et prospective du design, à même de répondre aux défis écologiques contemporains. Il propose que les cartes issues de données numériques soient non seulement des instruments de diagnostic mais également des déclencheurs d'imaginaires, permettant aux designers de spéculer sur des futurs alternatifs, hybrides et écosystémiques. Cette réflexion ouvre la voie à une reconfiguration du rôle du designer, désormais data-littéré, capable d'articuler savoirs numériques, engagement écologique, et créativité critique.

A.5 Deuxième partie. Le *laboratoire*

La thèse aborde ici un changement d'échelle et de registre, en ancrant sa réflexion dans une expérience empirique structurée autour d'un *laboratoire* pédagogique. Ce *laboratoire* articule deux approches méthodologiques complémentaires : la recherche par le projet, et la recherche qualitative. Le recours à la recherche par le projet permet d'analyser les processus de conception à travers les propositions élaborées par les étudiants. Ces projets, conçus dans un cadre académique, mobilisent des outils numériques, en particulier les Systèmes d'Information Géographique, dans le but de produire des scénarios urbains spéculatifs avec la nature. La recherche qualitative, quant à elle, repose sur des entretiens et un focus group, menés auprès des étudiants après la réalisation des exercices, afin d'évaluer les effets durables sur leur pratique et leurs compétences. Cette double approche, croisant analyse des productions et retour réflexif des participants, inscrit la recherche dans une logique de recherche pour le design, visant à nourrir les pratiques professionnelles et pédagogiques.

Méthodologie. L'élaboration du laboratoire s'appuie sur une volonté de construire une pédagogie du regard critique et de la pensée spatiale. Cette orientation vise à dépasser les logiques linéaires de la formation en design pour intégrer des dimensions réflexives, critiques et spéculatives. Dans cette optique, les outils numériques ne sont pas considérés comme de simples instruments techniques, mais comme des dispositifs cognitifs, capables d'induire une transformation dans les modes de perception, d'analyse et de projet. Le chapitre met en évidence l'intégration progressive des SIG dans les cursus pédagogiques, marquant une rupture avec les approches antérieures qui se limitaient à des outils analogiques ou à une cartographie descriptive. Il est souligné que les SIG permettent non seulement une acquisition plus fine des données, mais aussi une augmentation de l'information par traitement, visualisation et mise en relation, ouvrant ainsi un champ d'exploration inédit pour les pratiques de projet.

L'analyse des projets étudiants permet d'identifier un ensemble de compétences fondamentales mobilisées dans les processus de conception. Ces compétences sont organisées autour de quatre grands pôles, émergeant du texte *Terra Fluxus* de James Corner: l'opération, l'imaginaire, le processus temporel, et le champ d'intervention. Le pôle opération concerne la capacité à percevoir, augmenter, analyser et synthétiser les données, ainsi que la maîtrise technique des SIG et leur intégration dans le flux de travail du projet. L'accent est mis sur la manière dont les outils numériques permettent de construire des alliances inédites entre humains, nature et technologie, en générant des représentations systémiques et multiscalaires. Le pôle imaginaire concerne la capacité spéculative, la mobilisation de représentations culturelles de la nature, et la faculté de communication visuelle et narrative des projets. Il est noté que l'usage des SIG ne se limite pas à une logique d'objectivation, mais qu'il peut aussi devenir un levier d'imagination et de narration de futurs alternatifs.

Le pôle processus dans le temps s'intéresse à la manière dont les projets intègrent des dimensions temporelles, systémiques et évolutives. La capacité à représenter les dynamiques écologiques, les temporalités de transformation, les effets différés des interventions, est considérée comme un acquis essentiel de l'usage des outils numériques dans le design. Enfin, le pôle champ d'intervention englobe la capacité à travailler à différentes échelles spatiales, de l'élément constructif au territoire, et à articuler les logiques locales et globales dans une même approche de projet.

Le chapitre décrit en détail la mise en place du *laboratoire* à travers plusieurs séminaires et studios organisés au KIT, dans lesquels les étudiants, sans connaissance préalable des SIG, ont été amenés à les utiliser comme outils de conception. Les projets ont été développés à partir de cas d'étude réels dans des villes de taille moyenne en Allemagne et en Suisse, choisies pour leur diversité de contextes et leur accessibilité en termes de données ouvertes. Le corpus d'exercices produits est riche et varié, explorant des thématiques allant de la biodiversité urbaine à la gestion des sols, en passant par l'éclairage nocturne, les communs ou encore la résilience des infrastructures végétales. La sélection des villes, des outils et des données disponibles est présentée comme un facteur déterminant dans l'orientation des projets, mais aussi comme une contrainte formatrice, incitant les étudiants à développer des stratégies d'adaptation, d'interprétation et de créativité.

Au fil de l'analyse, il est observé que l'introduction des SIG ne produit pas seulement un effet technique sur les projets, mais induit un véritable déplacement épistémologique dans la posture des étudiants. Ceux-ci deviennent progressivement capables de formuler des problématiques de manière autonome, d'articuler des lectures complexes du territoire, et de projeter des scénarios de transformation intégrant des données écologiques, sociales et spatiales. Cette évolution suggère une redéfinition des compétences professionnelles attendues dans les disciplines du projet : le designer de l'Écocène est conçu non seulement comme un auteur de formes, mais comme un interprète de systèmes, un médiateur entre données, imaginaires et contextes.

Ce chapitre, en articulant cadre théorique, expérimentation pédagogique et retour critique, met ainsi en lumière les potentialités transformatrices des outils numériques dans l'enseignement du projet urbain et paysager. Il plaide pour une intégration systématique des SIG non pas comme finalité technique, mais comme catalyseur d'une nouvelle manière de penser et de faire le projet, en réponse aux défis écologiques et sociétaux contemporains.

Analyse des exercices. Le chapitre 5 propose une analyse approfondie des processus de conception menés par les étudiants dans le cadre du laboratoire, à partir d'un corpus de dix exercices sélectionnés. Chaque projet est examiné selon la grille de compétences identifiées, permettant d'évaluer la manière dont les données géographiques ont été mobilisées pour structurer une pensée spatiale critique et spéculative. Cette analyse met en évidence les mécanismes d'appropriation, les dynamiques d'apprentissage et les stratégies de représentation déployées. À titre d'exemple, l'exercice 5.6 sera intégralement traduit en français.

Écosystèmes et pollution lumineuse à Zirkel. Toutes les créatures ne redoutent pas l'obscurité. La pollution lumineuse profite à certaines espèces animales, notamment celles qui se nourrissent d'insectes attirés paradoxalement par les sources lumineuses artificielles telles que les lampadaires et les bâtiments éclairés. Les araignées, les hérissons, les grenouilles, les crapauds, certaines espèces de souris et certains chauves-souris exploitent ces zones en raison de l'abondance de nourriture disponible : les araignées tissent leurs toiles à proximité des lumières et les chauves-souris y chassent les insectes volants. Toutefois, cette concentration artificielle d'insectes perturbe les réseaux trophiques et les relations prédateur-proie, causant des déséquilibres écologiques. À l'inverse, plus de 60 % des espèces nocturnes souffrent de la pollution lumineuse, qui perturbe des activités essentielles telles que la pollinisation, la reproduction et la recherche de nourriture. La lumière artificielle, en particulier à proximité des lampadaires à LED, réduit la pollinisation des plantes de près des deux tiers, affectant ainsi l'approvisionnement alimentaire des pollinisateurs diurnes comme les abeilles. La pollution lumineuse entraîne également la mort de milliards d'insectes, désoriente les oiseaux et a des effets néfastes sur la faune aquatique.

Cet exercice met en évidence la coexistence, dans un périmètre très restreint, de la zone la plus lumineuse et de la zone la plus sombre du centre-ville de Karlsruhe. Il interroge la possibilité de créer des zones et des prototypes urbains favorisant une interdépendance mutuelle, où le contact entre ces espaces bénéficierait au développement de l'écosystème. Quatre jeux de données distincts ont été collectés pour la préparation de cet exercice succinct. Le premier est une image de l'intensité lumineuse nocturne couvrant l'ensemble de la ville, avec une résolution de 30 mètres. Celle-ci permet d'identifier clairement que le Zirkel constitue l'articulation entre la zone urbaine la plus éclairée et la plus sombre, en raison de la présence du château de Karlsruhe et de la forêt de Hartwald. Le deuxième jeu de données recense l'ensemble des lampadaires, classifiés et catégorisés. Les deux autres jeux de données proviennent respectivement des photos issues de la plateforme de médias sociaux Flickr prises à Karlsruhe, et des observations animales enregistrées via l'application iNaturalist dans la zone. Tous ces jeux de données sont en libre accès et aisément consultables.

Les trois derniers jeux de données sont analysés à travers plusieurs opérations. Une série d'hypothèses d'intensité lumineuse est attribuée aux différents lampadaires, afin d'obtenir une image plus précise de l'influence lumineuse au sein du Zirkel que celle fournie par l'image aérienne nocturne à résolution de 30 mètres. Le résultat est une sorte de « topographie de l'intensité lumineuse », avec des courbes indiquant son gradient. Le jeu de données Flickr est filtré pour ne conserver que les images prises de nuit, les métadonnées des clichés comprenant l'heure exacte de la prise de vue. La carte de chaleur ainsi produite est pondérée selon les horaires, en accordant un poids plus important aux clichés pris pendant les heures les plus sombres. Enfin, les observations animales sont également filtrées selon l'heure d'observation, et les différentes espèces sont examinées afin de mieux comprendre leurs interdépendances.

La cartographie finale compile l'ensemble de ces cartographies augmentées, dépeignant un terrain d'interaction pour diverses espèces au sein d'un paysage de gradient lumineux. Elle cherche à identifier des zones propices aux rencontres interspécifiques et met l'accent sur les zones de contact entre les espaces éclairés et les zones sombres, perçues par de nombreux animaux comme des barrières franches. Ce faisant, la cartographie adopte une perspective non-humaine, rendant visible la manière dont ces espèces expérimentent le site. Elle intègre également les mouvements humains dans la zone en identifiant les lieux où les personnes partagent des images sur les réseaux sociaux, explorant ainsi les espaces de rencontre entre humains et non-humains. Incontestablement, l'orientation thématique de l'exercice résulte de la disponibilité des données, question particulièrement prégnante dans un exercice de courte durée tel que celui-ci. L'utilisation de multiples jeux de données numériques, dont la complexité élevée découle du nombre de lampadaires, de clichés Flickr et d'observations animales, rendrait cette investigation impossible sans l'appui des jeux de données géographiques et des outils de calcul numérique.

Une fois l'impact de la lumière artificielle sur les écosystèmes non-humains constaté, une question émerge : et si cette zone de contact constituait une opportunité écologique à l'articulation entre lumière et obscurité ? Et si la cohabitation de l'ombre et de la lumière pouvait devenir un moteur pour des écosystèmes florissants ? Quelles espèces pourraient tirer parti de cette situation exceptionnelle ? Où se situeraient les zones les plus susceptibles d'accueillir ces écosystèmes symbiotiques ? Comment pourrait-on doter ces espaces d'une infrastructure naturelle contribuant à leur amélioration ? Quelles figures paysagères pourraient accueillir cette infrastructure ? Comment les habitants approcheraient-ils ces prototypes orientés vers le non-humain ? L'exercice propose ainsi des réflexions critiques sur la relation entre les humains et les agents non-humains, tout en tentant d'imaginer un avenir possible fondé sur des interdépendances renouvelées.

Bien qu'il ait été mené sur une période très courte, l'exercice témoigne d'une lecture pertinente des données et de l'usage de plusieurs techniques telles que les cartes de chaleur pondérées, la classification temporelle et l'analyse spatiale. La superposition de l'ensemble de ces investigations aboutit à une cartographie composite, ouverte à de futures interprétations et constituant une base solide pour un éventuel projet critique prospectif. La nature brève d'un *Stegreif* — réalisé en moins de deux semaines —, combinée à l'absence d'expérience préalable en SIG pour la moitié des étudiants, n'a laissé d'autre choix que de compiler les jeux de données dès la première heure de l'atelier, ce qui pourrait être qualifié « d'opportunisme des données » (Ortner, 2019). Tous les étudiants ont travaillé à partir des mêmes données, indépendamment de leur approche individuelle. Néanmoins, ils ont su initier des investigations spatiales intégrant des formes complexes et sensibles de pensée en réseau. En particulier, le jeu de données iNaturalist, localisant les observations de plantes et d'animaux dans le Zirkel, leur a permis de mener des recherches inspirées par la notion de « maille » développée par Timothy Morton. Ils ont pu aisément représenter certains réseaux complexes susceptibles de se décliner en différents cycles temporels : horaire, jour/nuit ou saisonnier — voir figure 5.33, produite par une autre équipe d'étudiants.

Cet exercice mobilise judicieusement les techniques de télédétection et parvient à préparer et interpréter les données de manière pertinente. Il débute avec l'idée initiale de « protéger les animaux de la pollution lumineuse », considérant l'écosystème du Zirkel comme une entité passive à conserver. Ce concept évolue grâce aux cartographies puissantes produites par les étudiants, révélant que l'enjeu dans cette zone réside précisément dans la juxtaposition des zones les plus sombres et les plus lumineuses de la ville. Cette analyse spatiale est enrichie par une pensée systémique : la représentation des espèces peuplant les paysages nocturnes du Zirkel. Imaginer une série de dispositifs paysagers servant d'infrastructure à un écosystème occupant l'interstice entre lumière et obscurité relève d'une approche systémique, ouvrant la voie à une forme novatrice de *natureculture*. La présence humaine est également prise en compte — à travers les images capturées la nuit — mais elle est envisagée « simplement » comme une espèce supplémentaire évoluant sur ce terrain commun.

L'analyse spatiale des données complexes aurait vocation à orienter le processus de localisation des prototypes paysagers. Ceux-ci ne sont toutefois pas développés dans le cadre de cet exercice de 30 heures. Bien que les étudiants aient été en mesure d'esquisser quelques pistes envisageables pour une proposition de design, l'intégration effective de la cartographie dans un projet concret de conception n'a pas été démontrée ici. Lors de la présentation finale, des questions ont émergé concernant les fréquences lumineuses spécifiques, ainsi que des remarques sur les bénéfices et opportunités inhérents au scénario spéculatif proposé, et sur la manière dont ceux-ci pourraient orienter un schéma de conception précis.

Le projet *Multispecies Chandelier*, réalisé par les architectes espagnols TAKK en 2024, entre en résonance avec plusieurs des thématiques explorées dans cet exercice. Ce dispositif suspendu, intégrant des plantes et des espaces construits pour différentes espèces, incorpore plusieurs sources lumineuses. La lumière émise, visible à l'œil humain, est classée en huit couleurs distinctes, qui, au-delà de leur valeur esthétique, apportent des bénéfices aux plantes, aux insectes et à diverses espèces nocturnes. Un spectre lumineux élargi pourrait même accentuer davantage les effets positifs sur la faune et la flore. Ce prototype célèbre un espace dédié aux rencontres interspécifiques. Il permet l'échange d'énergie, de lumière, de nutriments, d'informations, générant des conditions très spécifiques autour de lui et façonnant les paysages dans lesquels il s'inscrit.

Cet exercice se distingue par sa capacité à imaginer des paysages hybrides où la cohabitation des humains, des non-humains et de la technique produit des résultats inattendus. Il envisage des dispositifs dépassant les schémas *inspirés par la nature*, intégrant pleinement les interactions humaines et non-humaines grâce à des usages innovants de la cartographie numérique.

Analyse qualitative. Le chapitre 6 prolonge l'analyse entamée dans la partie précédente en s'intéressant non plus aux résultats visibles des projets, mais aux dynamiques internes qui ont conduit à leur élaboration. Il s'agit de comprendre comment les étudiants, en travaillant avec les SIG dans un cadre de design spéculatif, développent des postures nouvelles vis-à-vis du projet, de la donnée, et de la nature urbaine. Cette lecture se fonde sur une enquête qualitative menée auprès des participants à travers des entretiens semi-directifs et un focus group, quelques mois après la fin des ateliers. Ce recul temporel permet de cerner les effets durables de l'expérience pédagogique, non seulement en termes de savoir-faire, mais aussi en termes de transformation des logiques de pensée et d'engagement dans le projet.

La démarche qualitative vise à saisir ce qui échappe à l'observation directe : les hésitations, les déclics, les cheminements singuliers, les déplacements de regard opérés au fil du processus. Il en ressort que l'introduction des SIG dans un contexte de design spéculatif produit des effets complexes, qui vont bien au-delà d'un simple apprentissage technique. Pour beaucoup, le contact avec les données géographiques transforme profondément la manière d'aborder le territoire : au lieu d'y voir une toile de fond à remplir, il est perçu comme un système vivant, stratifié, en constante mutation, et traversé de relations multiples. Cette prise de conscience modifie les priorités du projet : on ne part plus de la forme à dessiner, mais des relations à activer, des cohabitations à imaginer, des logiques systémiques à révéler.

Une première transformation relevée par les participants est l'évolution du rapport à l'analyse. Loin d'une étape préliminaire au projet, elle devient un moteur actif de la conception, produisant des idées, des hypothèses, des pistes d'intervention. L'analyse par les données permet de sortir d'une approche centrée sur l'intuition ou l'expérience sensible, sans pour autant l'annuler : elle ouvre un espace intermédiaire où la donnée devient matière à interprétation, support d'exploration narrative, levier de spéculation. Ce glissement méthodologique entraîne une redéfinition de l'autonomie du designer, qui ne se situe plus dans l'invention formelle, mais dans la capacité à construire des lectures originales du territoire à partir de couches d'information hétérogènes.

Un autre aspect important est la manière dont les étudiants se réapproprient les outils techniques. Alors que les SIG sont souvent perçus comme rigides, normés, orientés vers des usages experts, ils sont ici investis dans une logique créative et critique. Les participants évoquent une forme de décentrement face aux savoirs établis : ils apprennent à manipuler l'incertitude, à bricoler avec les données manquantes, à composer avec les limites de l'outil. Cette relation pragmatique au numérique est porteuse d'un rapport plus souple à la technique, envisagée non comme une solution, mais comme un langage à apprivoiser. Cette attitude d'appropriation s'inscrit dans une pédagogie du détour, où l'exploration prime sur la maîtrise, et où l'erreur devient source d'apprentissage.

L'expérience du design avec les données semble également induire un déplacement du rôle attribué au projet. Plutôt que de viser des solutions figées ou des objets définis, les étudiants construisent des récits, des dispositifs ouverts, des scénarios ancrés dans des réalités complexes. Ce passage d'une logique de l'objet à une logique de la situation reflète une évolution des cultures du projet vers des formes plus spéculatives, relationnelles et contextuelles. Le projet devient un cadre de discussion, un médium critique, un outil de représentation du possible. Cette approche s'accompagne d'une attention accrue à la temporalité : les projets prennent en compte les cycles, les rythmes, les durées écologiques, en rupture avec les visions instantanées de l'intervention urbaine.

Enfin, une autre dimension relevée dans les entretiens est le changement de perspective sur la nature. Grâce aux croisements opérés entre données écologiques, infrastructures humaines et dynamiques territoriales, les participants appréhendent la nature urbaine comme un acteur à part entière, doté d'une agentivité propre. Ce regard transforme le design écologique en une pratique de cohabitation, d'écoute et de médiation. Il ne s'agit plus d'intégrer la nature dans la ville, mais de concevoir avec elle, à partir d'elle, en reconnaissant ses logiques et ses besoins. L'expérience du laboratoire renforce ainsi une posture écosystémique, fondée sur la mise en relation, l'interdépendance et la responsabilité.

Ce chapitre met en lumière la valeur transformatrice d'un enseignement du design qui mobilise la cartographie computationnelle dans une logique spéculative. Il montre comment cette approche, loin de produire une technicisation de la pensée, favorise au contraire l'émergence d'une culture du projet sensible, critique et située, capable de répondre aux défis contemporains de l'écologie urbaine.

A.6 Troisième partie. Conclusion.

La troisième partie de cette thèse analyse de manière critique les résultats issus du laboratoire, en mettant en lumière deux transformations majeures induites par l'intégration des méthodes basées sur les SIG : une transformation épistémologique et une transformation méthodologique. D'une part, l'apprentissage des outils numériques et de la cartographie computationnelle déplace les étudiants d'une logique cartésienne et positiviste vers une approche plus relationnelle, située et spéculative du design. D'autre part, l'usage des SIG reconfigure les flux de travail des étudiants, en favorisant des processus non-linéaires intégrant la pensée systémique, critique et spéculative. Ce double déplacement est facilité par la pédagogie mise en place, axée sur l'auto-apprentissage et l'expérimentation. Enfin, la discussion propose des pistes pour une nouvelle pratique professionnelle du designer, soulignant les conditions pédagogiques et institutionnelles nécessaires à l'émergence de cette figure.

Résultats. Le chapitre 7 propose une mise en perspective des résultats de la recherche en les structurant autour de trois niveaux de lecture conceptuelle : la notion de regard, la notion de compétence, et celle de transformation. Il ne s'agit pas ici de synthétiser les résultats de manière linéaire, mais d'explorer les effets plus profonds et systémiques que la démarche expérimentale du laboratoire a pu générer. Ce chapitre ne vise donc pas à évaluer le succès ou l'échec de l'expérience, mais à comprendre comment elle transforme les manières de voir, de penser et de faire dans le champ du design urbain et paysager.

Le premier niveau de lecture proposé est celui du regard. L'introduction des SIG et d'un cadre de travail fondé sur l'exploration de données conduit à un déplacement du regard des étudiants : la ville n'est plus vue comme un ensemble figé de formes et de fonctions, mais comme un espace dynamique, relationnel et systémique. Cette transformation du regard permet d'adopter une posture plus critique et plus distanciée vis-à-vis des évidences du territoire. Grâce à la cartographie computationnelle, les couches invisibles du contexte – flux, données, écologies, régulations – deviennent accessibles, rendant possible une nouvelle intelligibilité de l'espace. Le design devient alors un acte de lecture autant que de projection. Ce regard transformé permet de faire émerger des problématiques inédites et d'identifier des zones d'intervention qui échappent aux approches traditionnelles du projet.

Le second niveau analysé est celui des compétences. Le travail avec les SIG dans une logique spéculative permet de développer un ensemble de compétences à la fois techniques, critiques et projectuelles. Les étudiants apprennent à manier des outils numériques complexes, mais surtout à les intégrer dans un processus de conception où les données ne sont jamais acceptées telles quelles. Elles sont interrogées, sélectionnées, interprétées, manipulées pour produire du sens. Ce rapport actif à la donnée est une compétence clé dans un contexte où les territoires sont de plus en plus gouvernés par des indicateurs, des modèles et des simulations. En parallèle, une compétence narrative se développe : il s'agit de savoir transformer des constats cartographiques en récits spatiaux, en propositions sensibles, en hypothèses de transformation. Le projet devient alors un espace de traduction entre données et spatialités, entre systèmes et usages, entre milieux et imaginaires.

La troisième dimension, centrale dans le chapitre, est celle de la transformation. Ce terme est à entendre dans un double sens : transformation du territoire envisagée à travers le projet, mais aussi transformation des individus et des pratiques à travers l'expérience pédagogique. Le laboratoire ne produit pas seulement des résultats, mais transforme ceux qui y participent. Les étudiants interrogés témoignent de changements profonds dans leur manière d’appréhender le projet : ils se sentent mieux outillés pour faire face à la complexité, plus sensibles aux temporalités longues et aux relations écosystémiques, et plus conscients des implications politiques et sociales de leurs choix de conception. Cette transformation touche également la posture professionnelle : il ne s’agit plus d’imaginer des formes idéales, mais de composer avec l’existant, de révéler des potentiels, de proposer des bifurcations.

Le chapitre insiste sur le fait que cette transformation n’est pas le fruit d’un enseignement normatif, mais d’un processus exploratoire, où l’erreur, le tâtonnement et l’invention jouent un rôle structurant. L’enseignement n’est pas ici transmission de savoirs stabilisés, mais création d’un cadre propice à la recherche individuelle et collective. Cette approche pédagogique, fondée sur la confiance, la prise de risque et la réflexivité, est en elle-même un levier de transformation. Elle permet l’émergence d’une culture du projet qui dépasse les frontières disciplinaires, intégrant données, écologies, techniques et récits dans un même mouvement.

Enfin, le chapitre propose une réflexion plus large sur les conditions nécessaires pour que de telles pratiques se développent dans les contextes académiques et professionnels. Il souligne l’importance d’un accès libre aux données, d’un apprentissage critique des outils numériques, et d’une pédagogie ouverte à la spéculation et à l’incertitude. Ce cadre est vu comme essentiel pour former des designers capables de répondre aux défis du XXIe siècle, en particulier ceux liés à la crise écologique, à l’urbanisation croissante et à la numérisation des territoires.

En définitive, ce chapitre montre que l’intégration des SIG dans une démarche de design spéculatif ne relève pas simplement d’un enrichissement méthodologique, mais d’une redéfinition profonde des pratiques. Elle engage un déplacement des regards, une hybridation des compétences, et une transformation des postures. Le projet n’est plus seulement un aboutissement formel, mais un processus d’enquête, de narration et de cohabitation. Cette approche ouvre la voie à une écologie du design, attentive aux milieux, aux données, aux temporalités, et aux possibles.

Discussion. Cette thèse ne vise pas uniquement à élaborer une théorie sur un plan intellectuel et conceptuel, mais aussi et surtout à réfléchir sur la pratique réelle. Cependant, qu'entend-on exactement par ‘pratique’ et à quelle forme de ‘pratique’ ce texte fait-il référence ? Indéniablement, cela englobe diverses tâches, actions et devoirs, mais Mappings Exploring Speculative Scenarios with Urban Nature, MESSUN, occupent une place clé. Ensuite, les contours de cette pratique future sont tracés grâce à trois manœuvres émergentes de l’analyse empirique des exercices, des discussions avec les étudiants, des résultats et des savoirs extraits du laboratoire, ainsi que de l’expérience didactique de l’auteur au cours des cinq dernières années. Celles-ci permettent d’interroger les implications pour les professions du design, la biosphère et les outils de demain. Ces trois manœuvres constituent un appel à l’action. Elles émergent de situations problématiques et proposent des voies pour une évolution souhaitable. Enfin, les changements, distorsions et défis académiques, institutionnels, professionnels, sociétaux et écologiques nécessaires pour mener à bien ces manœuvres en dehors du cadre académique sont questionnés.

Première manœuvre. Agrandir le possible: redéfinir l’agence des designers. Cette manœuvre explore l'évolution du rôle des designers dans un contexte numérique vers l’Ecocene, mettant l'accent sur l'acquisition de compétences en littératie des données. Les designers doivent développer leur capacité à extraire, structurer et interpréter les ensembles de données numériques, en particulier ceux issus des SIG, afin de devenir des penseurs critiques et des acteurs du changement écologique. Cette évolution implique non seulement une maîtrise des outils numériques mais aussi une révision profonde de la relation entre l'homme et la nature. Les designers doivent intégrer les écologies urbaines dans leurs pratiques en repensant leur rôle vis-à-vis des systèmes non humains. Le recours à des scénarios spéculatifs, comme le contre-cartographie et la narration critique, devient essentiel pour imaginer des futurs transformateurs. Cette approche réclame une réforme des formations académiques, l'intégration des pratiques spéculatives dans les politiques environnementales et un développement des outils numériques adaptés à ces nouvelles pratiques.

Deuxième manœuvre. Au-delà du donné: designers construisant outils et méthodes. Cette manœuvre met en avant le passage des designers d'utilisateurs passifs des outils SIG à des créateurs actifs d'outils personnalisés pour la cartographie spéculative. En réutilisant des outils SIG existants ou en développant leurs propres routines, les designers peuvent s'engager de manière critique avec la technologie, remettre en question les biais et favoriser des solutions plus créatives et spécifiques au contexte. L'émergence des logiciels open-source, de l'IA et des modèles linguistiques LLM permet aux designers d'adapter leurs flux de travail sans nécessiter de grandes compétences en programmation, bien que cela soulève des questions sur la transparence algorithmique. La médiation culturelle dans les processus de conception est cruciale, où les designers doivent mélanger différentes épistémologies: connaissance spatiale, spéculative et incarnée. Cela encourage une approche réflexive et adaptable qui intègre les savoirs locaux et invite à la collaboration avec les parties prenantes.

Troisième manœuvre. Restructuration académique pour des futures spéculatives cartographiant des naturecultures. La dernière manœuvre de cette thèse propose une restructuration de l'éducation en design pour intégrer pleinement la cartographie spéculative des naturecultures dans les programmes académiques. L'accent est mis sur la nécessité de renforcer l'expertise en SIG dans les cursus d'architecture, d'urbanisme et de paysagisme. L'idée est de dépasser la maîtrise technique des outils pour encourager les étudiants à les utiliser de manière critique et créative, en développant leurs propres outils et workflows. Des formats pédagogiques innovants, comme des studios hybrides ou des hackathons intensifs, permettent d'inculquer une approche expérientielle et spéculative. L'objectif est de transformer la cartographie SIG en un outil génératif de conception et de réflexion critique, permettant aux étudiants de fusionner données spatiales, récits spéculatifs et conception. De plus, la thèse souligne l'importance d'un apprentissage continu après l'académie, notamment à travers des plateformes d'apprentissage en ligne et des ateliers professionnels. Enfin, la recherche doit accompagner cette évolution en développant des méthodes SIG simples et accessibles, favorisant l'adoption de pratiques innovantes dans le domaine du design urbain et de la nature.

B Graphic annex of the student's exercises

The following pages compile more graphic information of each of the students' exercises for better comprehension.

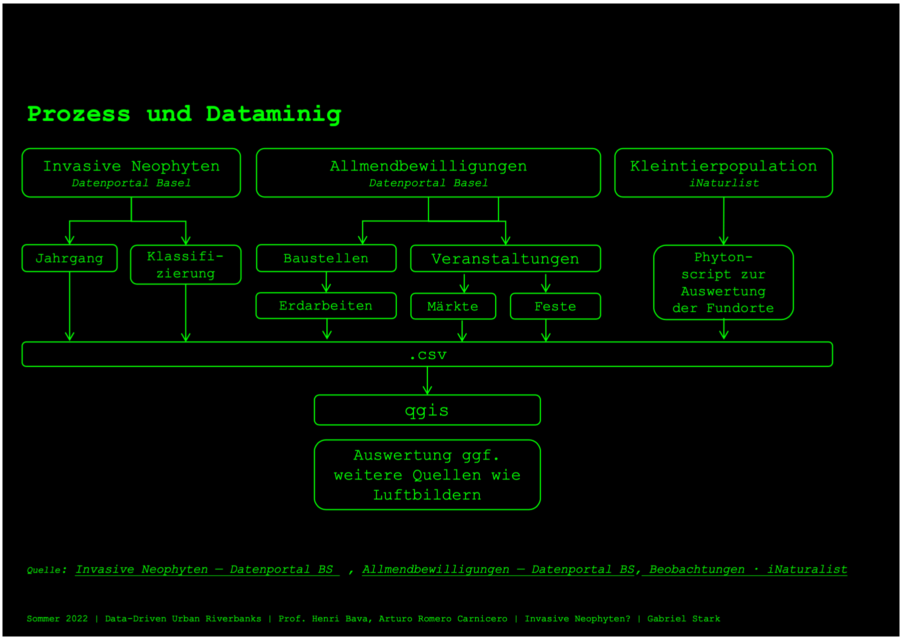
Nr.	Title	Author
1	Invasiven oder Neophyten	Gabriel Stark
2	Green capacity on an urban environment	Jasmine Párraga
3	Pull off the big green	Johanna Markus
4	City perception	Karla Jukic
5	Diversity of the commons	Alexander Albiez
6	Ecosystems and light pollution in Zirkel	Elena Heilig Sebastien Dremel
7	Auf der Suche nach Raum	Nicolas Astudillo Klárá Vasáková
8	ECOnnect	Elisa Muhr Oliver Leitbach
9	The great escape	Patrick Eissele Anna Klotzki
10	Soil: rethink, reconnect, regrow	Isabel Cardona Sophie Weiss

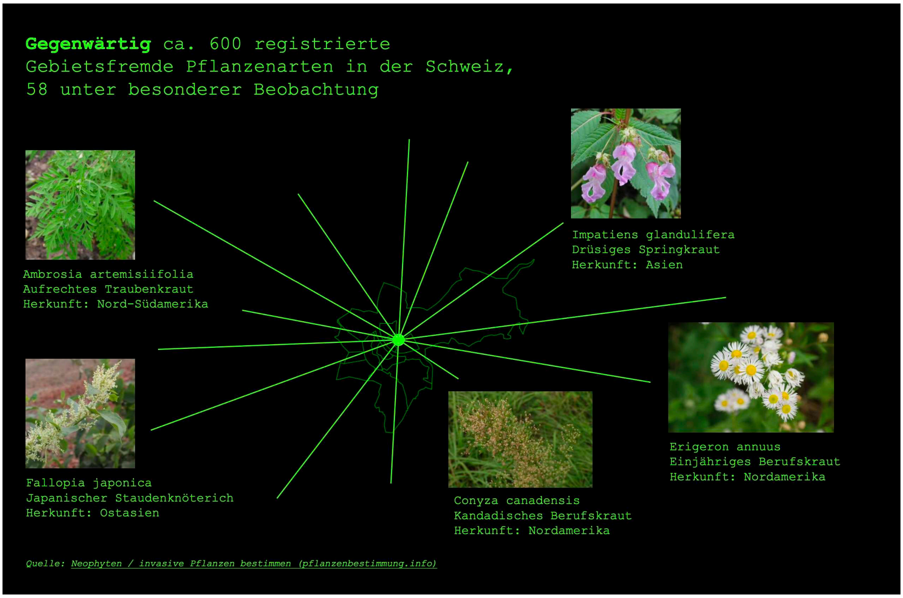
Images of the work of KIT students used with the kind permission of the authors.

B.1 Invasive oder neophythen?

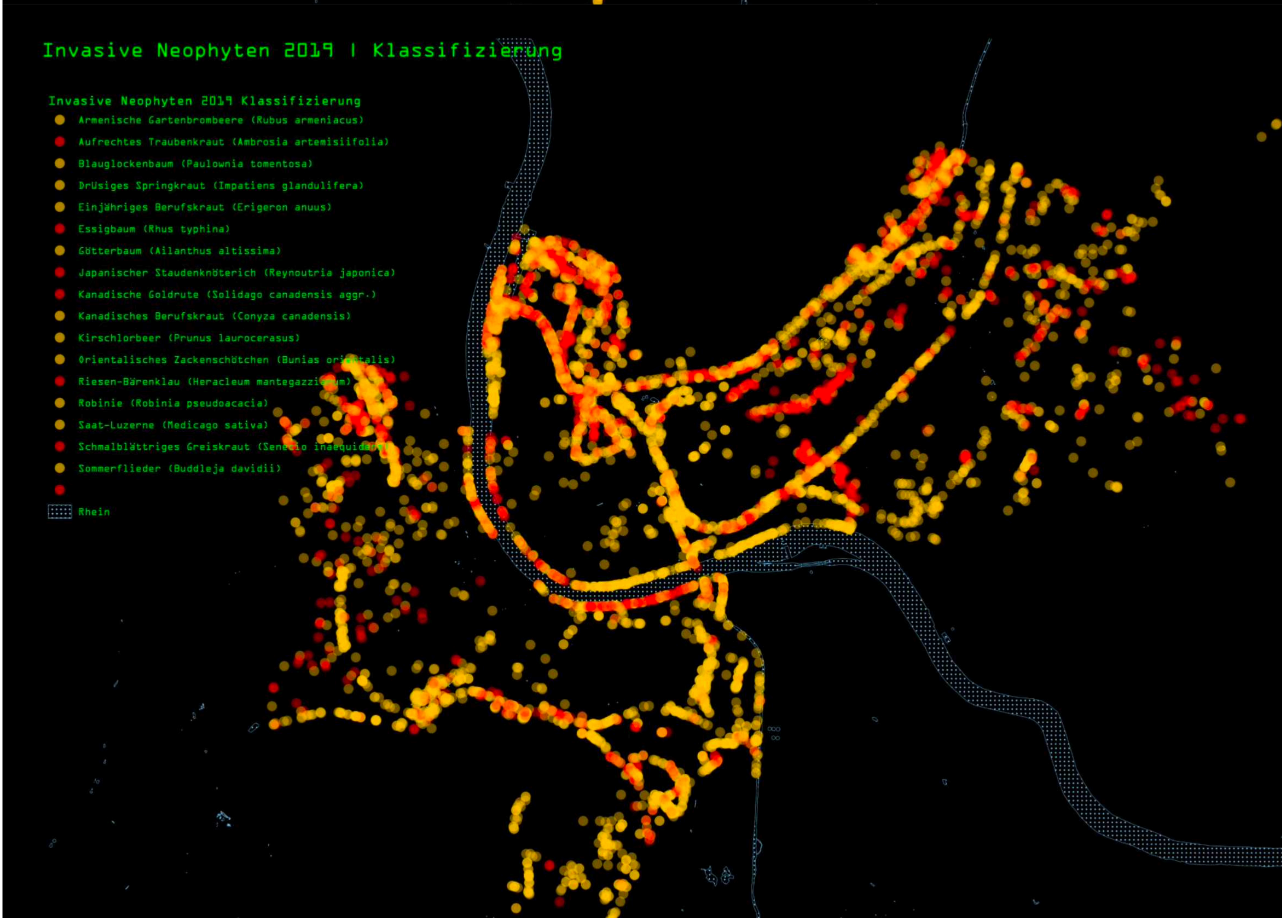
Gabriel Stark

Seminar Data-Driven Urban Nature Lab 2.0 Basel
Summer Semester 22





Invasive Neophyten 2006-2009 | Klassifizierung
Rhein
Invasive Neophyten 2006-2009 Klassifizierung
Armenische Gartenbrombeere (Rubus armeniacus)
Drüsiges Springkraut (Impatiens glandulifera)
Götterbaum (Ailanthus altissima)
Kanadische Goldrute (Solidago canadensis)
Riesen-Bärenklau (Heracleum mantegazzianum)
Schmalblättriges Greiskraut (Senecio inaequidens)
Sommerflieder (Buddleja davidii)
Spätblühende Goldrute (Solidago gigantea)
Japanischer Staudenknöterich (Reynoutria japonica)



Invasive Neophyten 2019 | Klassifizierung
Invasive Neophyten 2019 Klassifizierung
Armenische Gartenbrombeere (Rubus armeniacus)
Aufrechtes Traubenkraut (Ambrosia artemisiifolia)
Blauglockenbaum (Paulownia tomentosa)
Drüsiges Springkraut (Impatiens glandulifera)
Einjähriges Berufskraut (Erigeron anuus)
Essigbaum (Rhus typhina)
Götterbaum (Ailanthus altissima)
Japanischer Staudenknöterich (Reynoutria japonica)
Kanadische Goldrute (Solidago canadensis aggr.)
Kanadisches Berufskraut (Conyza canadensis)
Kirschlorbeer (Prunus laurocerasus)
Orientalisches Zackenschötchen (Bunias orientalis)
Riesen-Bärenklau (Heracleum mantegazzianum)
Robinie (Robinia pseudoacacia)
Saat-Luzerne (Medicago sativa)
Schmalblättriges Greiskraut (Senecio inaequidens)
Sommerflieder (Buddleja davidii)
Rhein

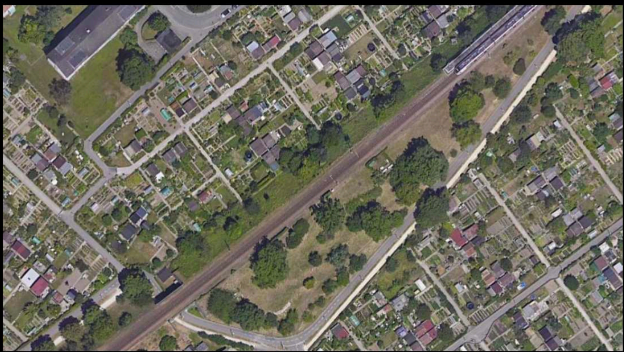
Invasive Neophyten | Bahnstrecke

Invasive Neophyten | Clipped 2019

Invasive Neophyten | Baustellen 2010-2013

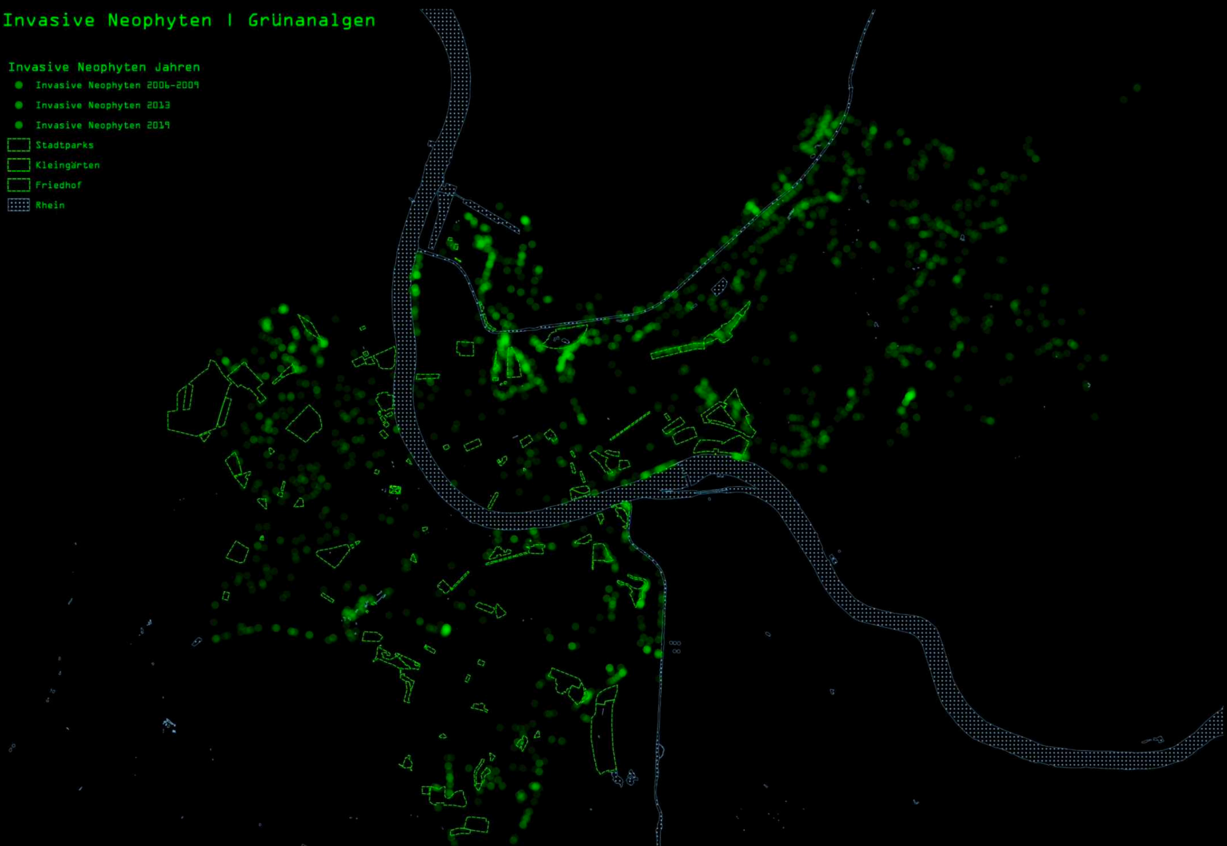
Invasive Neophyten | Baustellen 2014-2019

Luftbild Kanal „Wiese“
Vorkommen: Japanischer Staudenknöterich
Quelle: www.google.de/maps



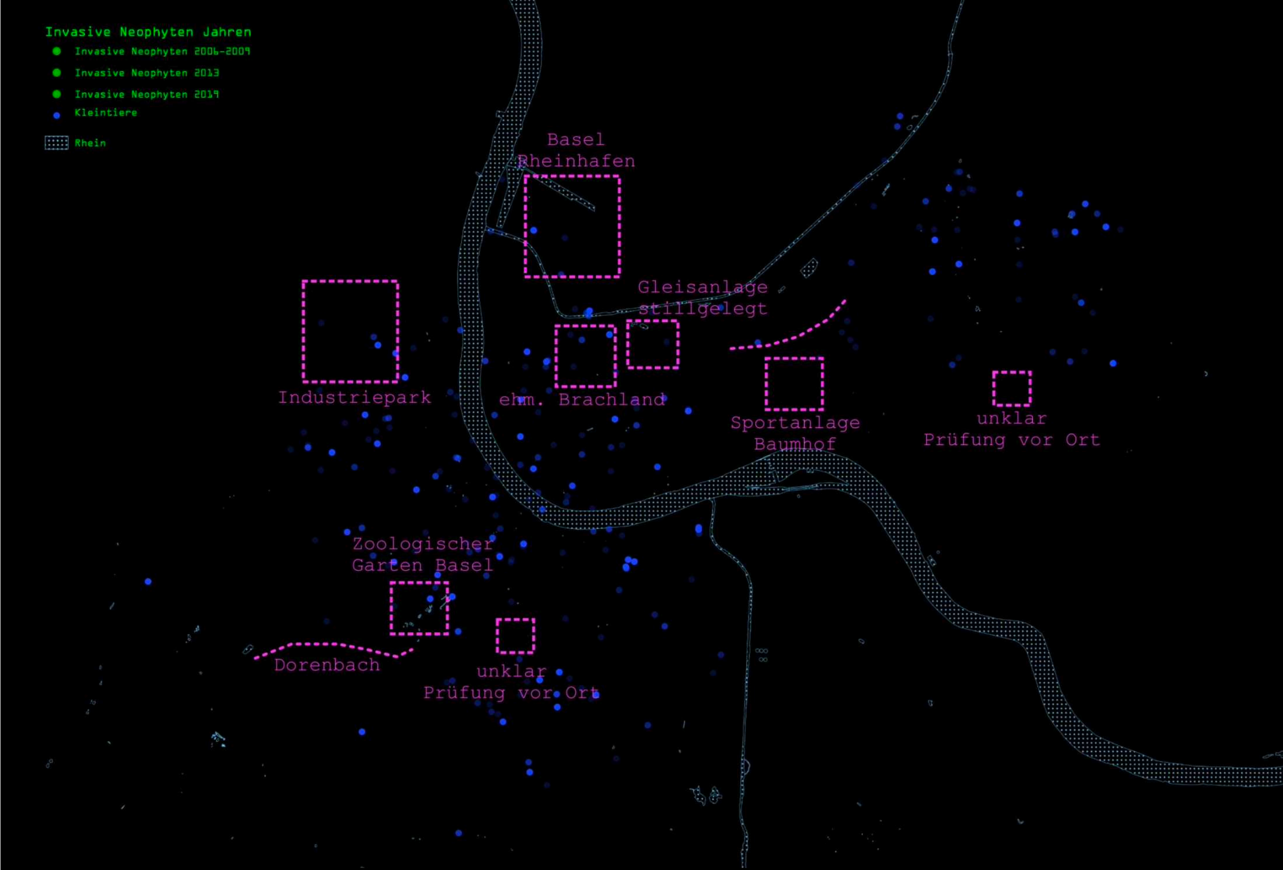
Luftbild Gleise
Vorkommen Einjähriges Berufskraut
Quelle: www.google.de/maps

Invasive Neophyten | Grünanalgen

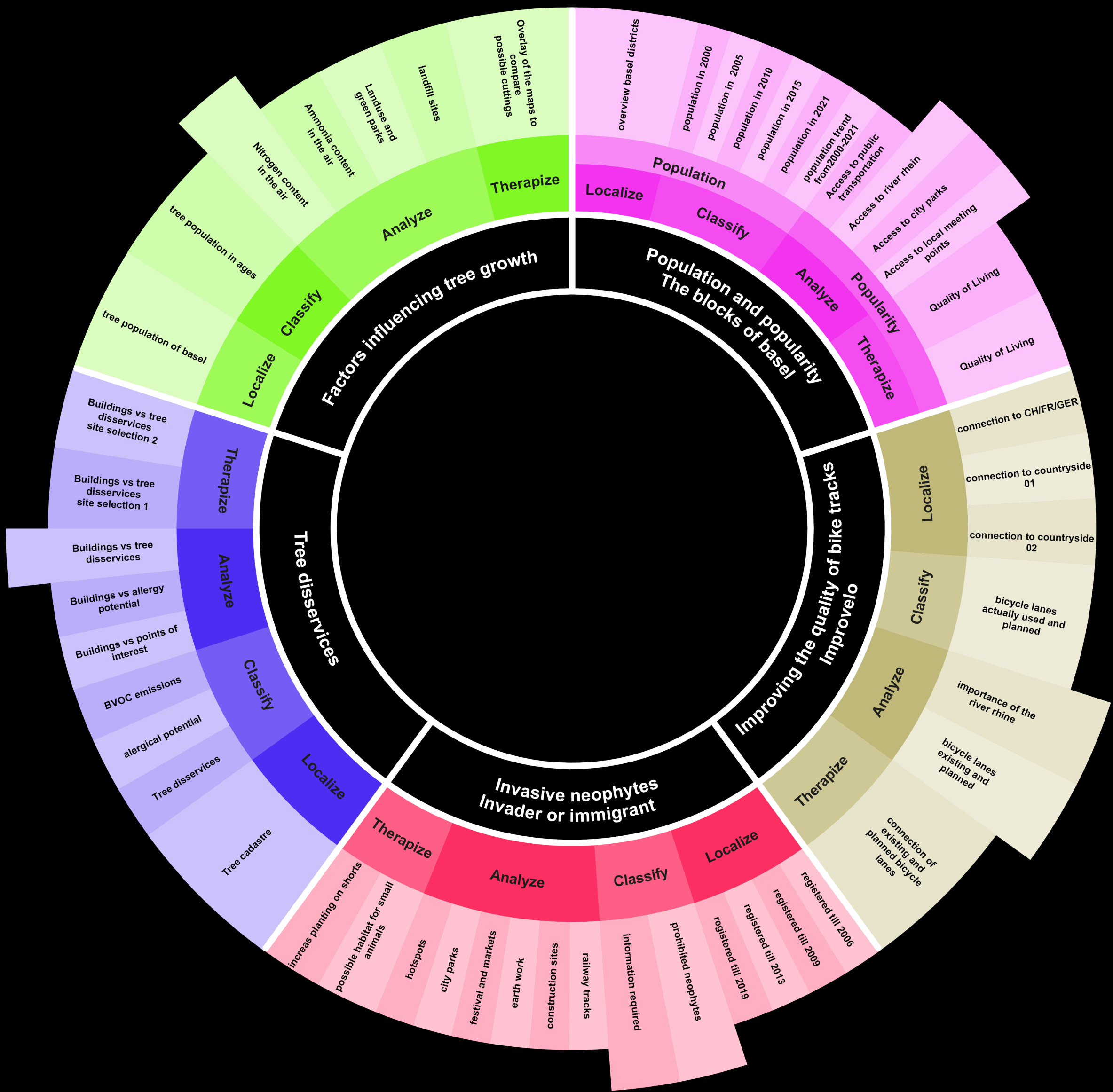


1:50.000

Invasive Neophyten | Kleintiere



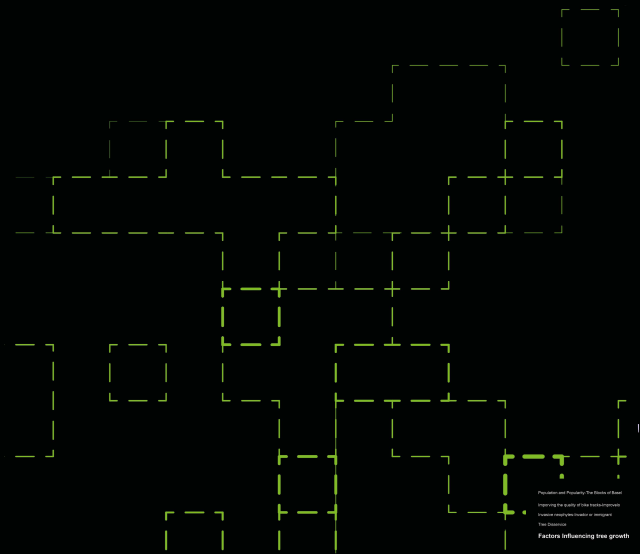
Invasive Neophyten 2019

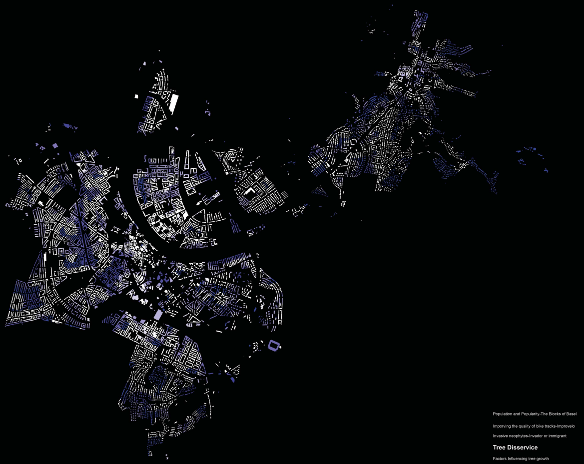


Factors influencing tree growth
Localize
Classify
Analyze
Therapize
tree population of basel
tree population in ages
Nitrogen content in the air
Ammonia content in the air
Landuse and green parks
landfill sites
Overlay of the maps to compare possible cuttings
Population and popularity
The blocks of basel
Population
Popularity
overview basel districts
population in 2000
population in 2005
population in 2010
population in 2015
population in 2021
population trend from2000-2021
Access to public transportation
Access to river rhein
Access to city parks
Access to local meeting points
Quality of Living
Quality of Living
Improving the quality of bike tracks
Improvelo
connection to CH/FR/GER
connection to countryside 01
connection to countryside 02
bicycle lanes actually used and planned
importance of the river rhine
bicycle lanes existing and planned
connection of existing and planned bicycle lanes
Invasive neophytes
Invader or immigrant
registered till 2006
registered till 2009
registered till 2013
registered till 2019
prohibited neophytes
information required
railway tracks
construction sites
earth work
festival and markets
city parks
hotspots
possible habitat for small animals
increas planting on shorts
Tree disservices
Tree cadastre
Tree disservices
alergical potential
BVOC emissions
Buildings vs points of interest
Buildings vs allergy potential
Buildings vs tree disservices
Buildings vs tree disservices site selection 1
Buildings vs tree disservices site selection 2


Population and Popularity-The Blocks of Basel
Improving the quality of bike tracks-Improvelo
Invasive neophytes-Invador or immigrant
Tree Disservice
Factors Influencing tree growth


Population and Popularity-The Blocks of Basel
Imporving the quality of bike tracks-Improvelo
Invasive neophytes-Invador or immigrant
Tree Disservice
Factors Influencing tree growth


Population and Popularity-The Blocks of Basel
Imporving the quality of bike tracks-Improvelo
Invasive neophytes-Invador or immigrant
Tree Disservice
Factors Influencing tree growth


Population and Popularity-The Blocks of Basel
Imporving the quality of bike tracks-Improvelo
Invasive neophytes-Invador or immigrant
Tree Disservice
Factors Influencing tree growth


Population and Popularity-The Blocks of Basel
Imporving the quality of bike tracks-Improvelo
Invasive neophytes-Invador or immigrant
Tree Disservice
Factors Influencing tree growth

Data-Driven Urban Riverbanks

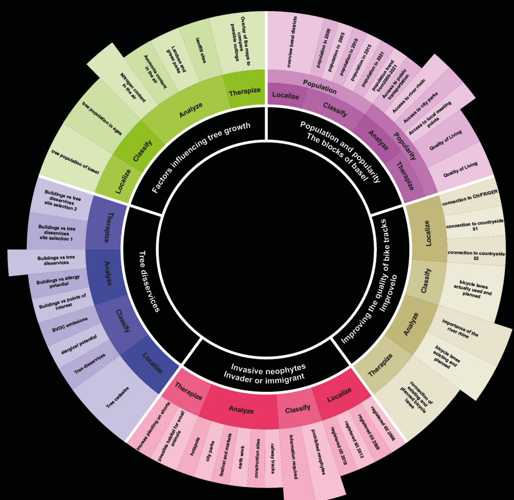
The Rhine at the Trinational Eurodistrict Basel

The crucial urban challenges of the coming years include traffic, Nature-Based Solutions of urban ecology, highly mixed uses, social integration or healthy and equitable cities. GIS data help us to analyze these complexities and to present the results in a new graphical way. The experimental site is the Rhine at the Trinational Eurodistrict Basel as a whole Cultural, natural social and built ecosystem to study the natural elements of quality of life. [1]

In a first investigation, quality of life indicators such as access to the Rhine, access to parks, availability of public transport and access to meeting places for residents were compared to the actual population distribution and good and bad places to live were determined based on the indicators. [2]
In the second step, the bicycle infrastructure around us in Basel was examined. As part of the analysis, routes planned and implemented by real users were compared with the current Basel road network and the bicycle connections proposed by the city administration to find similarities and differences that serve as a basis for further interpretation of bicycle friendliness. [3]
The next analysis of Invasive Neophytes in order to find solutions to minimize the spread and to integrate the plants alien to the Bite into our plant community. The first step was to classify plants according to their threat level and determine potential areas of spread along the Rhine River and railroad tracks. In the following steps, further causes of dispersal were defined. [4]
In the study on Tree Disservice, a map of Basel was created to provide information on urban areas where life is more difficult for people with severe allergies and respiratory problems. First step: number of trees with varying degrees of damage within 100m of individual houses. This results in a category from poor to poorly habitable. In a second formula, the trees were also categorized to obtain a result that represents areas that have very low tree diversity and high nuisance for residents. [5]
The final analysis in this series maps the relationship between the average age of trees and environmental factors such as nitrogen and ammonia concentrations in the air, as well as urban influences such as waste stations and land uses in the surrounding area. [6]

The attached map shows a linkage of individual analysis stages of the projects described. It serves as another building block in the study in the development of a city and the natural elements of the quality of life.

[1] *Booklet Data-Driven Urban Riverbanks 2022*
[2] *Population and Popularity-The Blocks of Basel_Hendrik Schütze*
[3] *Improvelo-Vorschlag für eine Verbesserte Fahrradinfrastruktur in Basel_Alexander Born*
[4] *Invasive neophytes-From Invador to immigrant_Gabriel Stark*
[5] *Tree Disservice_Yannick Ehinger*
[6] *Factors Influencing tree growth, Aleksandra Komina*



1 : 25 0000

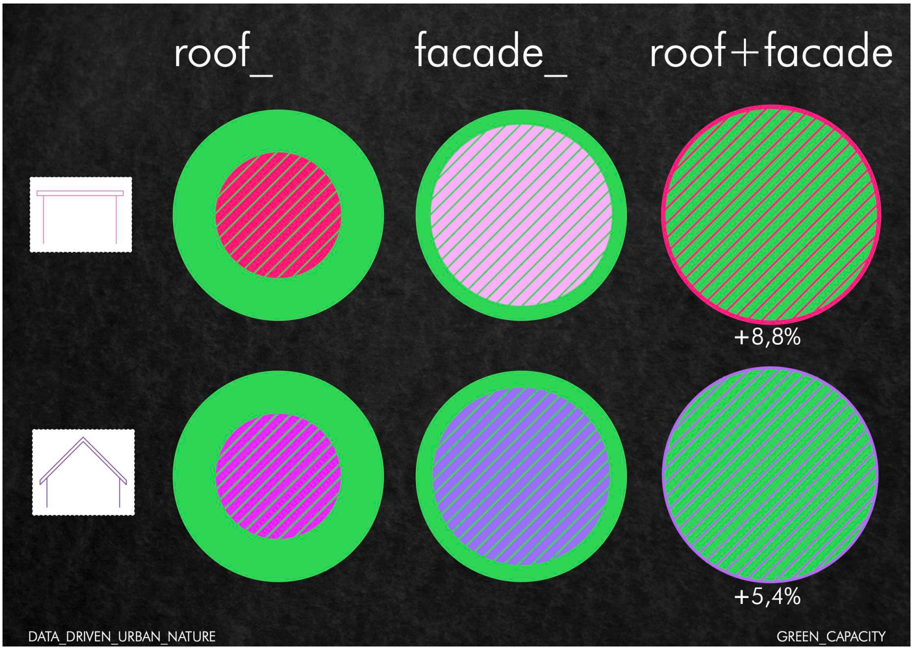
21.09.2022

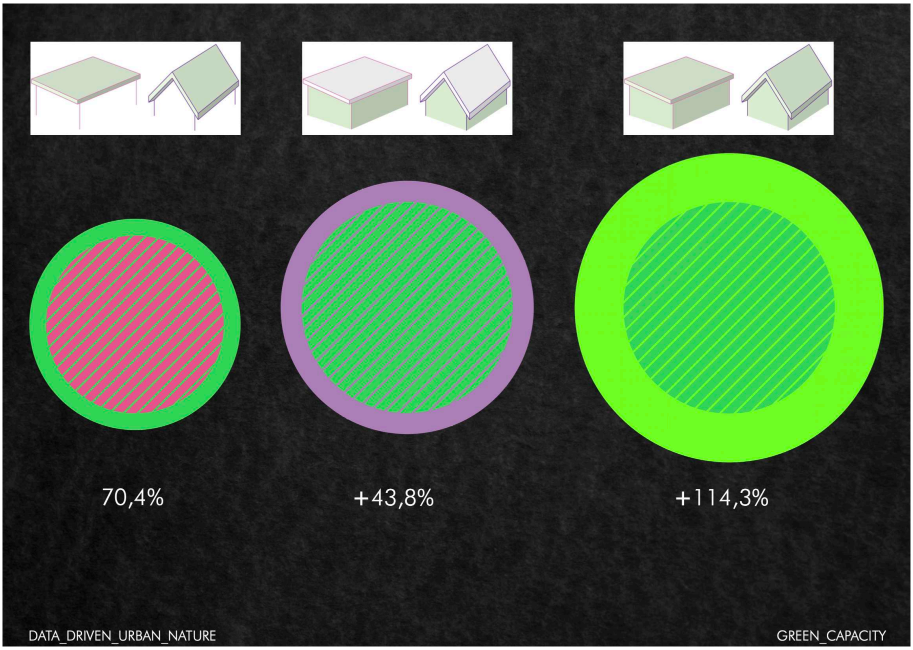
KIT | IESL Prof. Henri Bava | Arturo Romero Carnicero | Stegreif DDUR 2022 Gabriel Stark

B.2 Green capacity in an urban environment

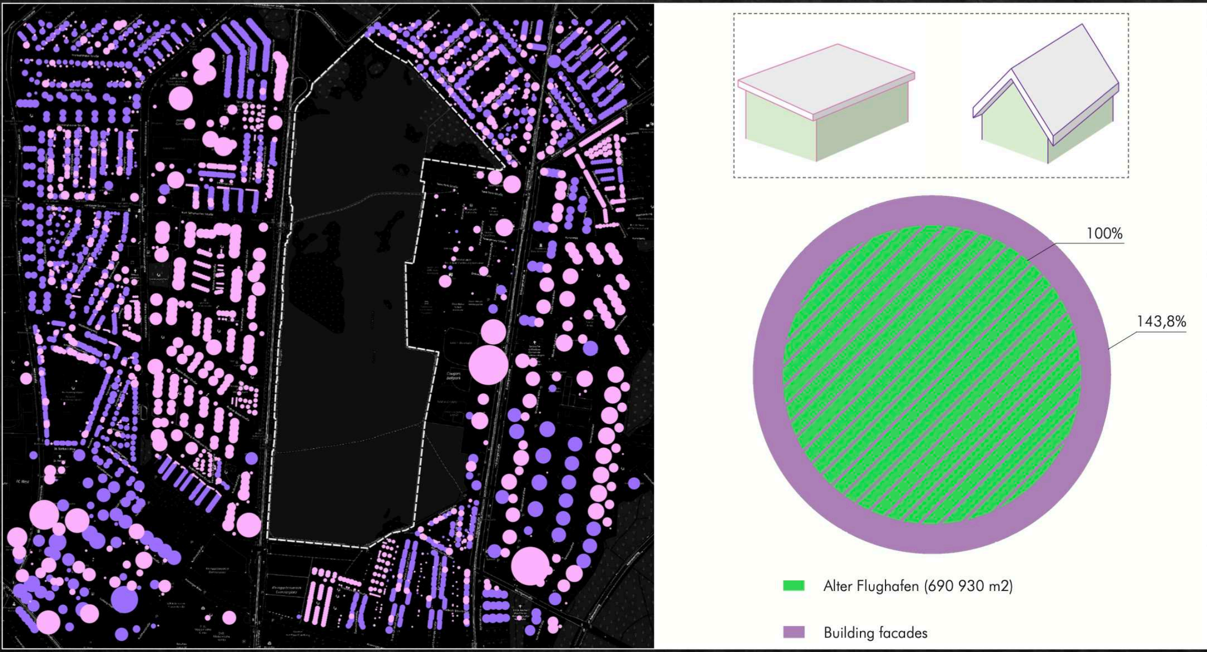
Jasmine Párraga

Seminar Data-Driven Urban Nature Lab 1.0 Karlsruhe
Winter Semester 20/21

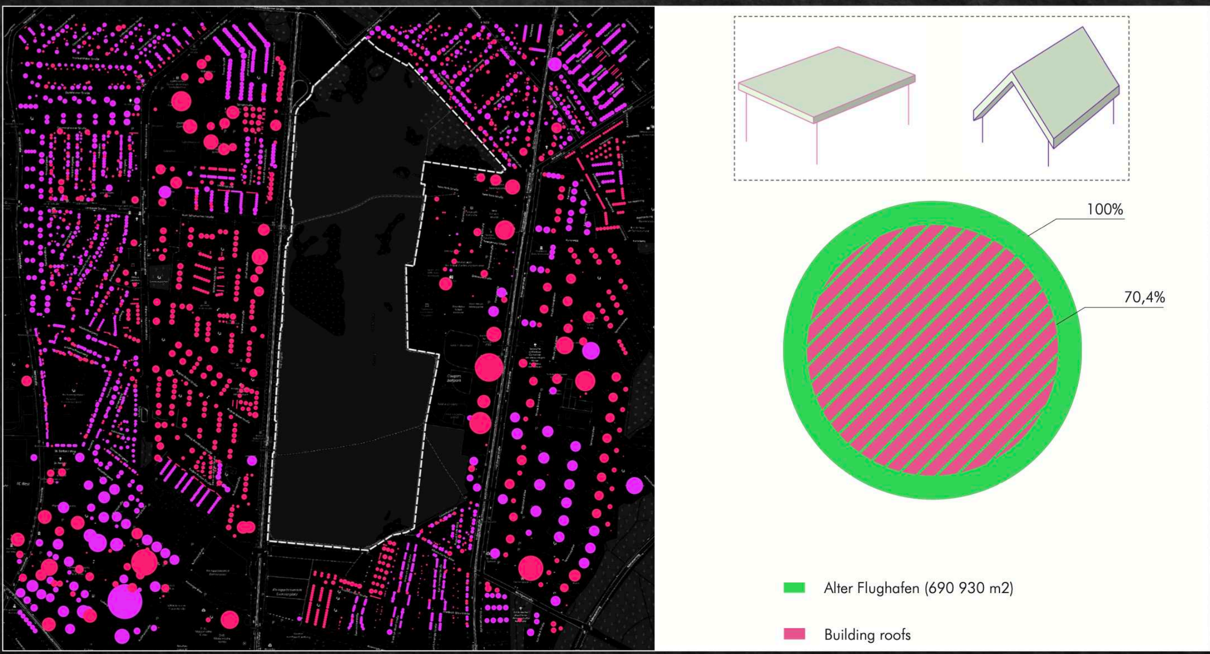




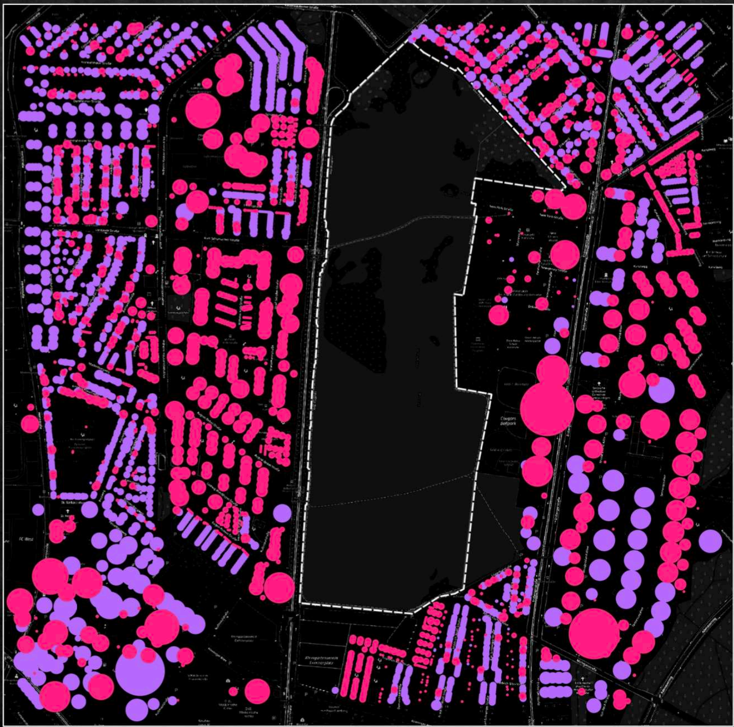
Buildings_facade

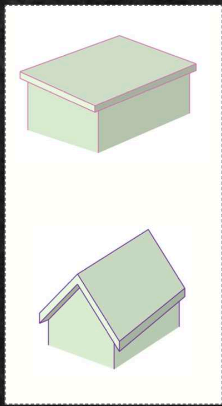


Buildings_roof

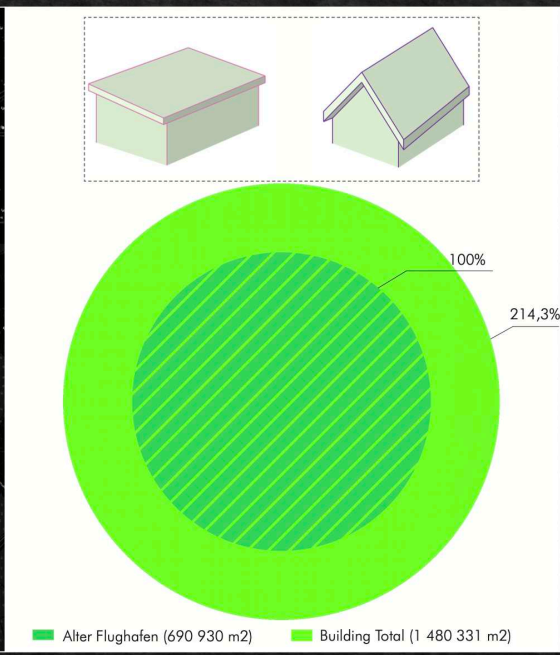


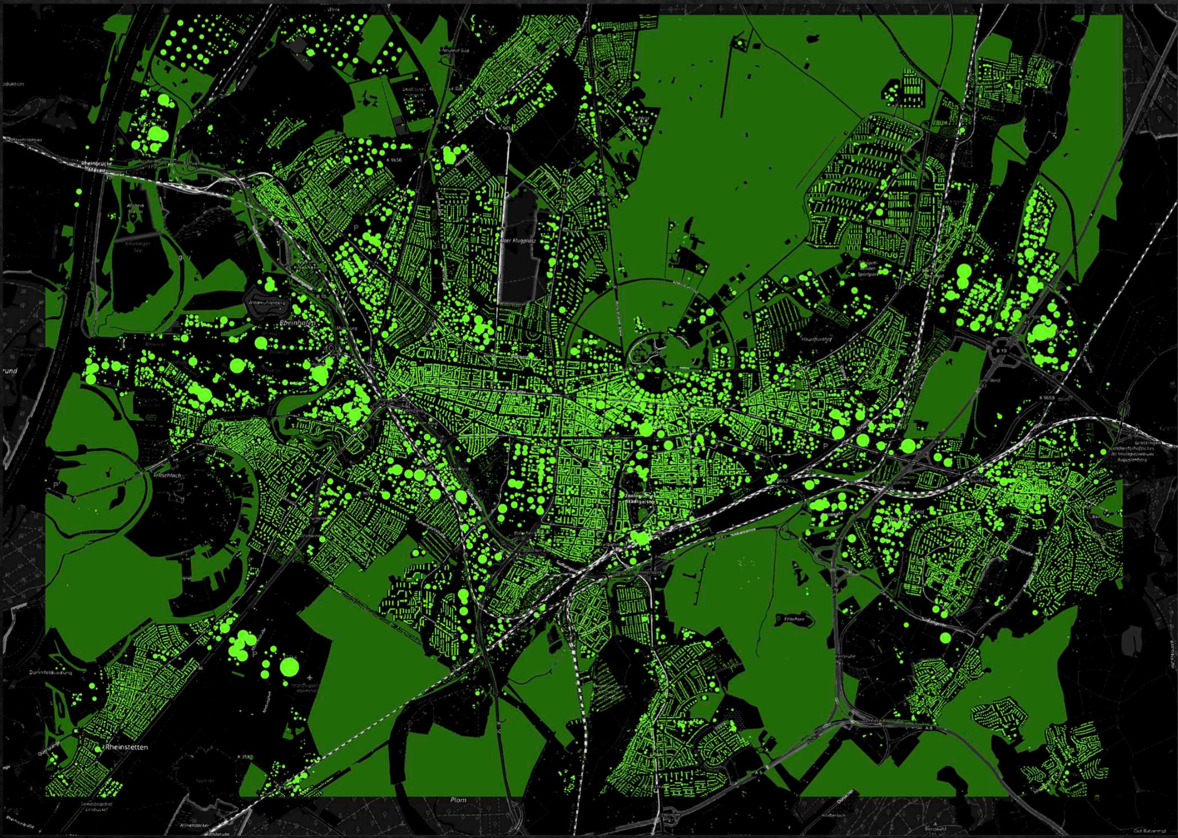
Buildings_total



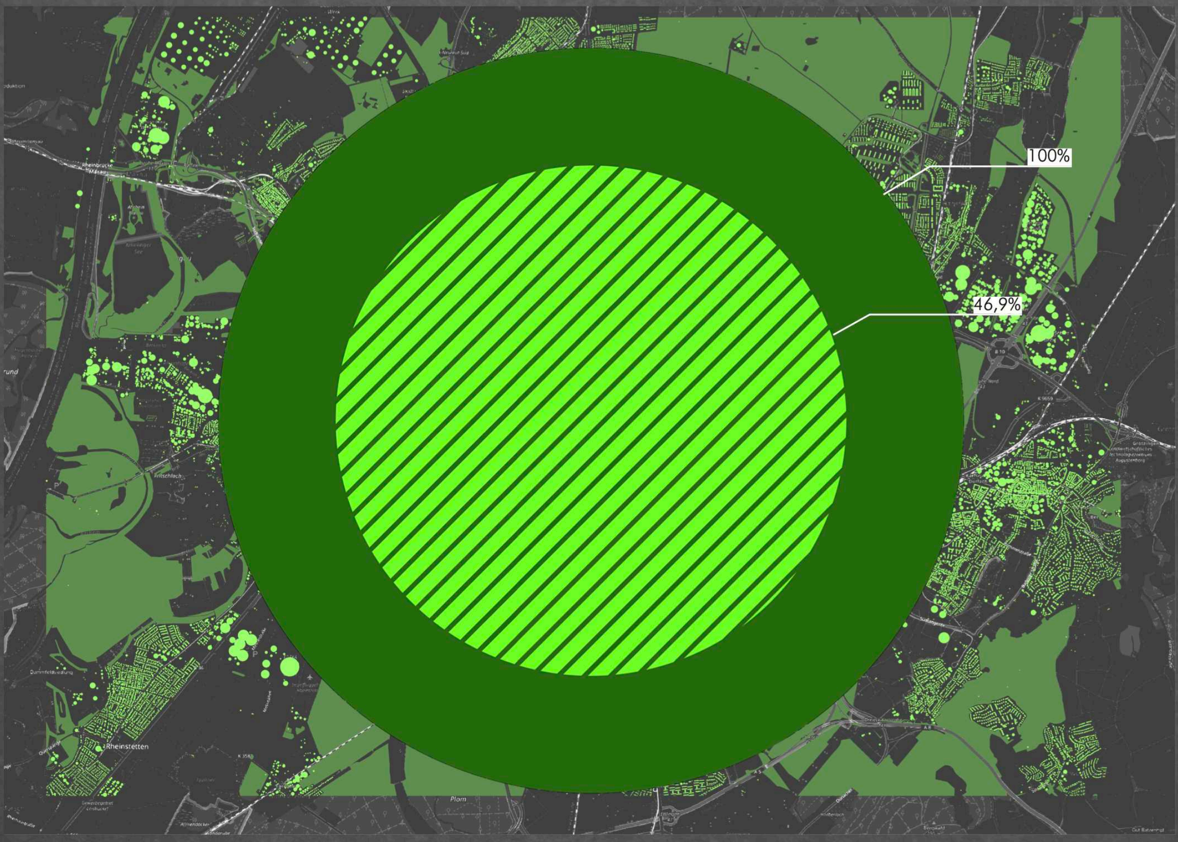


Buildings_total





DATA_DRIVEN_URBAN_NATURE GREEN_CAPACITY

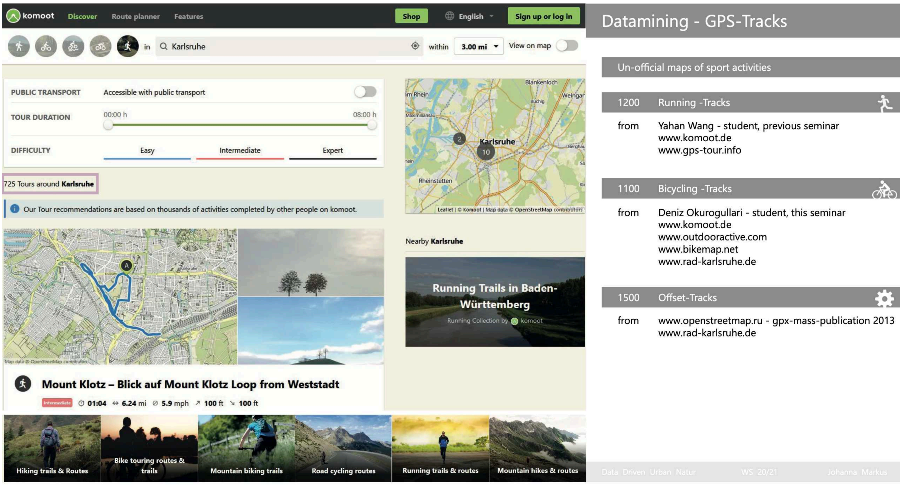


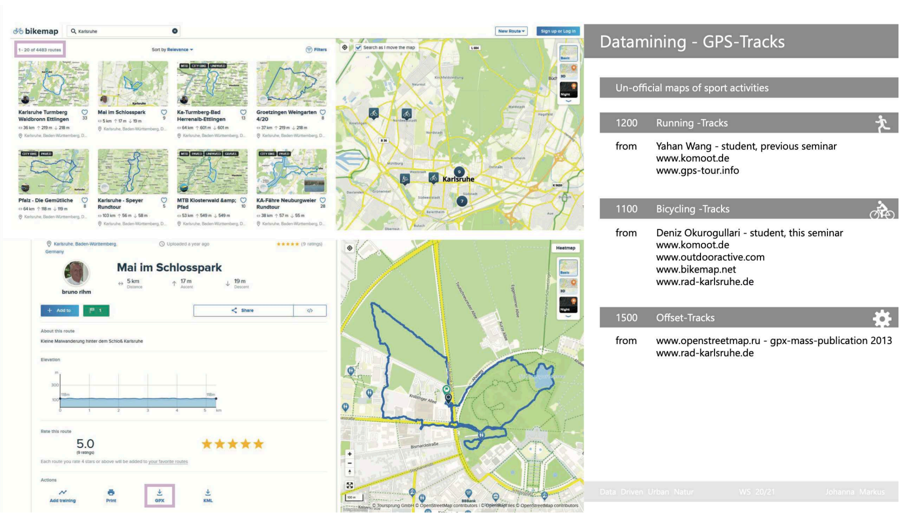
DATA_DRIVEN_URBAN_NATURE GREEN_CAPACITY

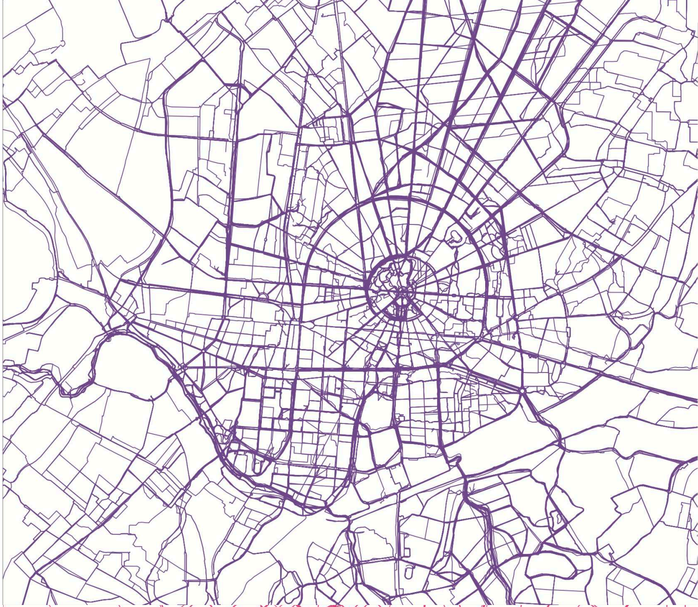
B.3 Pull off the big green

Johanna Markus

Seminar Data-Driven Urban Nature Lab 1.0 Karlsruhe
Winter Semester 20/21

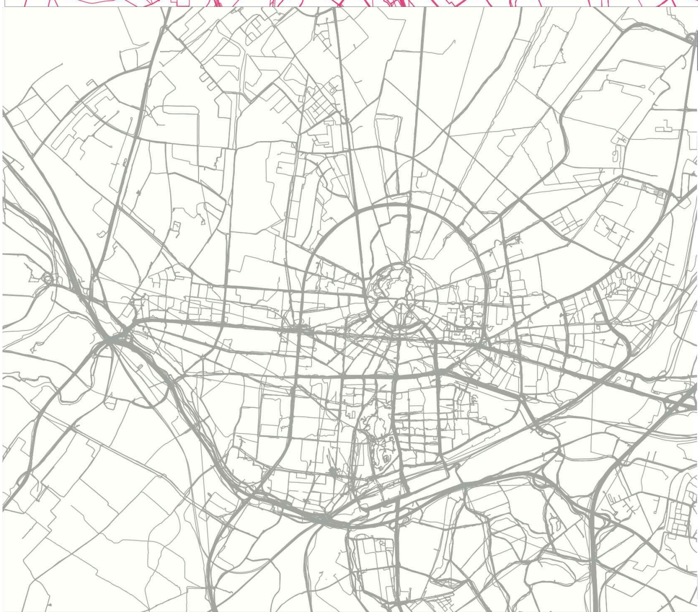




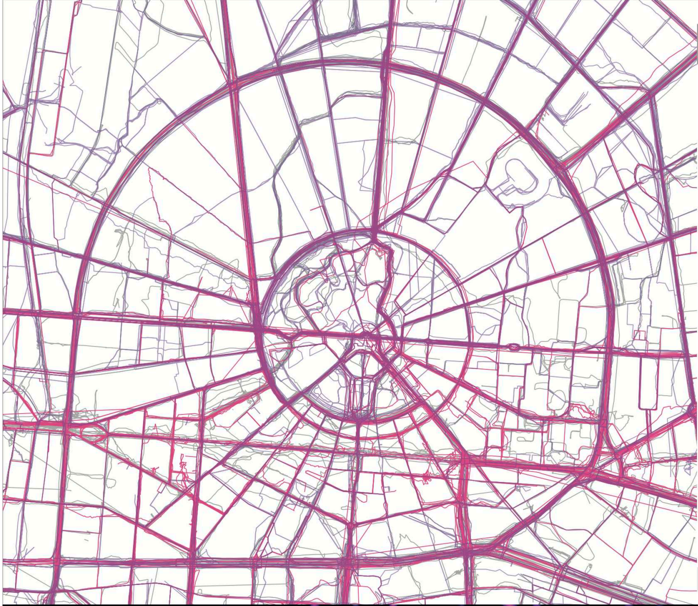


Mapping - Simple Line Map

Mapping - Simple Line Map

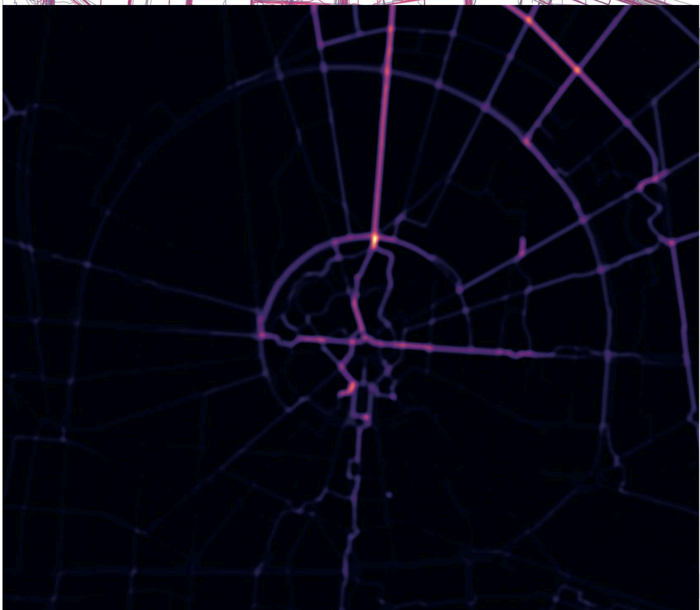


Mapping - Simple Line Map



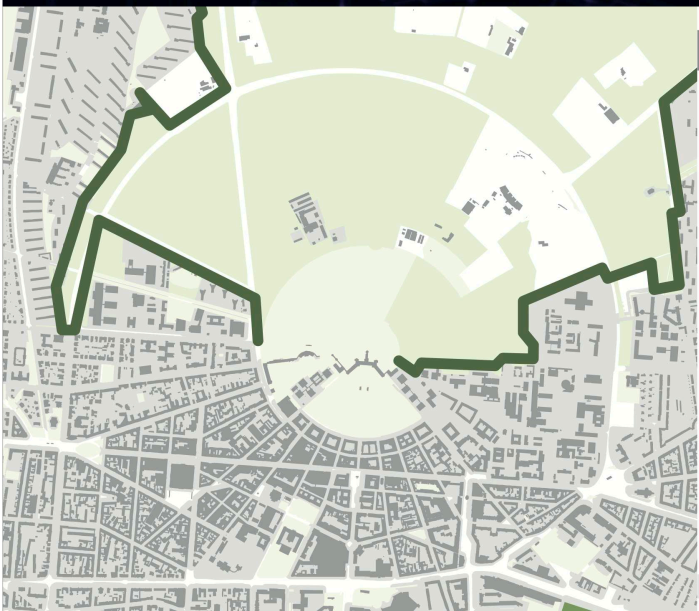
Mapping - Simple Line Map

Grain -Preferences



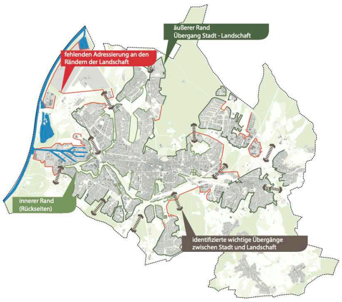
Mapping - Heatmap

Street Width ≠ Activity Quantity



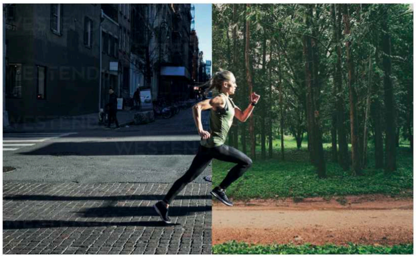
Mapping - Projects

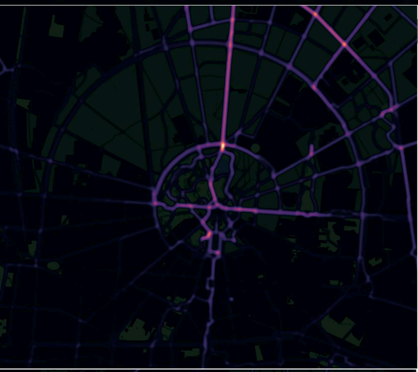
Thresholds



Mapping - Projects

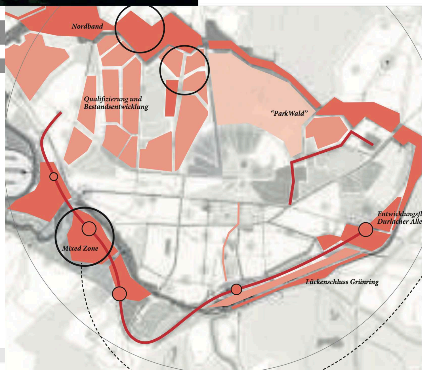
Thresholds





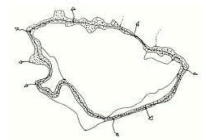
Mapping - Projects

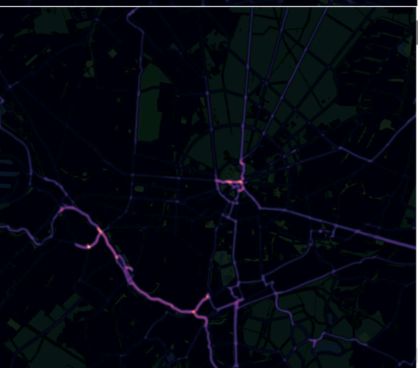
Quality



Mapping - Projects

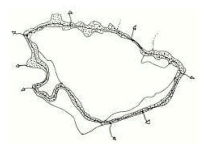
Green Ring + Bicycle Road

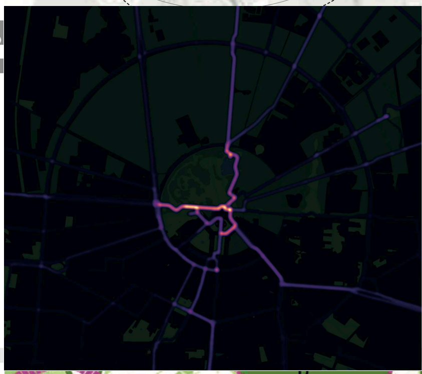




Mapping - Projects

Green Ring + Bicycle Road



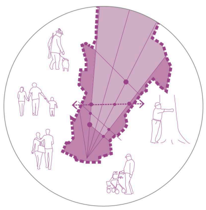


Mapping - Projects

Most activity close to large green areas

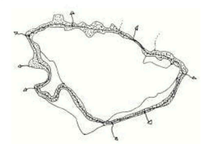
Mapping - Projects

Hardtwald as recreational area + link



Mapping - Projects

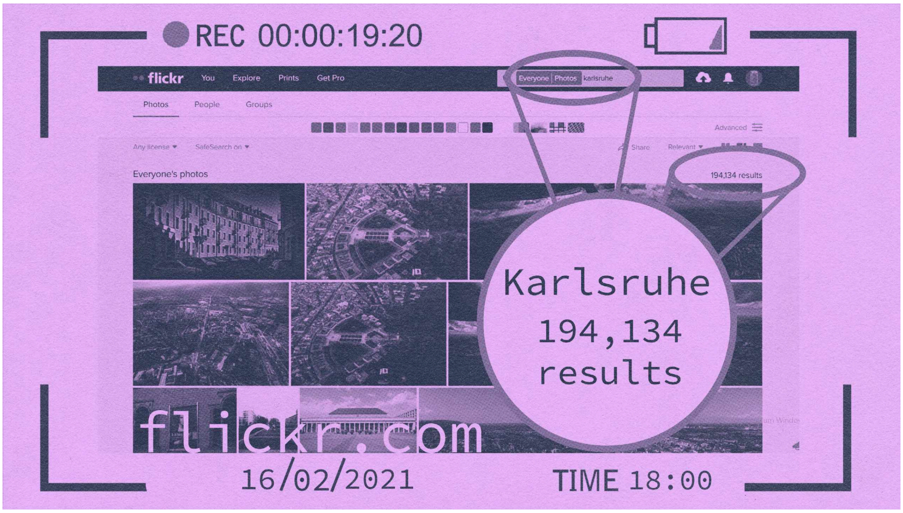
Green Ring + Bicycle Road

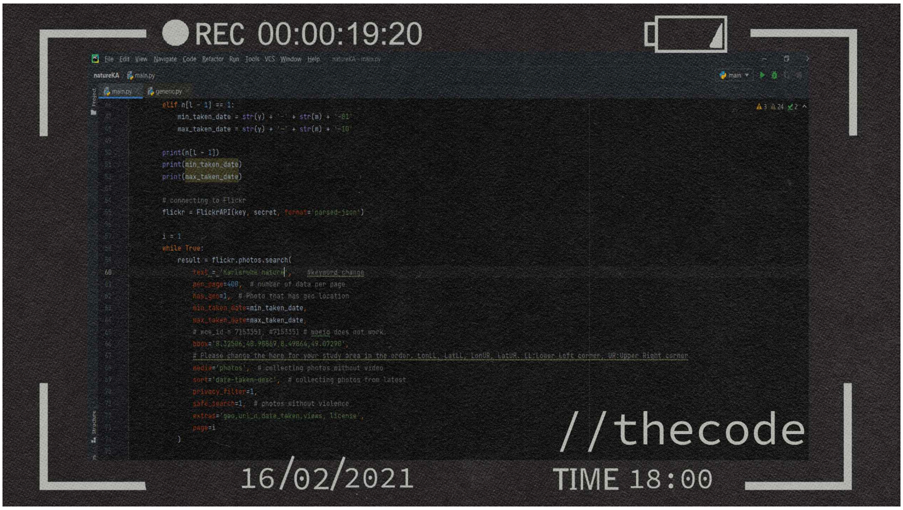


B.4 City perception

Karla Jukic

Seminar Data-Driven Urban Nature Lab 1.0 Karlsruhe
Winter Semester 20/21



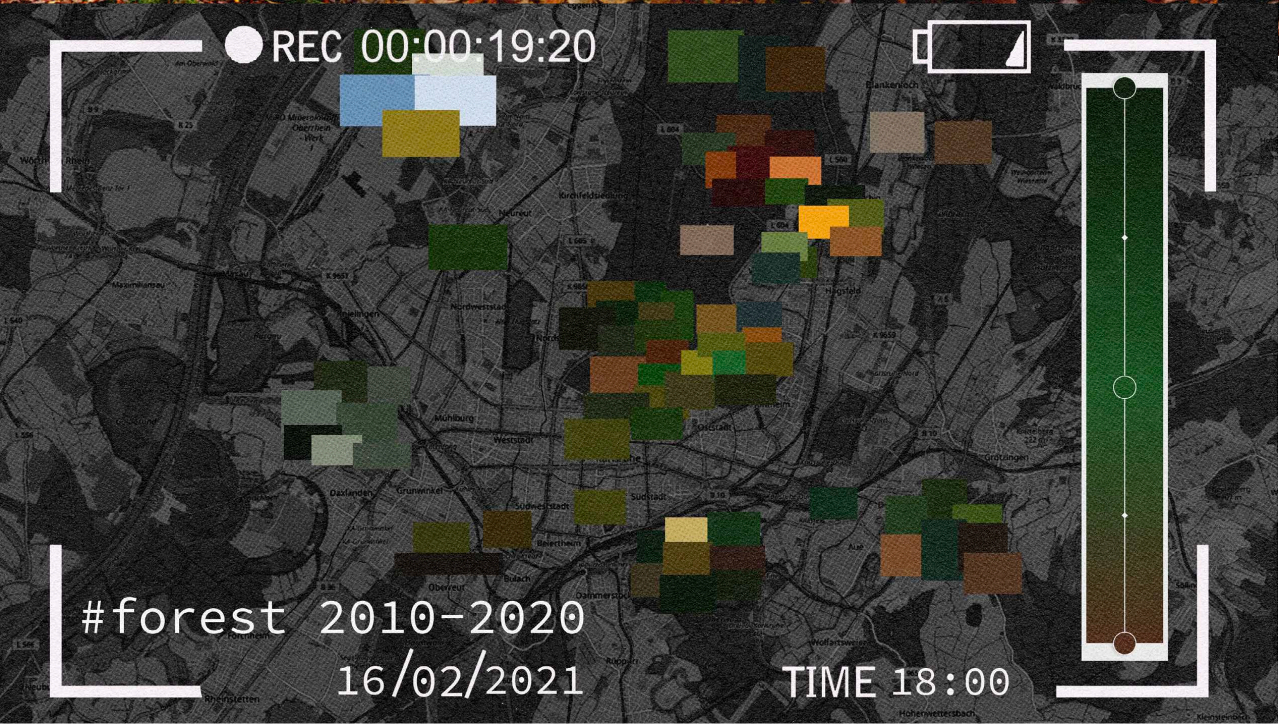



REC 00:00:19:20
#karlsruhenature 2020
16/02/2021
TIME 18:00
Nordweststadt
Nordstadt
Waldstadt
K 9658
Rintheim
Weststadt
Daxlanden
Grünwinkel
B 10
Bulach


REC 00:00:19:20
#karlsruhenature 2020
16/02/2021
TIME 18:00


REC 00:00:19:20
#karlsruhenature 2020
16/02/2021
TIME 18:00

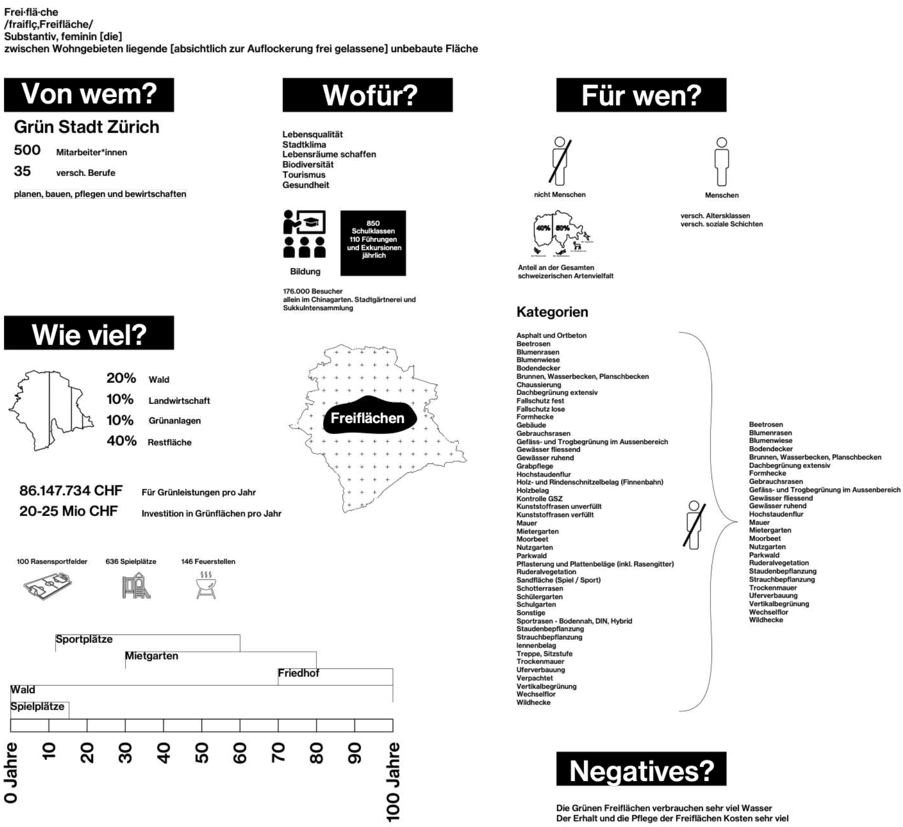

REC 00:00:19:20
#forest 2010-2020
16/02/2021
TIME 18:00

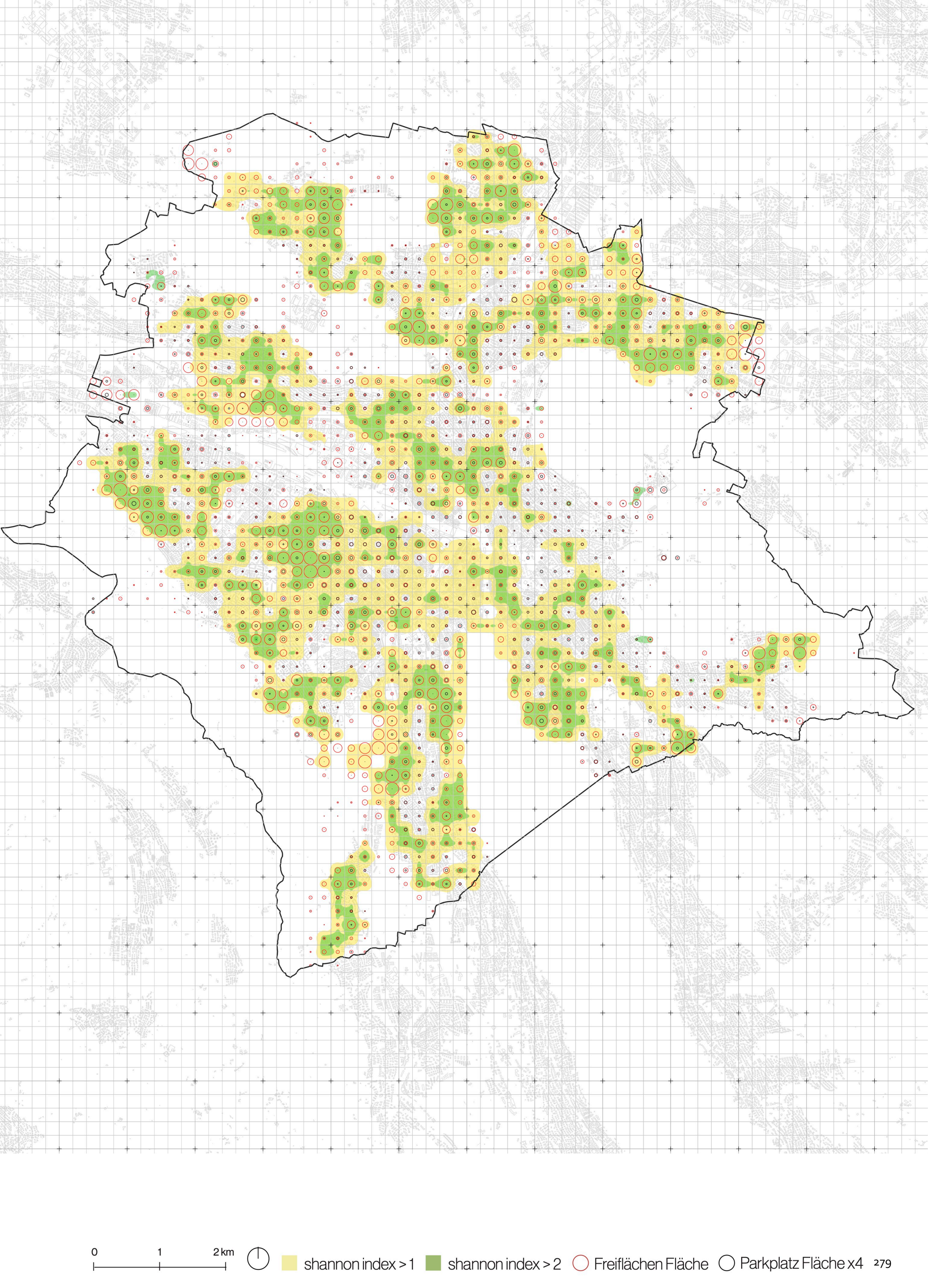

REC 00:00:19:20
#forest 2010-2020
16/02/2021
TIME 18:00

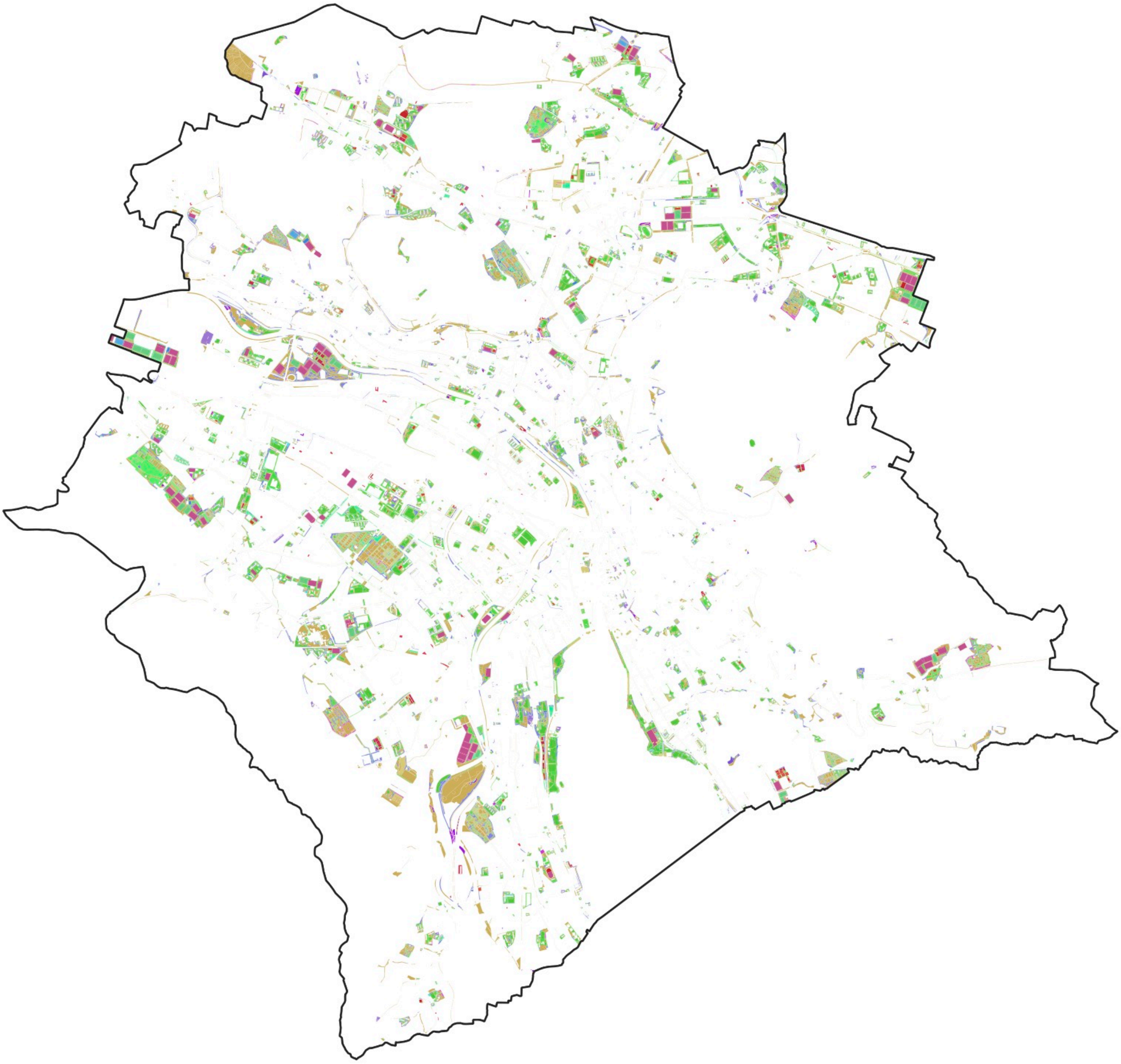
B.5 Diversity of the commons

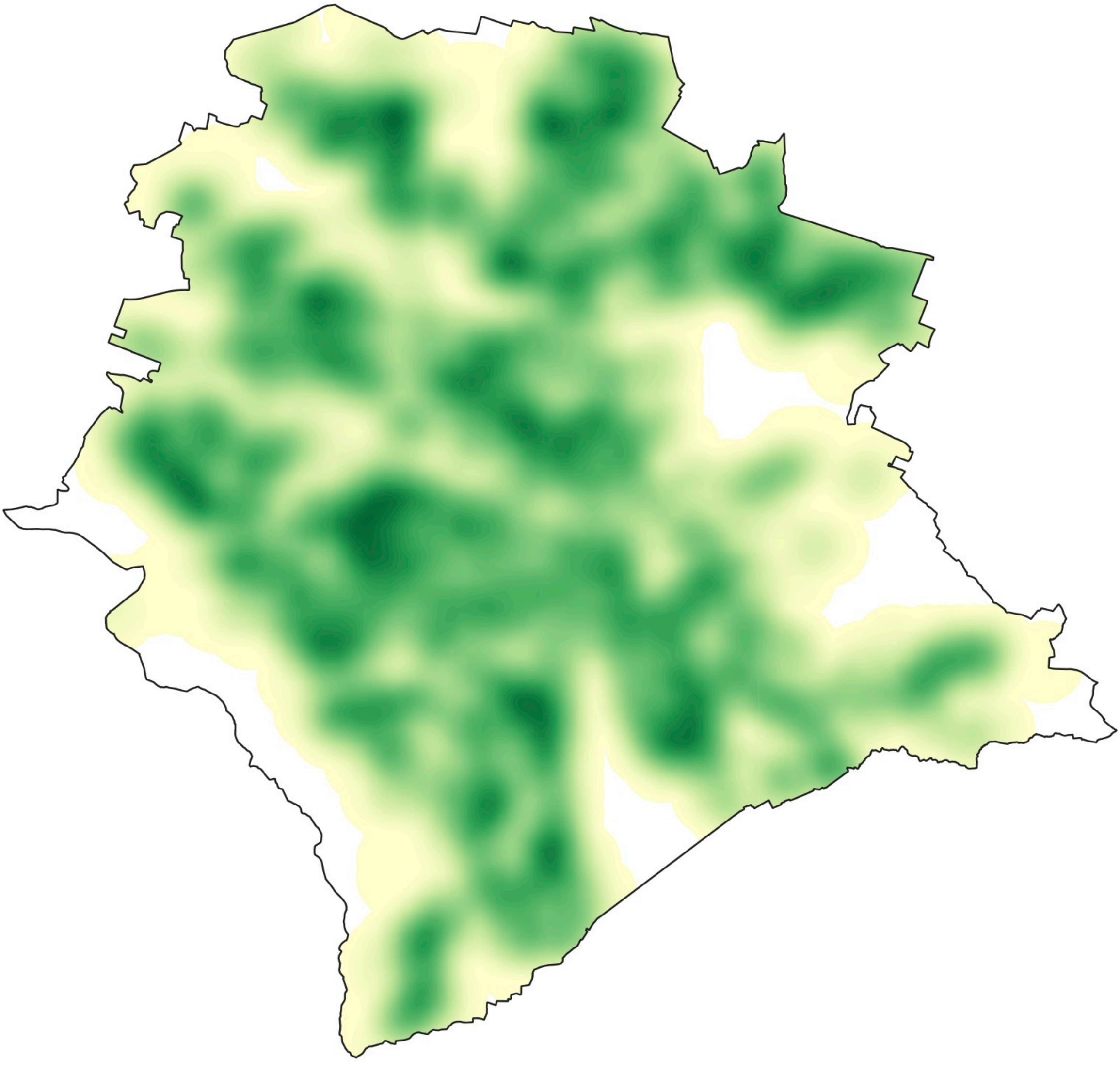
Alexander Albiez

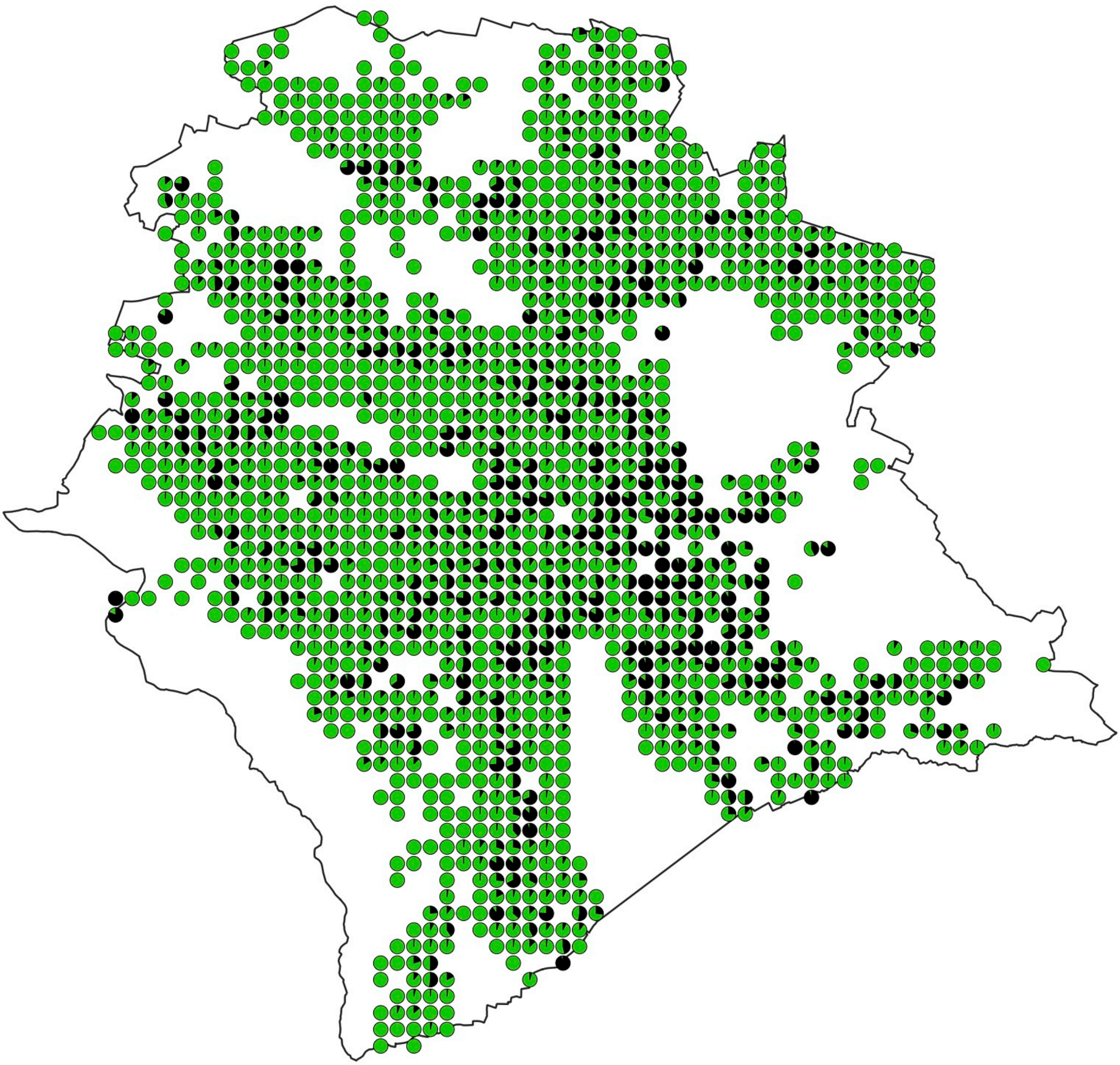
Seminar Data-Driven Urban Nature Lab 3.0 Zürich
Summer Semester 20/21




0
1
2 km
shannon index > 1
shannon index > 2
Freiflächen Fläche
Parkplatz Fläche x4



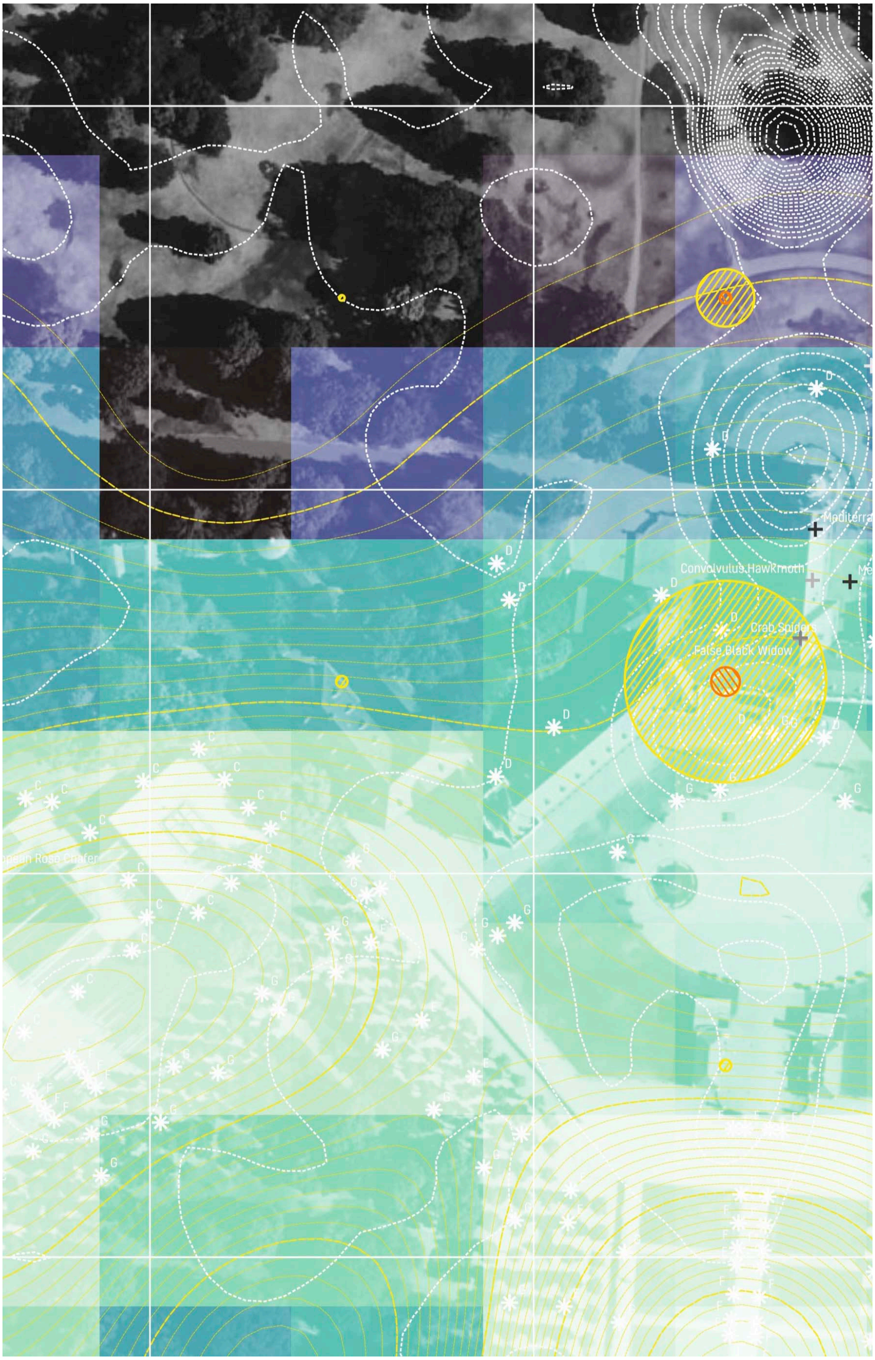


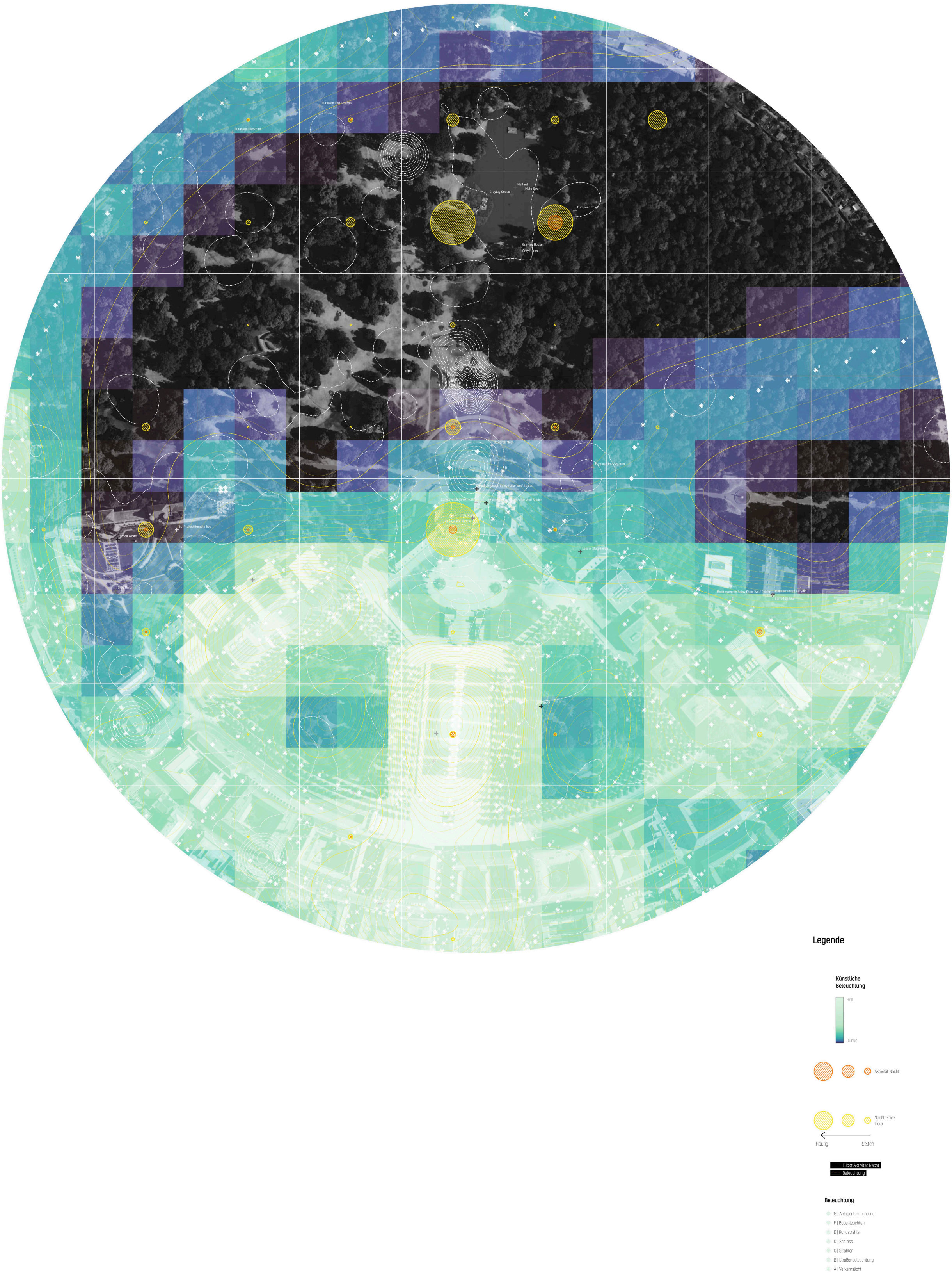


B.6 Ecosystems of light pollution in Zirkel

Sebastian Dremel, Elena Heilig

Stegreif Zirkel's ecological ocurrences
Winter Semester 23/24

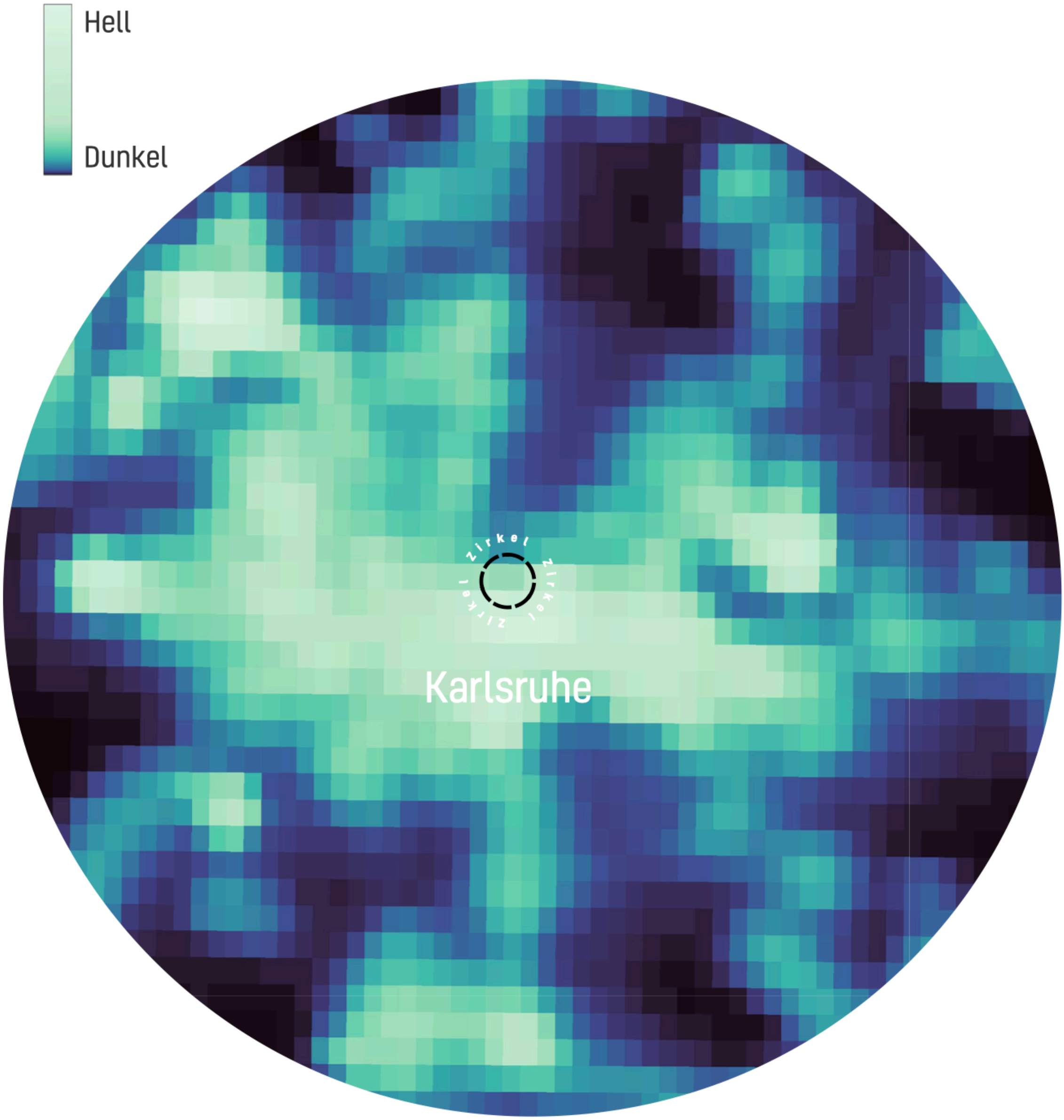




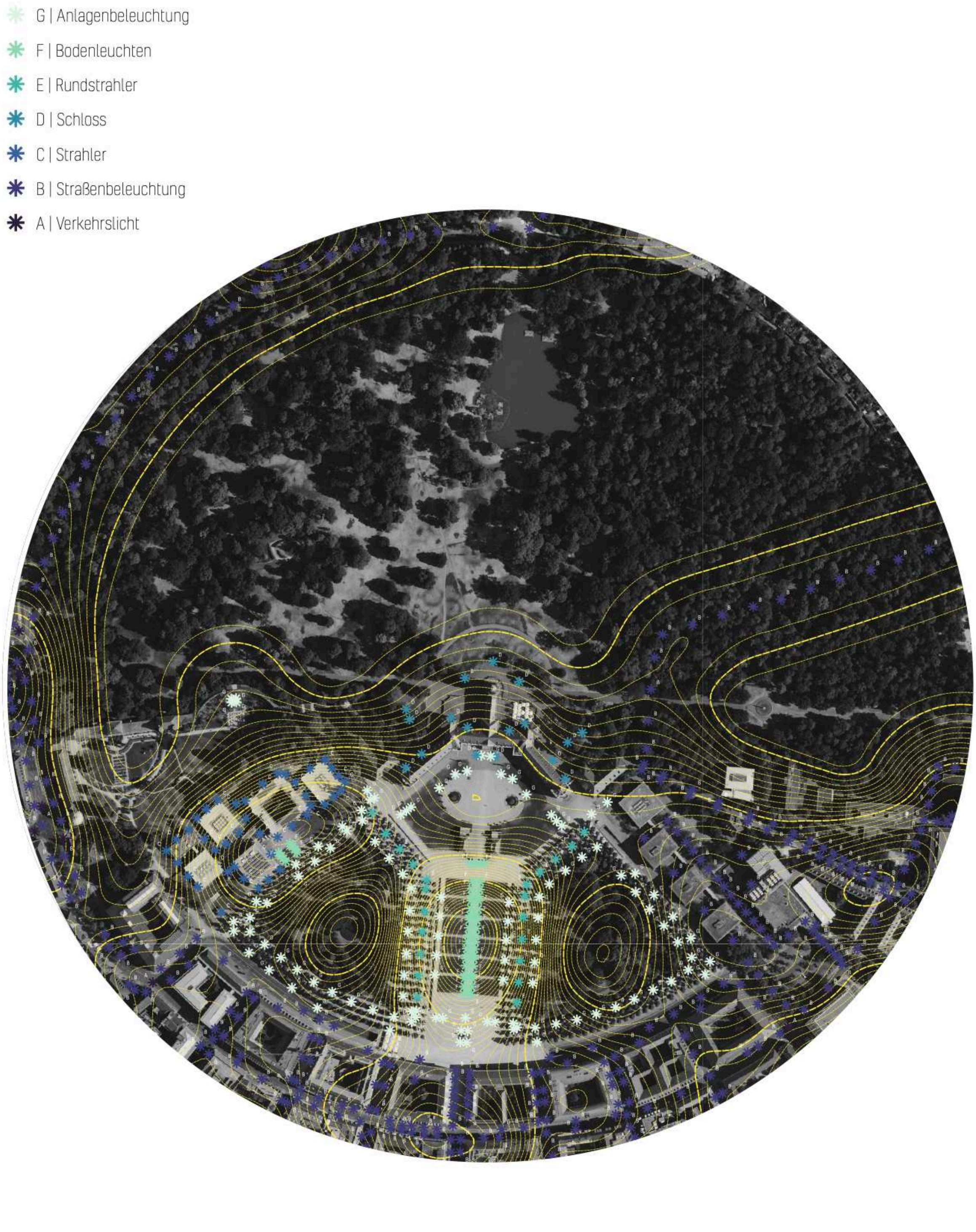
Legende
Künstliche Beleuchtung
Hell
Dunkel
Aktivität Nacht
Nachtaktive Tiere
Häufig
Selten
Flickr Aktivität Nacht
Beleuchtung
Beleuchtung
G | Anlagenbeleuchtung
F | Bodenleuchten
E | Rundstrahler
D | Schloss
C | Strahler
B | Straßenbeleuchtung
A | Verkehrslicht

Lichtverschmutzung
Raum Karlsruhe

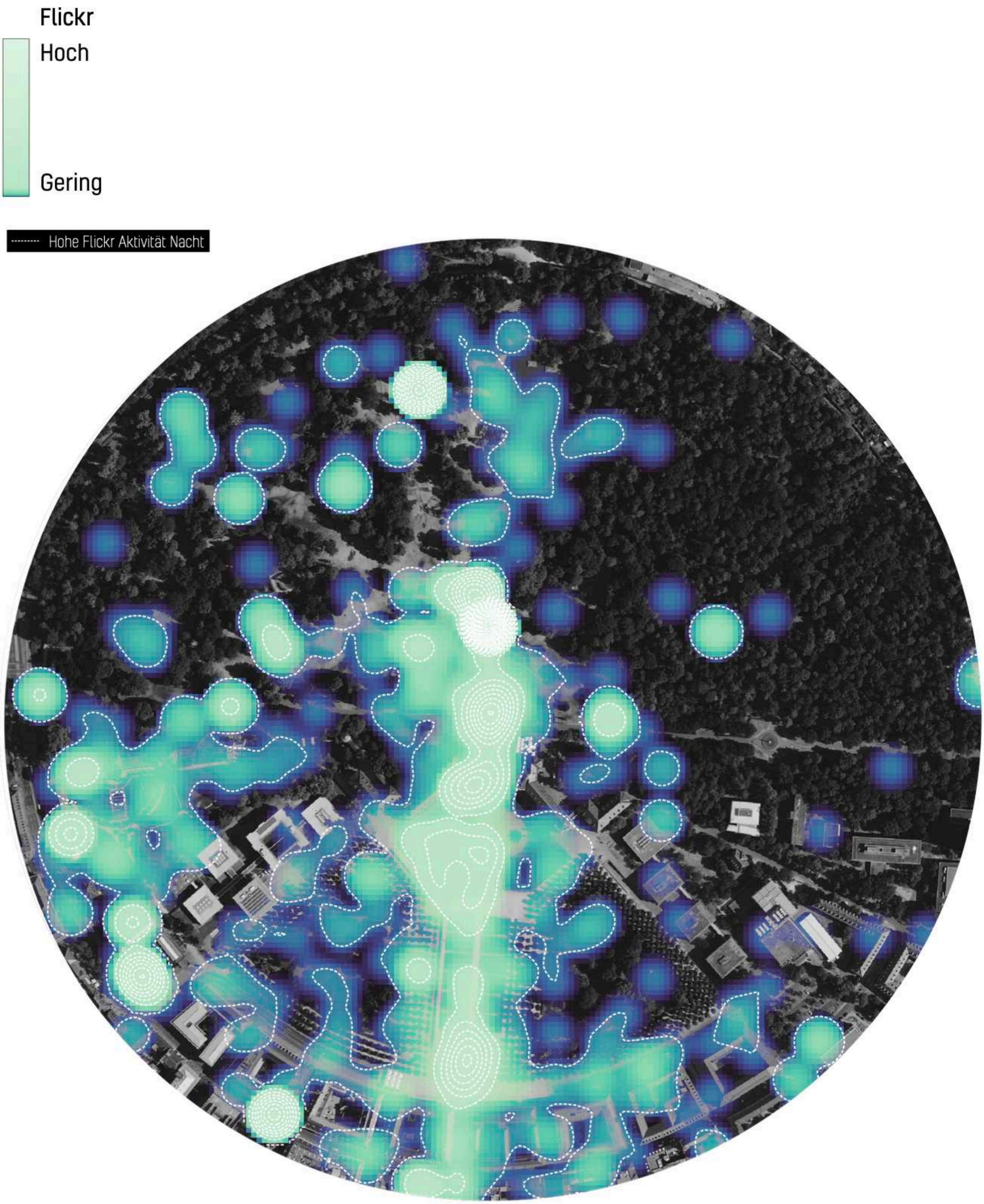
Zirkel



Beleuchtung



Aktivität Menschen



Gesichtete Tiere Nacht

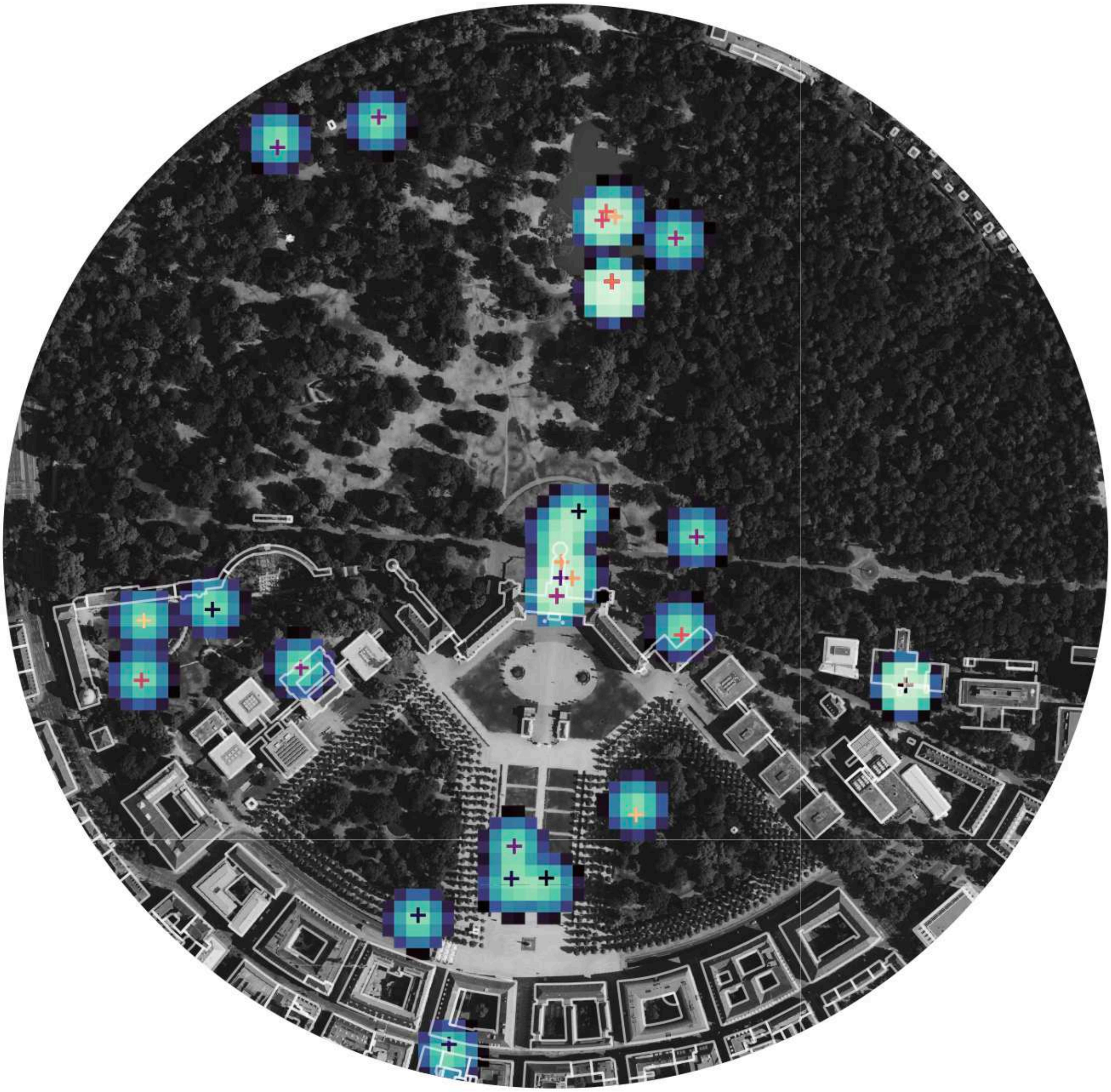
iNaturalist

Hoch

Gering

Art

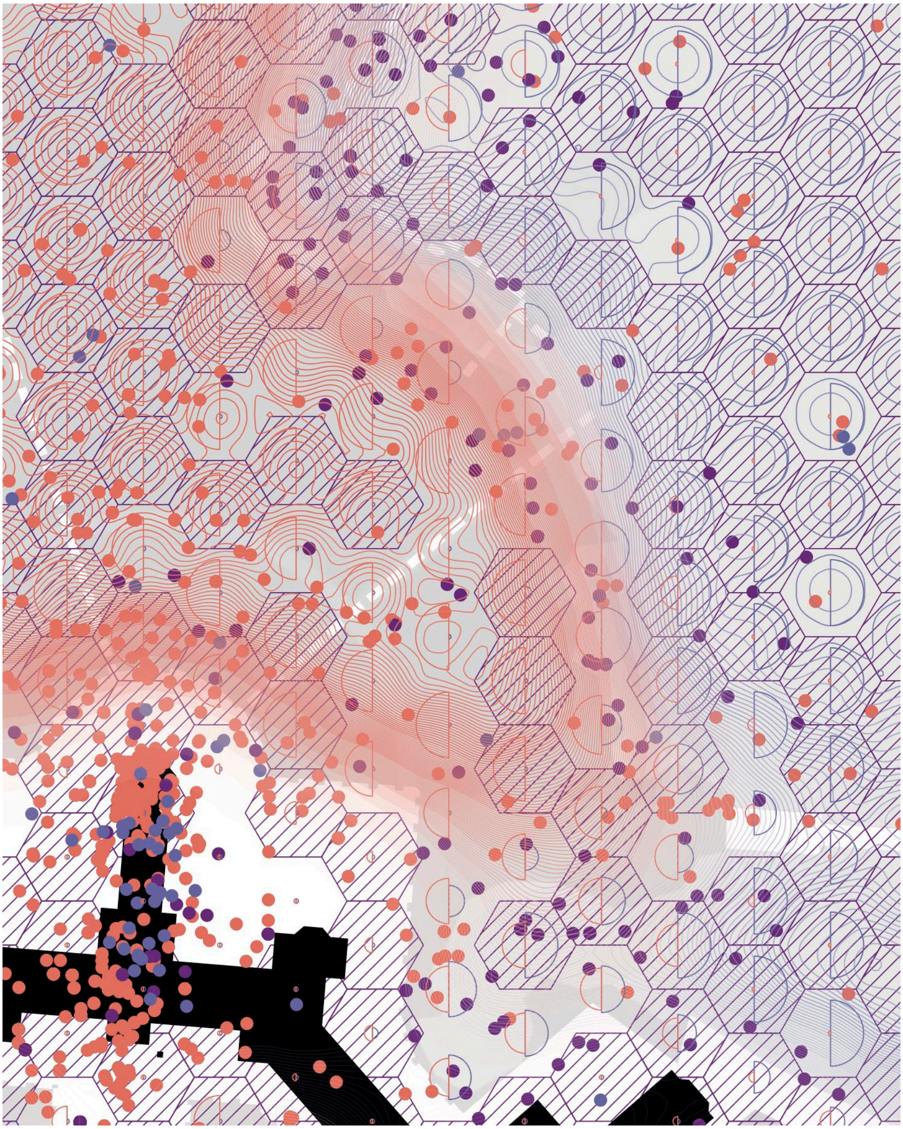
- Barred Sallow
- Black Redstart
- Box Tree Moth
- Buff-tailed Bumble Bee
- Carrion Crow
- Cobweb Spiders
- Common Moorhen
- Common Spitting Spider
- Convolvulus Hawkmoth
- Crab Spiders
- Eurasian Blackbird
- Eurasian Red Squirrel
- European Rose Chafer
- European Toad
- False Black Widow
- Feral Pigeon
- Great Tit
- Grey Heron
- Greylag Goose
- Lesser Stag Beetle
- Mallard
- Mandarin Duck
- Meal moth
- Mediterranean Katydid
- Mediterranean Spiny False Wolf Spider
- Mute Swan
- Rook
- Small White
- Southern Green Stink Bug



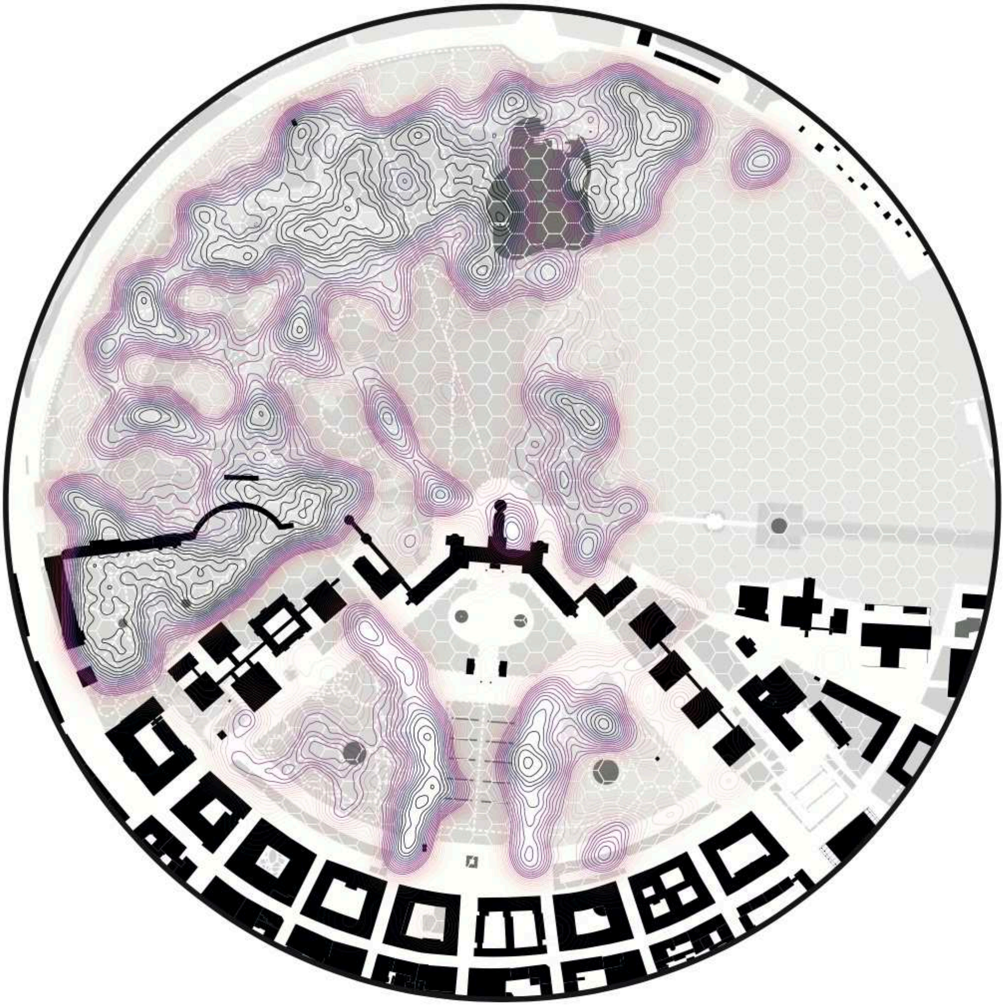
B.7 Auf der Suche nach Raum

Nicolas Astudillo, Klára Vašáková

Stegreif Zirkel's ecological ocurrences
Winter Semester 23/24



Wo findet Kohabitation schon statt?



Sind Mensch und Natur im Hexagon ausreichend vertreten oder fehlt etwas?

	Vielfältigkeit ↓
< 1,5	
1,7433	
2,0919	
2,4406	
2,7892	
3,1379	

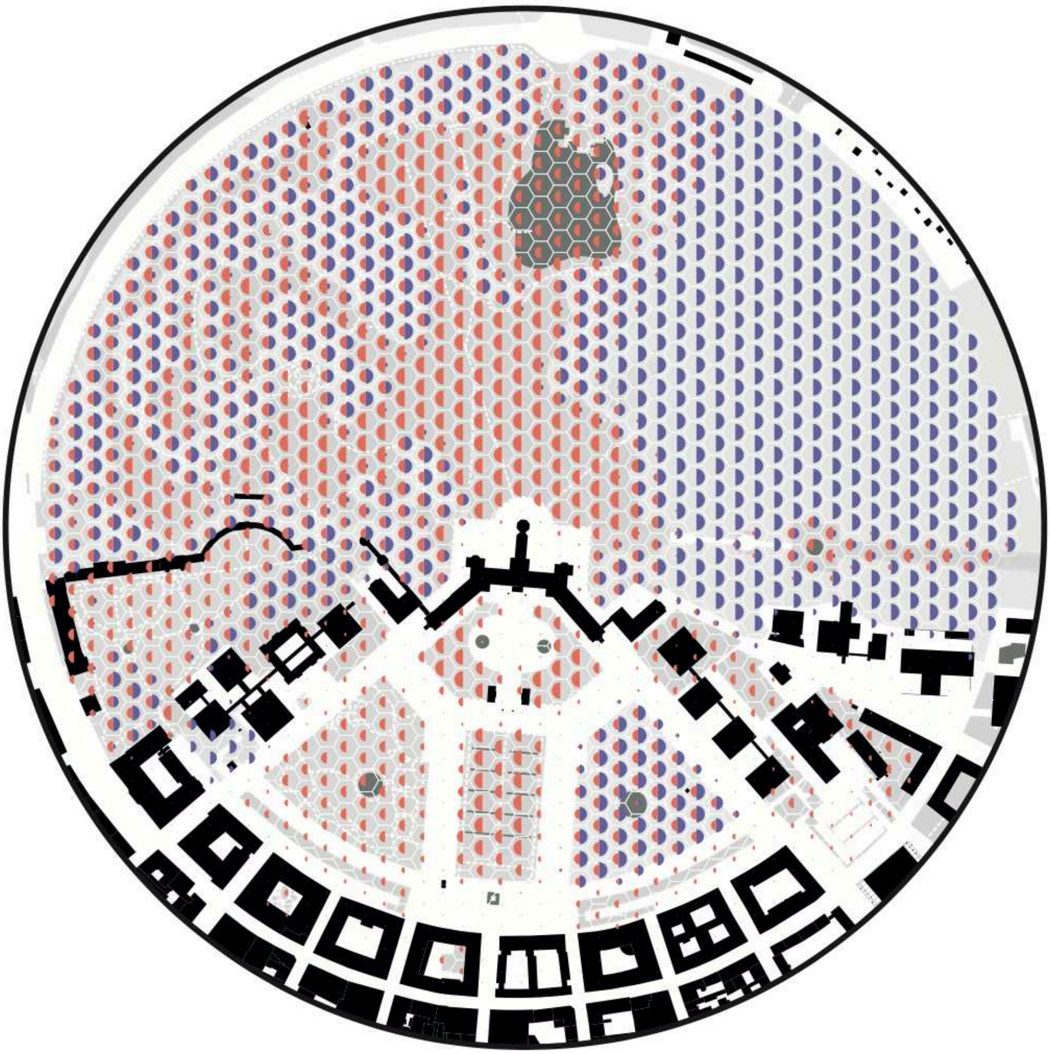
Shannon – Wiener Vielfältigkeit Index:

$$H = -\sum_{i=1}^{S} p_i \ln p_i$$

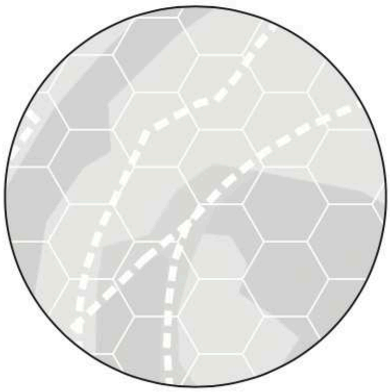
normale Wert:

1,5 – 4,5

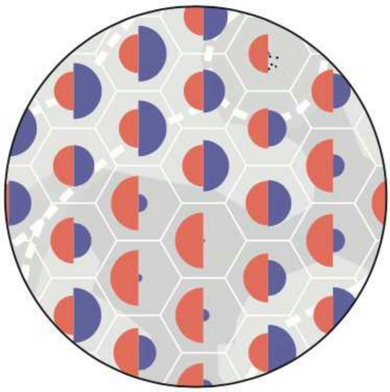
Verurteilung der Nutzung des Raums pro Hexagon.



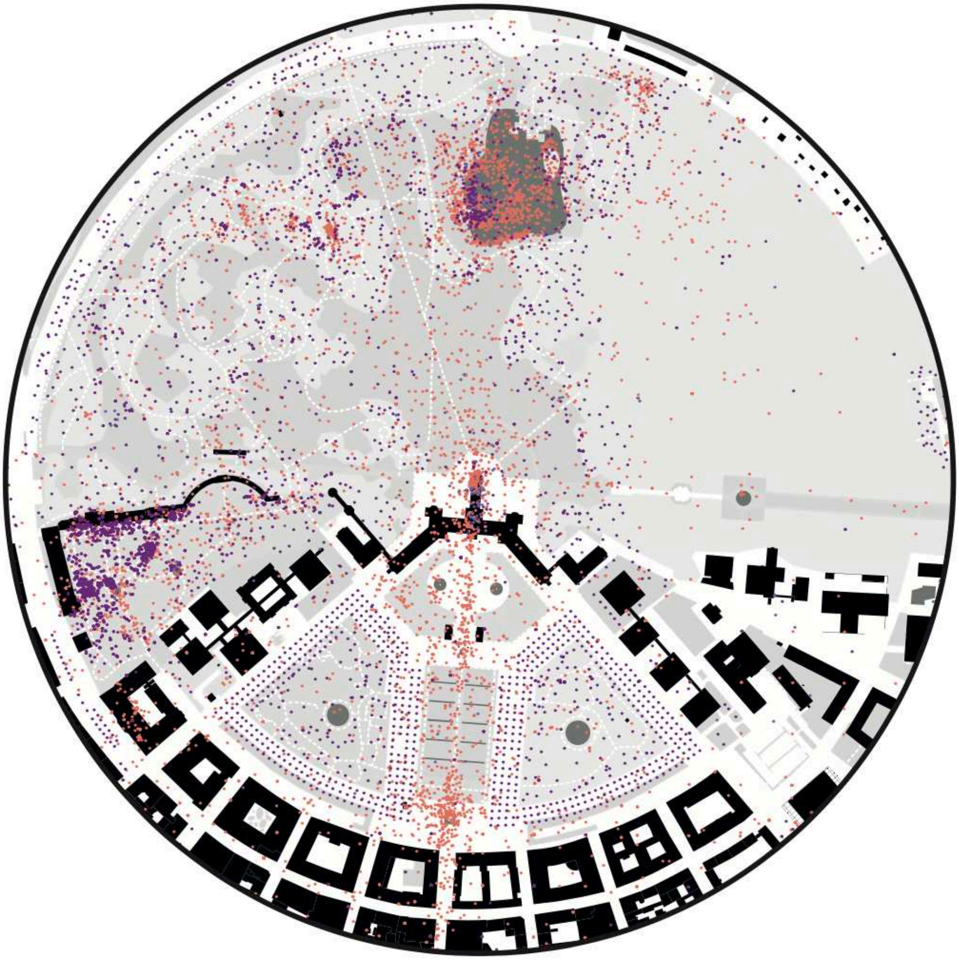
1.Grid erstellt



NATUR X MENSCH



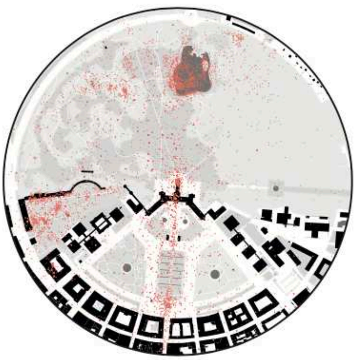
Benutzer des Raums

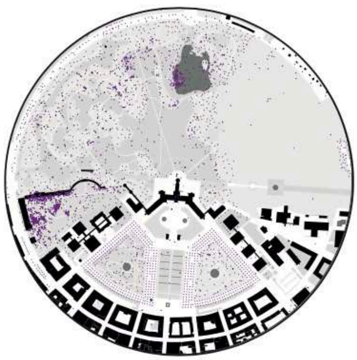


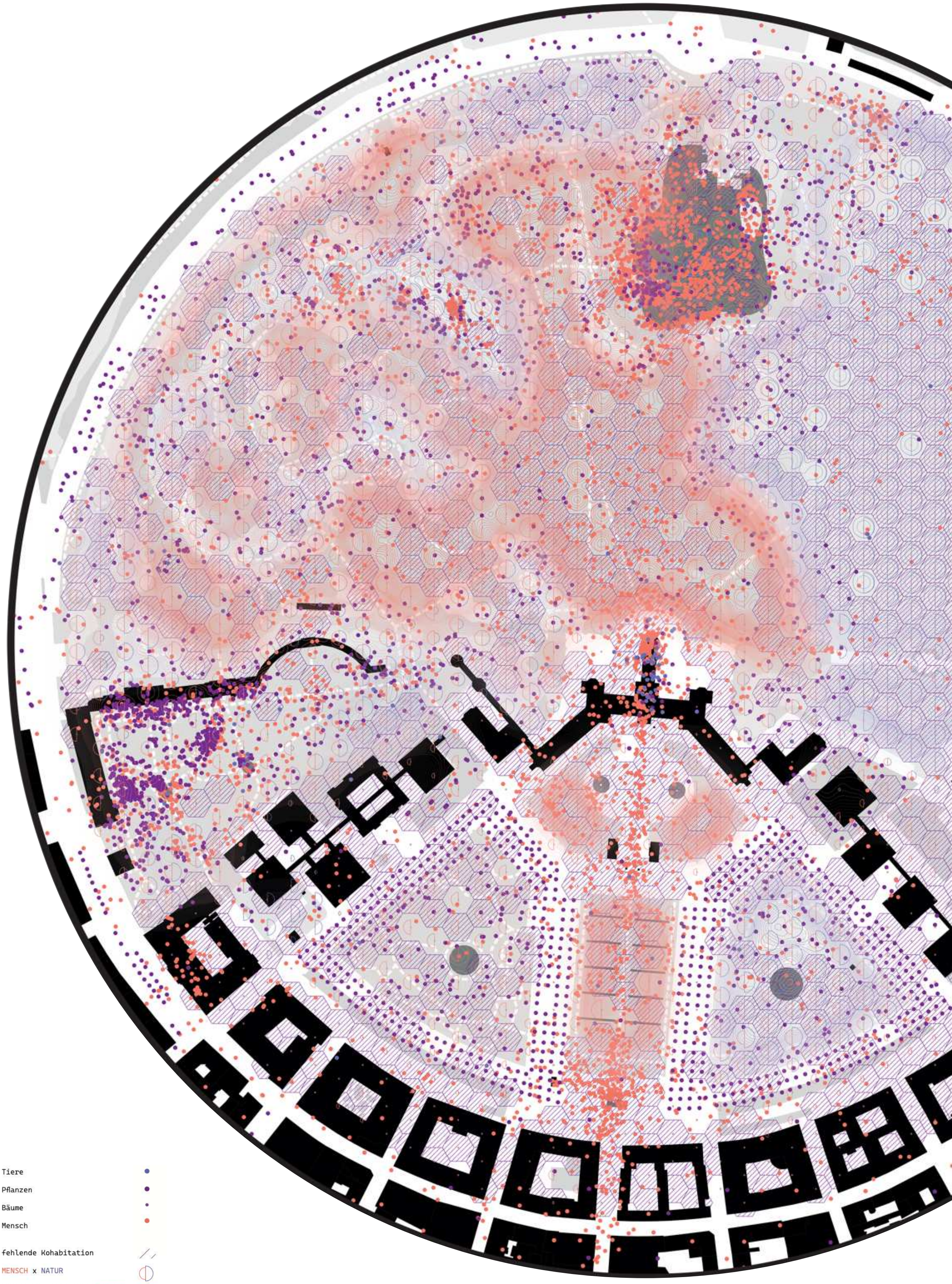
Menschen

Bäume + Pflanzen

Tiere + Insekten





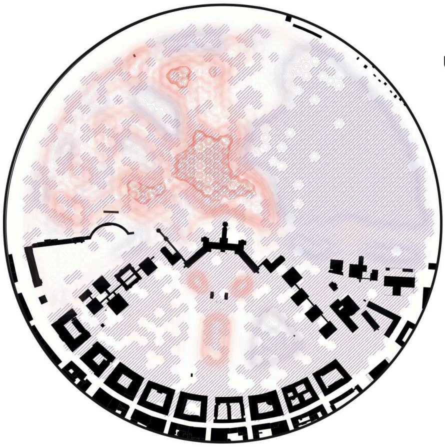


Tiere
Pflanzen
Bäume
Mensch

fehlende Kohabitation
MENSCH x NATUR
Anzahl der Besucher - Mensch
Anzahl der Besucher - Natur

Annex B

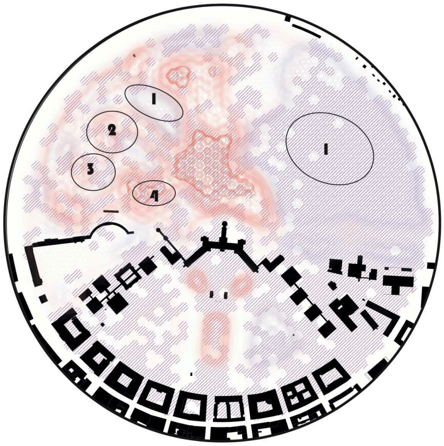
AUSWERTUNG 2:



WAS fehlt um bessere Kohabitation zu erreichen?

NATUR X MENSCH

AUSWERTUNG 3:

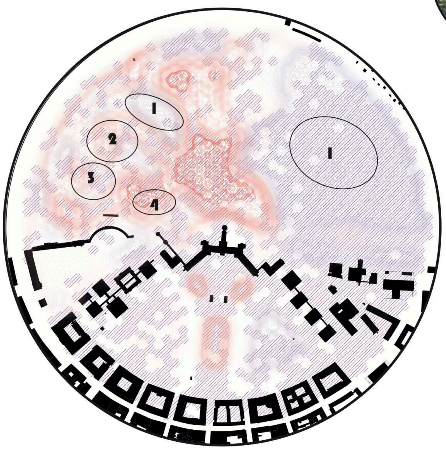


Teilweise unzureichende Daten.

Muss die Symbiose überall des Parks sein?

POTENTIELLER RAUM

mögliche SZENARIOS



1

Steg durch
Natur

2

Meditationsecke

3

Programmierte
Fläche für
Menschen

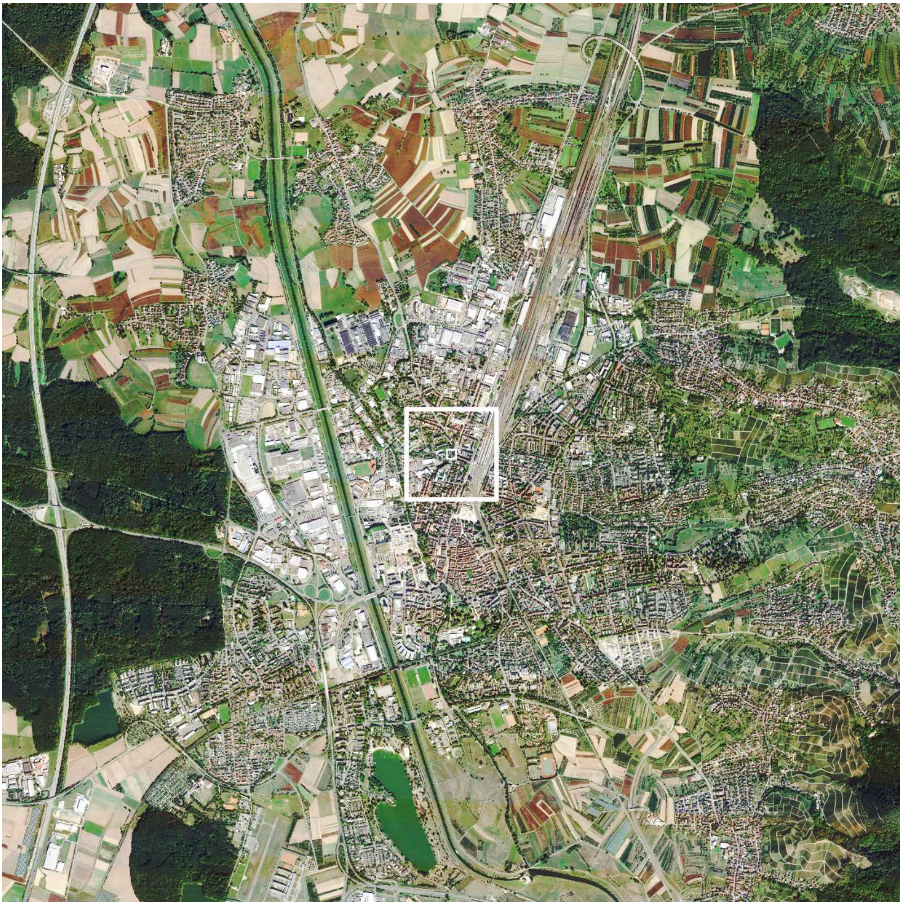
Wildgarten

4

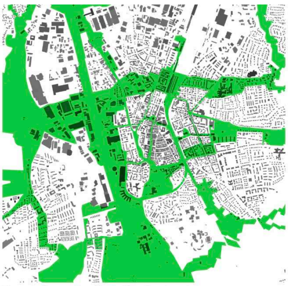
B.8 ECOnnect

Oliver Leitzbach, Elisa Muhr

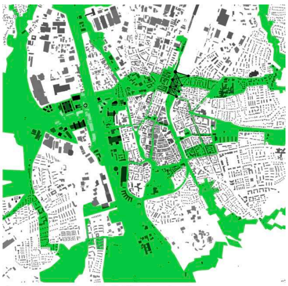
Masterstudio Urban Gaia
Winter Semester 23/24



Bestehende Parkplätze



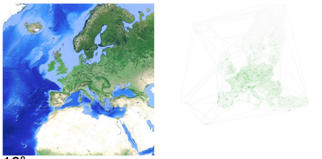
Bestehende Gebäudestruktur



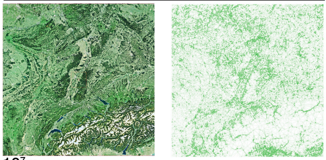
Angepasste Gebäudestruktur

URBAN GAIA

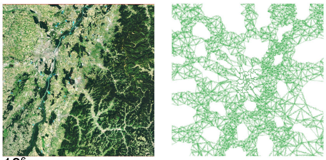
Landesresilienzschau Offenburg 2050



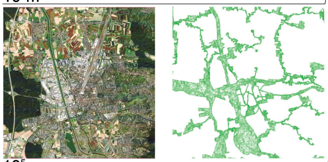
10^8m



10^7m



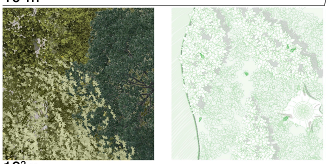
10^6m



10^5m

10^4m

10^3m



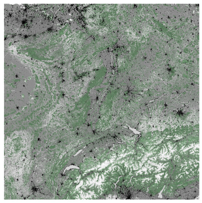
10^2m

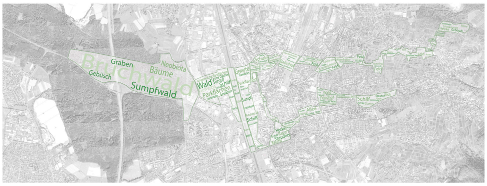
10^1m

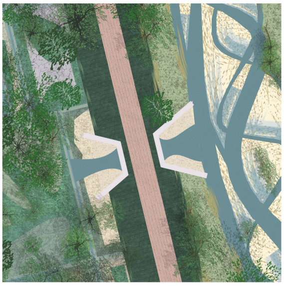
10^0m

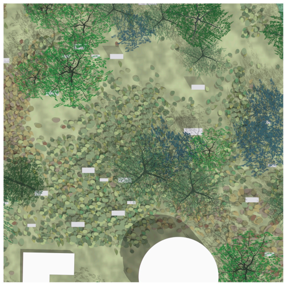
Betrachtet man den europäischen Raum, erkennt man, dass bereits hier ein Netz der Biotope besteht. Dieses Netz wurde durch Eingriffe der Menschen unterbrochen.

Die Ländergrenze zwischen Frankreich, Schweiz und Deutschland ist im Luftbild kaum erkennbar. Die einzige Trennung stellt der Rhein dar. Die Region ist bekannt für ihre sanften Hügel, grünen Wälder und malerischen Flüsse. Vor allem die Vogesen, der Schwarzwald und die Alpen prägen die Grenze.
Die Landschaft wurde jedoch im Laufe der Jahre stark durch menschliche Aktivitäten beeinflusst. Die Landwirtschaft hat eine wichtige Rolle bei der Gestaltung des Landes gespielt, wobei die Bauern große Waldflächen rodeten, um Felder und Weiden anzulegen. Infolgedessen wurde ein Großteil der natürlichen Vegetation durch Kulturpflanzen und Weideland ersetzt.









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Institut Entwerfen von Stadt und Landschaft - IESL
Professur Landschaftsarchitektur - LA
Prof. Henri Bava
Arturo Romero Carnicero

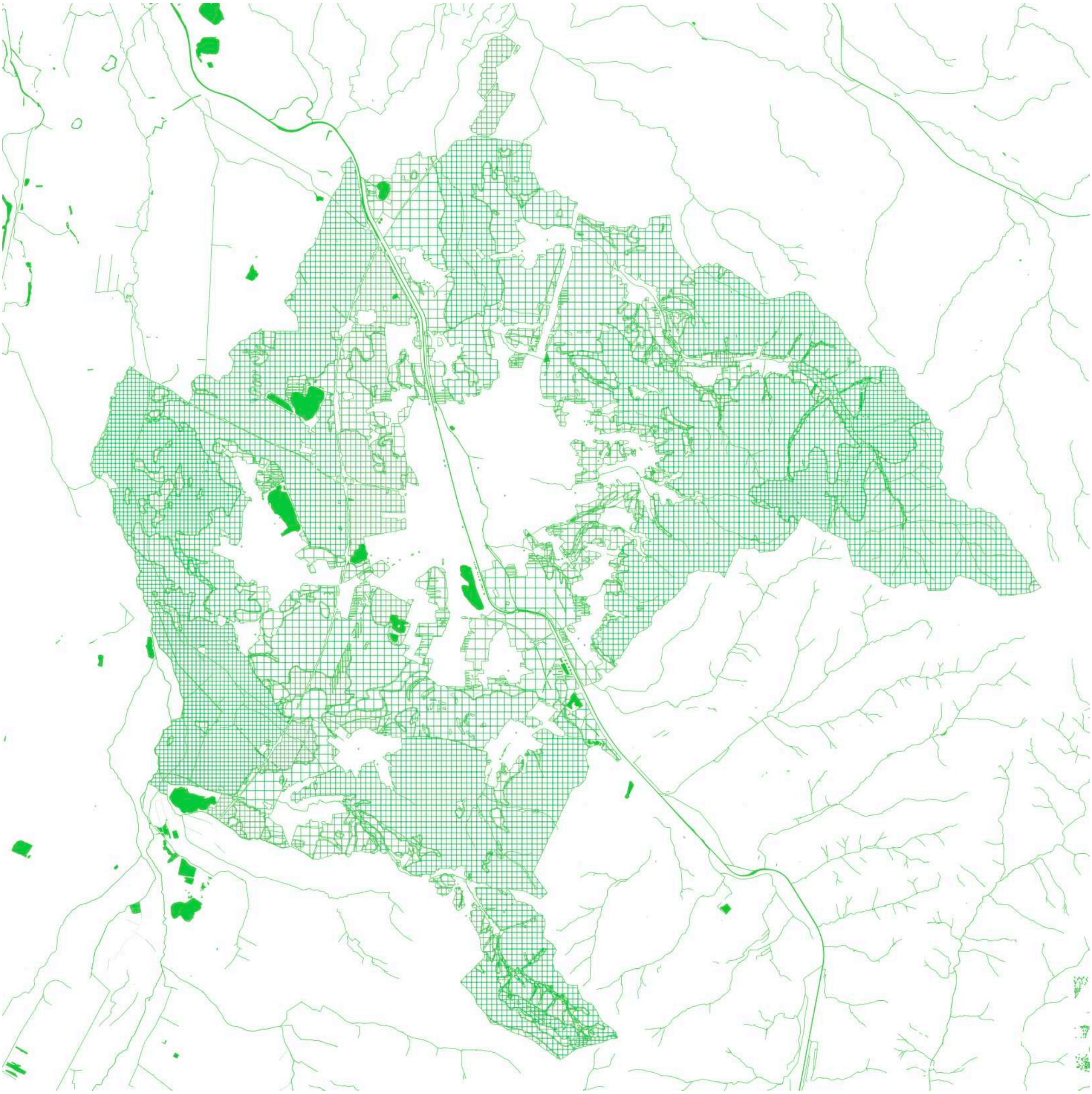
ECOnnect
Oliver Leitzbach, Elisa Muhr

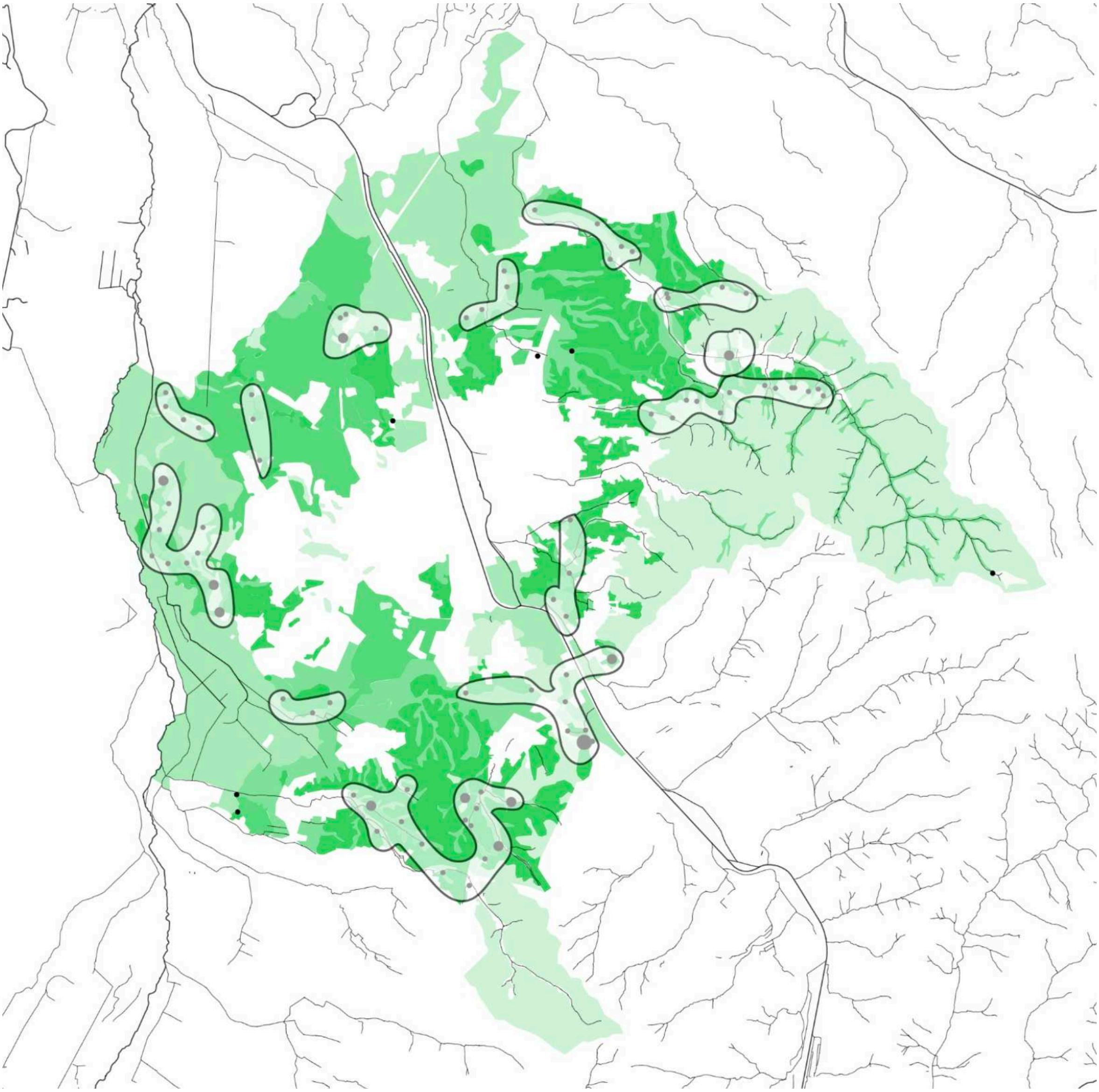
Zusammenfassung

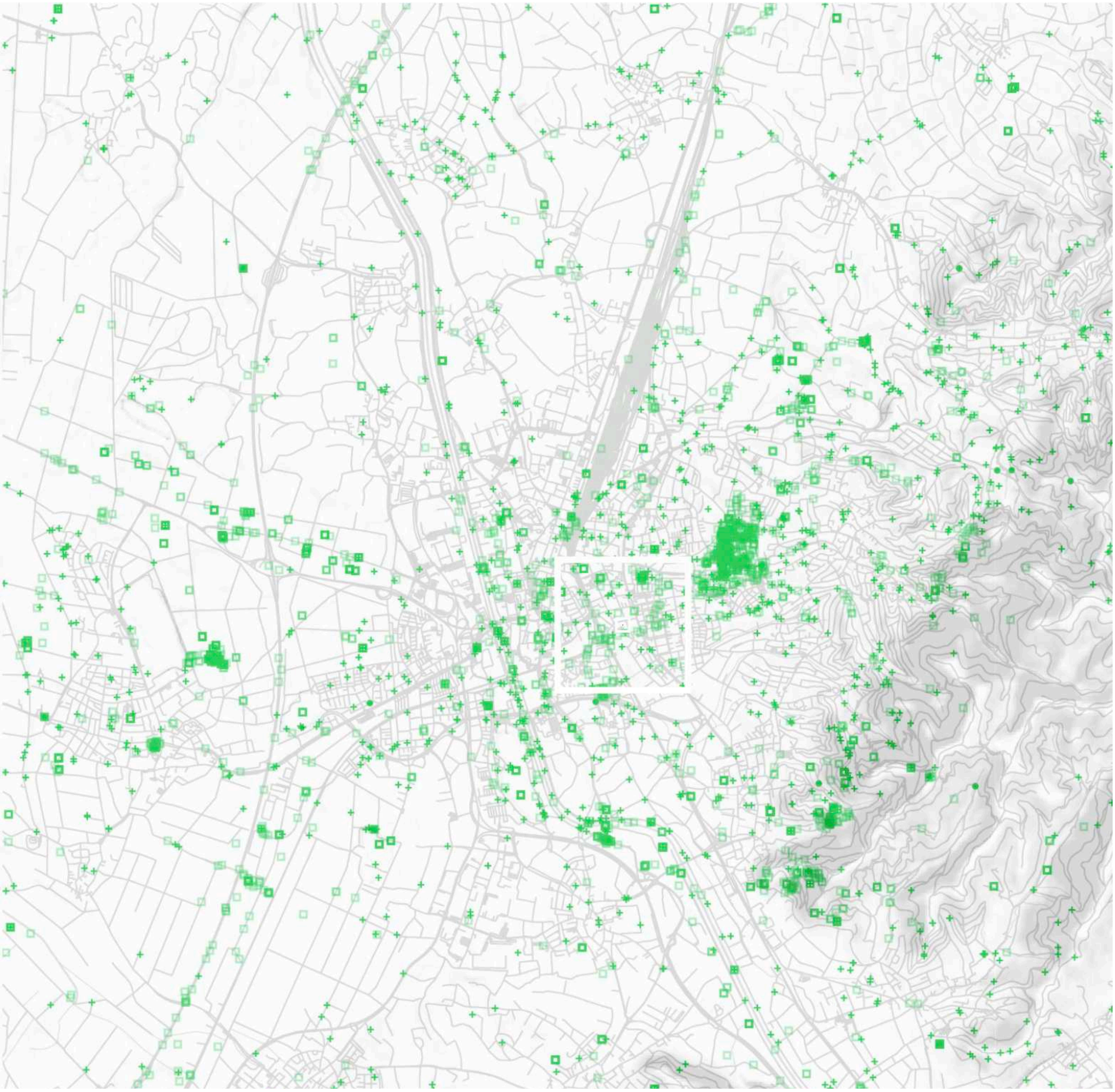
Master Entwurf WS 2022/23

URBAN GAIA
Landesresilienzschau Offenburg 2050

In Kooperation mit
Stadt Offenburg. Abteilung Grünflächen und Umweltschutz





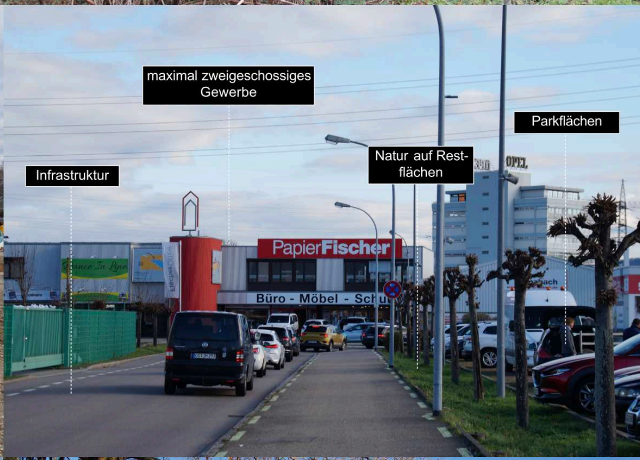


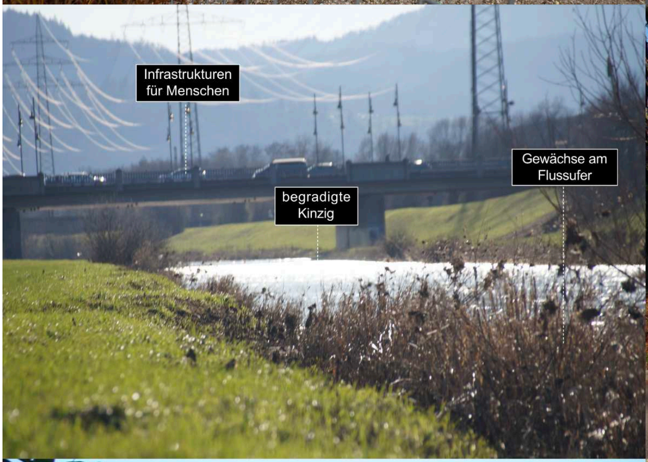

0
1
2 km

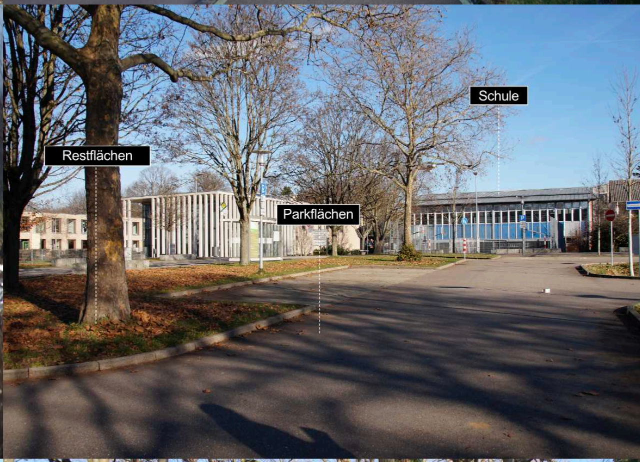

Potentialflächen für Sumpf
Bruchwald


Neophyten
Wohnen im Wald
Straße


Produktion
riesige Umbau-maßnahmen
direkt angrenzend an Wald


maximal zweigeschossiges Gewerbe
Parkflächen
Natur auf Rest-flächen
Infrastruktur
PapierFischer


Infrastrukturen für Menschen
Gewächse am Flussufer
begradigte Kinzig


Schule
Restflächen
Parkflächen


Hecken als Trennung der Privatgärten
kleine Verbindungs-wege
Gartenstadt


Kleingärten
Weinberge
beliebter Erholungsort
Hohlweg

URBAN GAIA

Landesresilienzschau Offenburg 2050

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ENTWURFSTITEL
Oliver Leitzbach, Elisa Muhr

Strategie

Master Entwurf WS 2022/23

URBAN GAIA
Landesresilienzschau Offenburg 2050

In Kooperation mit
Stadt Offenburg. Abteilung Grünflächen und Umweltschutz

B.9 The great escape

Patrik Eissele, Anna Klotzki

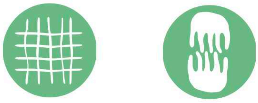
Masterstudio Street resilient ecologies
Winter Semester 22/23

#01 Resilientes Netzwerk Karlsruhe stärken und ausbauen

Biodiversität stärken

Straßen aufgrund ihrer Resilienz bewerten

Stresspunkte werden durch grüne Hotspots ersetzt



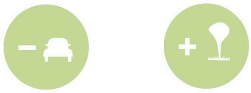
#03 GRÜNE DEZENTRALE BEGEGNUNGEN

Kriegstraße ist keine unüberwindbare Grenze mehr, sondern ein Ort des Austausches

Stufenweise Rückbau der Präsenz des Autoverkehrs

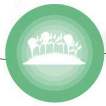
GRÜNE HOTSPOTS ausbilden

= markanter identifizierungspunkt mit intensiver Resilienz an ehemaligen Stresshotspots



Flächen entsiegeln

Regenwasser kann versickern und so Pflanzen davon profitieren



Resiliente Oasen

Hohe Pflanzen Intensität sorgt für starke Verschattung und Kühlungseffekt

Wasserauffangbecken

Überflutungszonen bei Starkregenereignissen

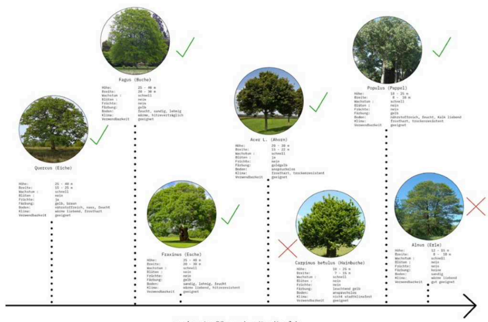
Wasser als kühlendes Element

Dachgärten

Flachdächer an Kriegstraße identifiezieren und begrünen

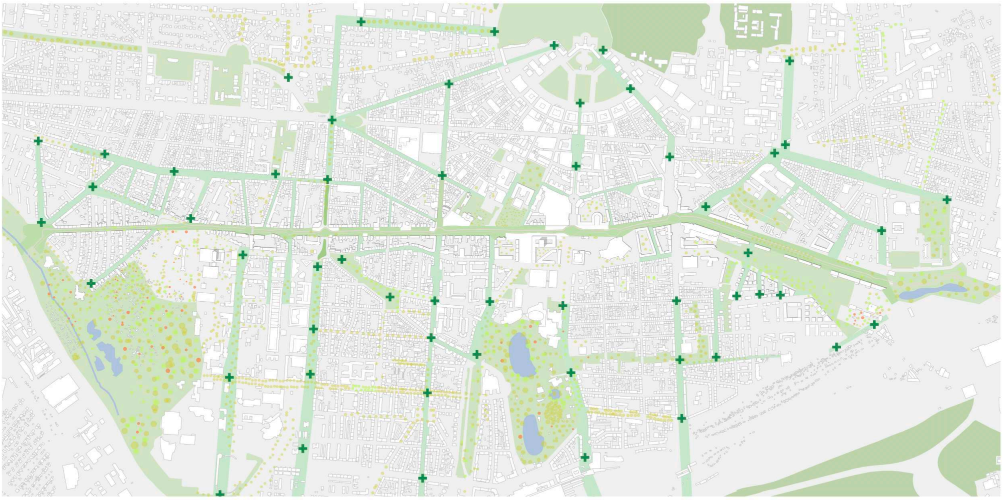
#02 RESILIENTE LÜCKEN FÜLLEN

Winterlinde, Kirschbäume, Spitzahorn, Hängebirke Waldföhre, Feldahorn, Traubeneiche, Hagebuche

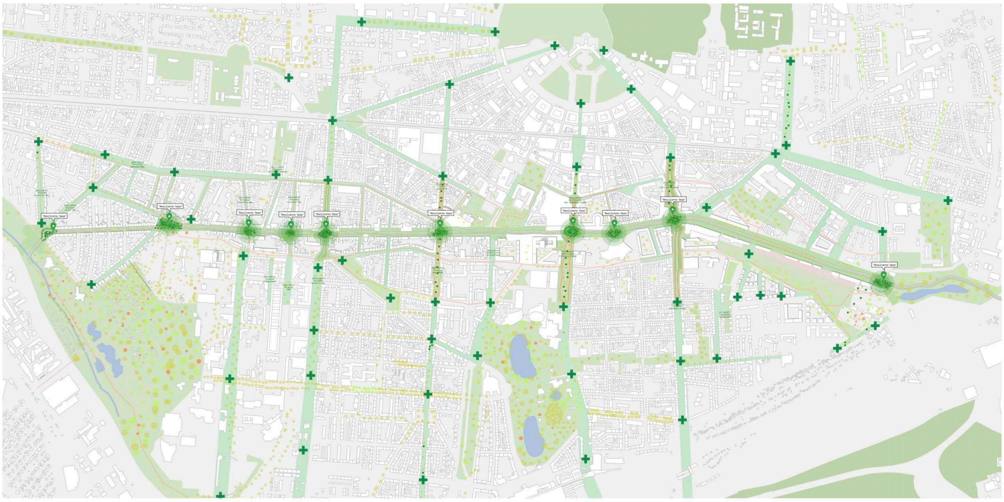


geeignete Bäume des Hardtwalds

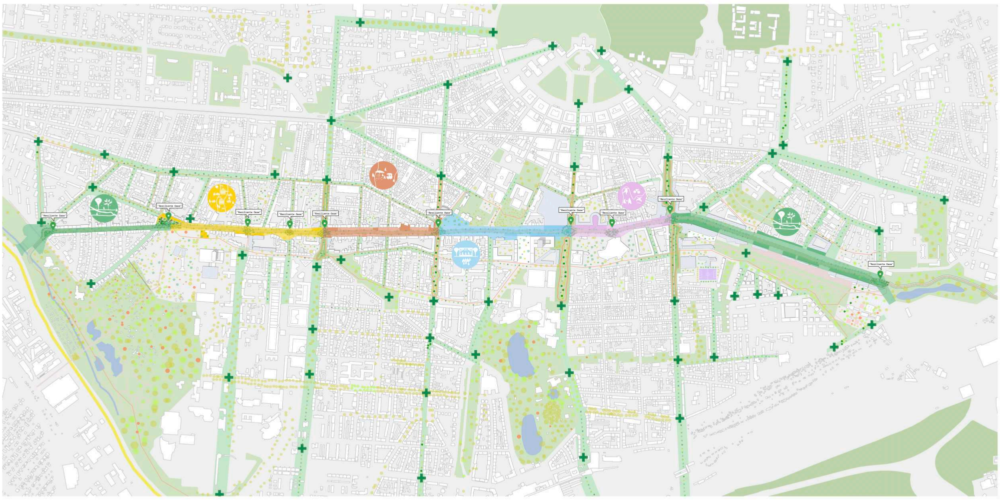
MASTERPLAN // RESILIENTE PFLASTER

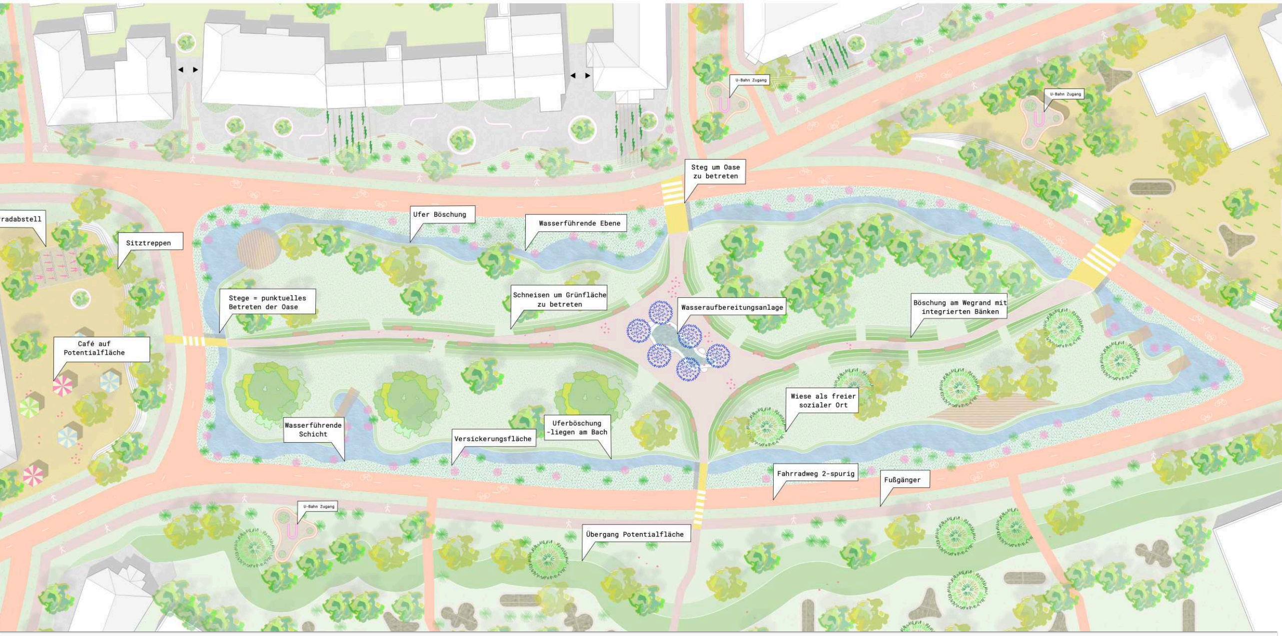


MASTERPLAN // RESILIENTE OASEN

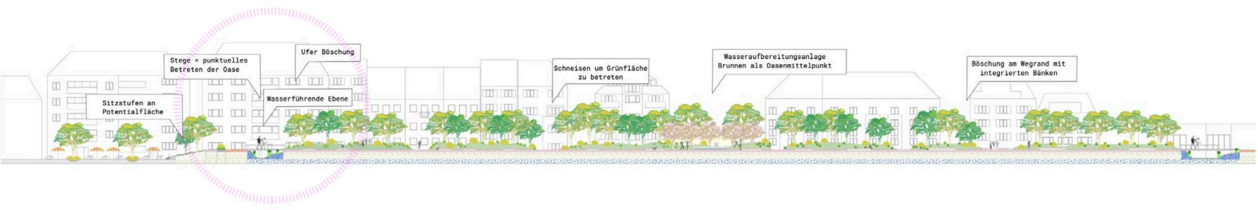


MASTERPLAN // POCKET PARKS





VERTIEFUNGSGEBIETE // WEINBRENNER OASE SCHNITT



B.10 Soil: rethink, reconnect, regrow

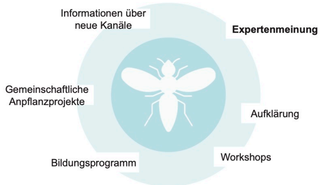
Isabela Cardona, Sophie Weiss

Masterstudio Urbane Hydrotopos
Summer Semester 24

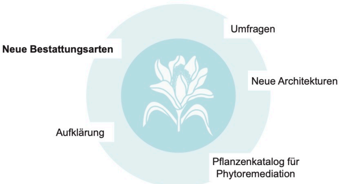
Transformationsprozesse

Im Karlsruher Auenwald

Alte Eisenbahnbrücke, 2024



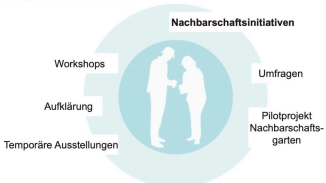
Friedhof Daxlanden, 2024



Landschaftszug mit Phytoremediation

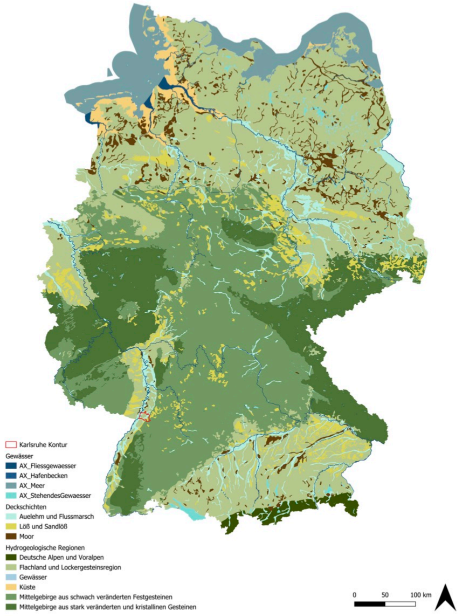
Treffpunkte an der Alb

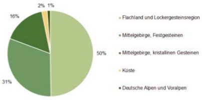
Zwischen Wohngebiet und Albufer, 2024



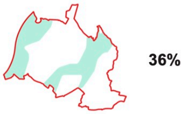
SOIL:
RETHINK
RECONNECT
REGROW

Isabela Cardona & Sophie Weiss





Anteile der hydrogeologischen Regionen in Deutschland

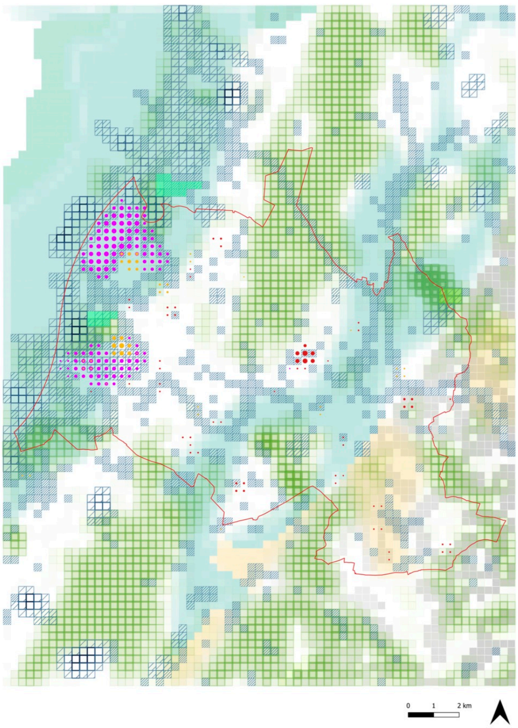


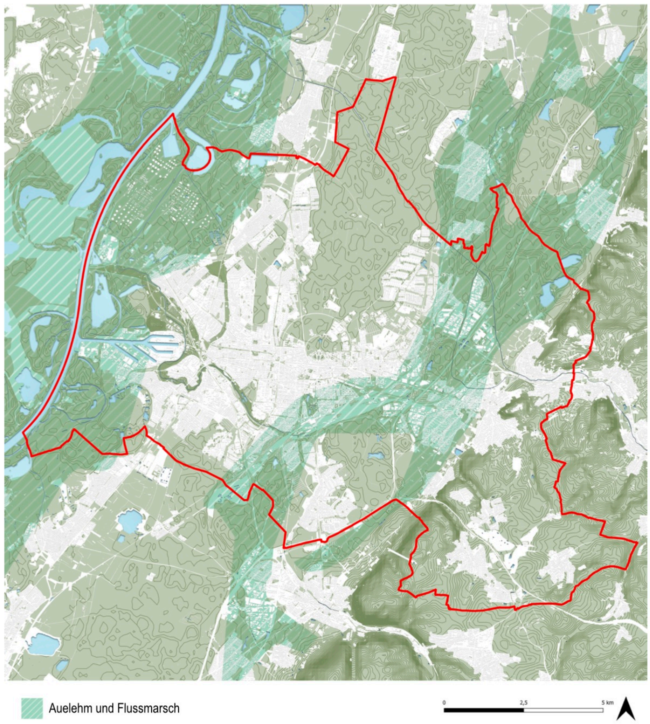
Anteil des Auelehms und Flussmarsch in Karlsruhe

Hohe Wasserdurchlässigkeit

Hohe Speicherkapazität

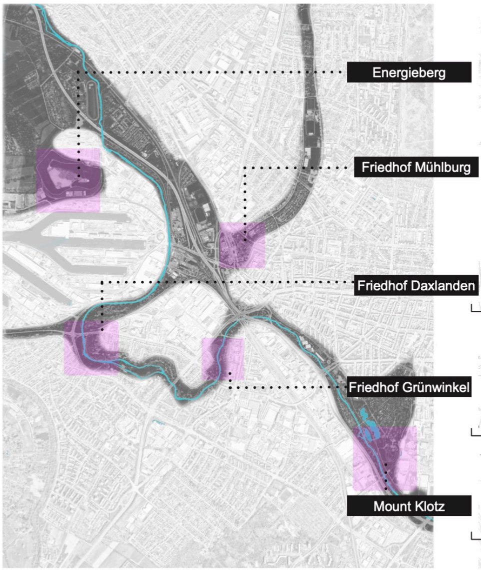
Bodeneigenschaften klassifizieren wichtige Ausgleichskörper für den Wasserkreislauf

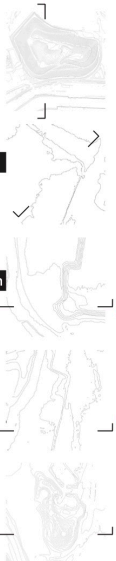




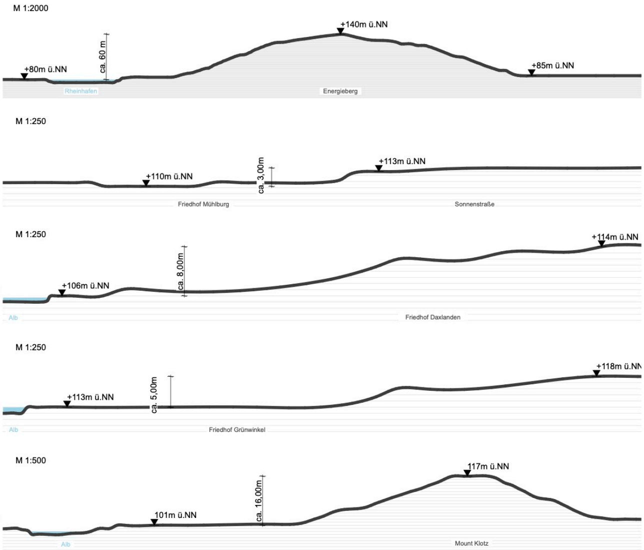
- Topographie
- Gewässer
- Deckschichten
  - Auelehm und Flussmarsch
  - Löß und Sandlöß
  - Moor
- Grüne Flächen
- Vegetation Moor
- Vegetation Sumpf
- Friedhöfe
- Industrie mit Gefahrstoffe
- Abfallmanagement
- Karlsruhe Kontur

Orte des Wandels entlang der Alb





LANDSCHAFTLICHE MERKMALE



TRANSFORMATION IM ÜBERBLICK

Energieberg

1965

Müllabladeplatz

1971

Planung einer städtischen Mülldeponie

1982

Mülldeponie West

1997

Energiegewinnung aus anfallenden Deponiegas

1999

Errichtung der Windkraftanlagen

2005

Deponierungsverbot

2006

Errichtung der Photovoltaikanlage

Friedhof Mühlburg

1670

Friedhof Mühlburg existierte seit spätestens 1670.

1974

Friedhof

Friedhof Daxlanden

1898

Der Friedhof Daxlanden wurde 1898 eingeweiht.

1976

Friedhof

Friedhof Grünwinkel

1913

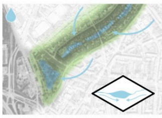
Der Friedhof Grünwinkel besteht seit spätestens 1913.

1989

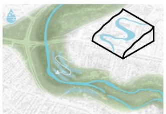
Friedhof

VISION

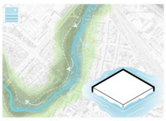
Die ökologische Bedeutung von Friedhöfen wächst



Regenwassermanagement

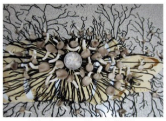


Wasserfiltration



Überschwemmungsfläche

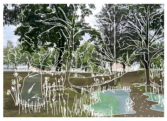
Capsula Mundi



Mushroom Death Suit

Neue Bestattungsformen schaffen vielfältige Gräber

Reerdigung

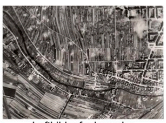


Integration von Wasser- und Bodeninfrastruktur zum Schutz der Ressourcen ..

.. schaffen Biodiversität und atmosphärische Orte

Mount Klotz

1945

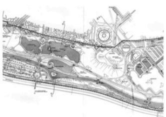


Luftbildaufnahme der Kriegzerstörung

1971

Planungswettbewerb für Naherholungsgebiet auf ebenen Fläche des Beiertheimer Feldes

1976



Baubeginn der Günther-Klotz-Anlage

Mount Klotz wird aus Teichaushub und Schutt errichtet

1985

Fertigstellung des gesamten Parkareals

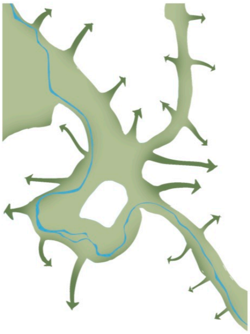
1987

Mount Klotz als Rodelberg

2024

Blick von Mount Klotz heute

Strategieentwicklung

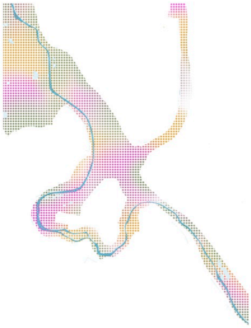


Integration der offenen Bodenstruktur

Neue grüne Korridore

Erweiterung der Grünfläche

Neue Wegenetz

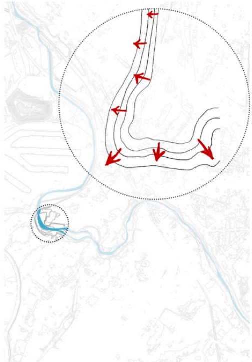


Vorschläge für Nutzmöglichkeiten

Naturförderungsmaßnahmen

Phytoremediation-, Gartennutzung

Kommunikation in sozialen Treffpunkten

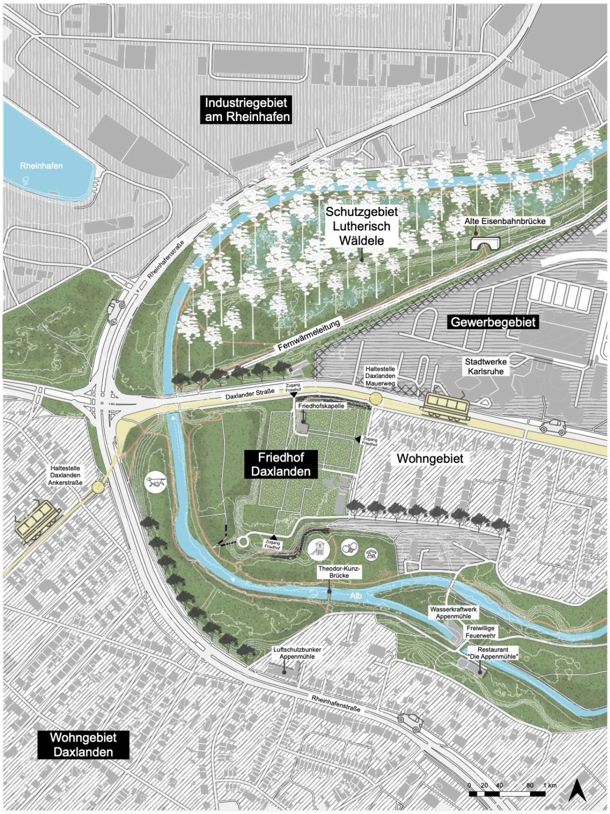


Topografische Anpassung

Aufhebung großer Gefälle

Umnutzung bestehender Grenzen

Integration des Wassermanagements



Flächen

- Industriegebiet
- Wohngebiet
- Gewerbegebiet
- Friedhof Daxlanden
- Unversiegelt
- Wasser

Verbindungen und Grenzen

- Straßen
- Bahngleise und Haltestelle
- Fußgänger- und Radweg
- Mauer
- Zaun
- Baumreihe

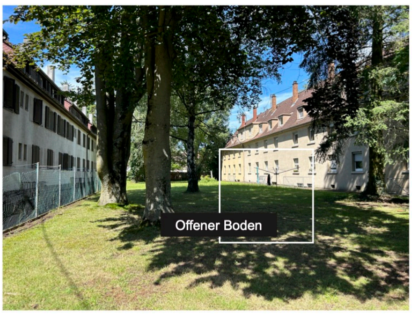
Aktivitäten

- Hundewiese
- Spielplatz
- Sport
- Jugendunterstand
- Ausflugsziele

1

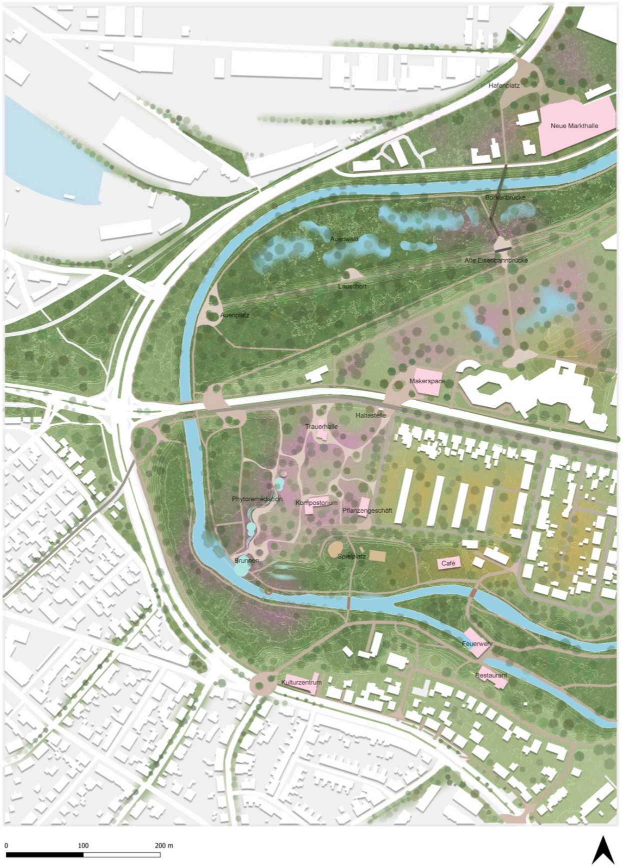
2

3

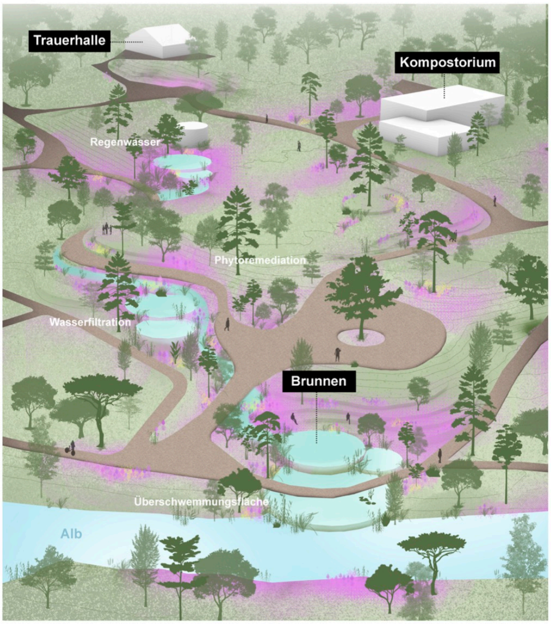


Umsetzung im Masterplan

- Phytoremediation
- Garten
- Häuser im Bestand
- Transformierte Gebäude
- Neues Wegenetz
- \- + Topographie
- Wasser

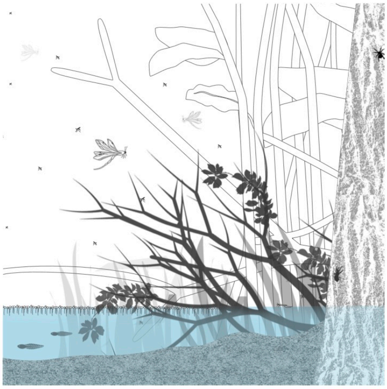


Perspektive Brunnen



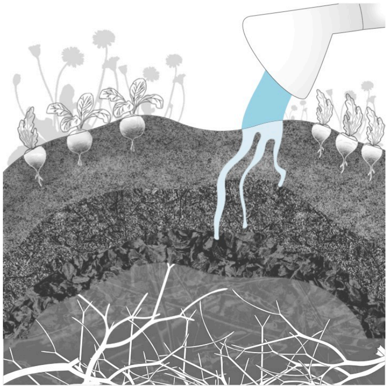
Böden und Kreisläufe

Bodendetails, M 1:2



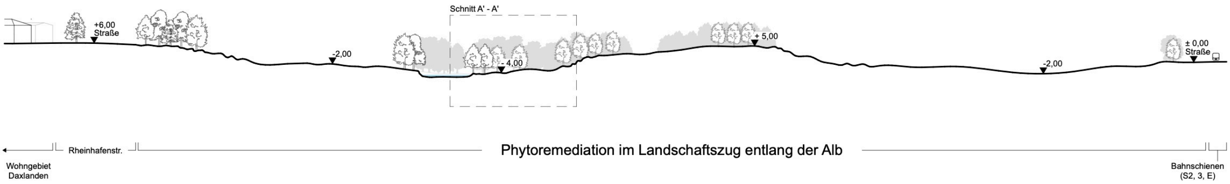
Auwald

Phytoremediation

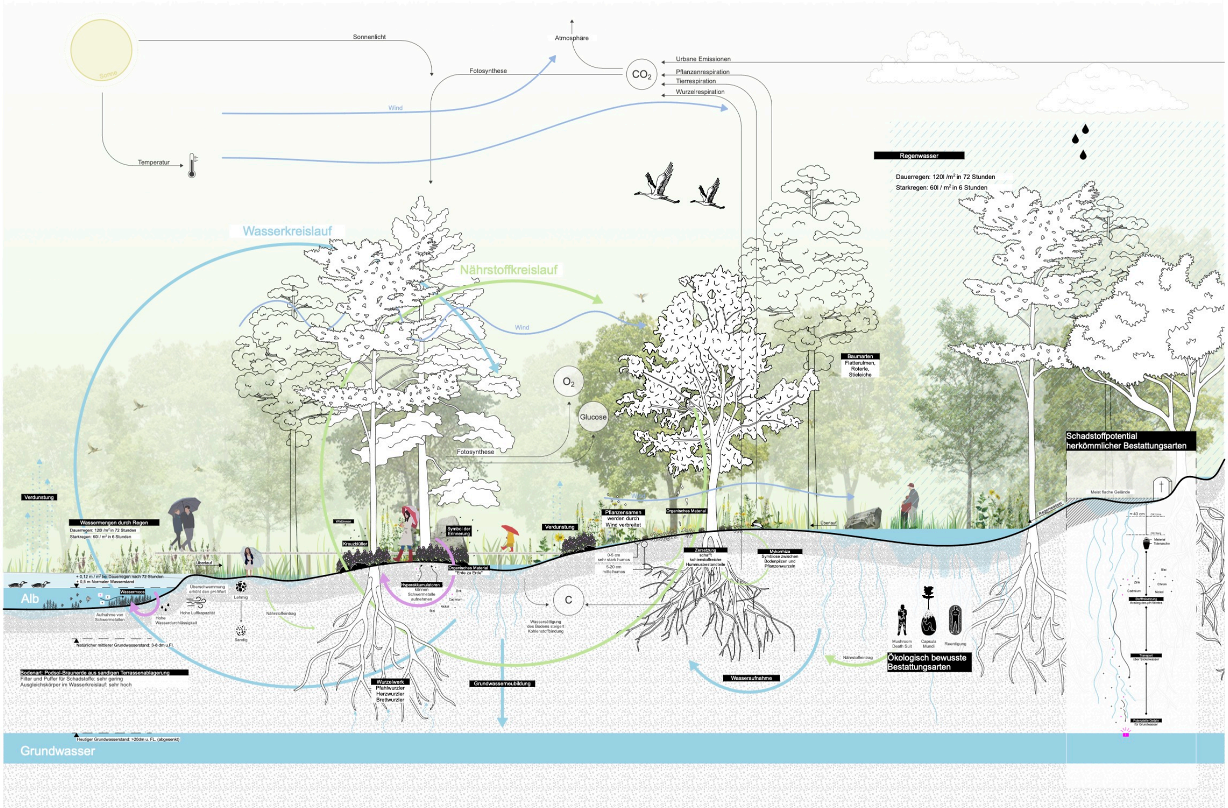


Gärten

Schnitt A-A, M 1:500



Schnitt A‘-A‘, M 1:50



C Interviews. A multilingual transcription

In the next sections it is possible to find the question guides of the focus group and the interviews. LLM have been used to refine the formulation of the questions in English. The transcriptions of the focus group and the interviews is presented here in the original language of the discussion, chosen by the students to feel most comfortable. Some of the students, though, are not German native speakers, and their expressions are mostly not modified in this text. The transcription is based on the results provided by AI transcription service WHISPER, programmed in Python by the author. Due to time constraints, it has not been possible to translate them into English. Some key extracts are presented in Chapter 6 translated into English by the author. The value of the original expressions are also considered highly interesting, motivating the presentation of them in the original language.

C.1 Focus group's question guide

Welcome and Introduction

Welcome the participants
Provide an overview of the focus group's purpose and structure.
Emphasize the importance of honest and respectful communication.

Icebreaker Activity

Tour de table, theme of what you studied with GIS.
Why were you interested in learning it?
What were your first impressions during the first weeks?

Conduct Discussion

Have you used GIS and Data analysis after the course?
If yes, for what? If no, why not?
What were you expecting to get form it? Get geographical information, cross it, site analysis, hints for a project (firestarter), open new perspectives, unveil hidden aspects, design tool, redefine tool, improve performance, ...
Have you worked with speculation? Could GIS be useful for this?
How do you think your design practice changed when you were using geographic data?
How would you like your design practice to change by using geographic data?
Have you integrated nature (biotops, ecosystems, non-human life forms) in your projects? If so, how do you face this task? What do you need for it?

Wrap up discussion

If you had 5 minutes with the Dean, how would you communicate him/her your aspirations about this kind of tools and methods to be taught in the university?
Is there anything that we have not talked about that you think is imporant about this topic?

C.2 Focus Group's transcription

Q: Warum habt ihr das ausgewählt, was hattet ihr gedacht, warum wolltet ihr das machen?

f7: Meine Mutter ist Stadtplanerin, und sie hatte damals, in den 90er-Jahren, als Masterarbeit, also als Diplomarbeit, eins von den ersten Versuchen von der Uni mit GIS-Technologien gemacht. Sie ist jetzt Beamtin, sie arbeitet jetzt für die Stadt, und sie benutzen da auch GIS, deswegen ich kannte es. Wir hatten schon drüber geredet, dass ich unbedingt so was in der Uni machen sollte. Das war im Bachelor, dann habe ich bis zum Ende des Bachelors benutzt, und dann in meinem Master, ich wusste, dass ich die Städtebauliche Vertiefung machen wollte, und dass ich bei einen Landschaftsarchitekturbüro arbeiten wollte. Also ich habe angefangen in dem Studio, gleichzeitig mit meinem Job bei dem Landschaftsarchitekturbüro, und deswegen ja, also ich sage eigentlich immer noch, die Richtung, in der ich jetzt gehen möchte, noch einmal war es ein Must.

f6: Ich hatte keine Idee. Mir war es, ich habe auf die Städtebau, also nicht die Vertiefungsdingen, aber halt dieses, muss man einen Kurs aus diesem Bereich für Städtebau machen, und das klang für mich dann am interessantesten eigentlich, weil es tatsächlich aber auch nicht mehr was die Alternativen waren, aber es war nicht die lange Hand geplant oder so.

f5: Ich weiß es ehrlich gesagt auch nicht, also ich fand das Thema irgendwie interessant gekommen, ich konnte mir nicht wirklich was darunter vorstellen. Wir waren in dem 5. Bachelorsemester. Ich habe dann relativ schnell gemerkt, dass es ziemlich praktisch ist, da wir Städtebau hatten, und es da ziemlich viel Nerven gespart haben.

f4: Ich kannte es auch gar nicht, aber ich habe jetzt auch in den Fall vor meinem Bachelor gemacht, also in der Städtebau waren wir ganz ein bisschen. Und ich glaube ich habe dann auch so dieses ganze GIS, immer mal gehört, immer gefragt, wie man sich die ganzen Karten macht, also so auch im großen Maßstab, dann genau bei dir das erste Mal so gehört und gemacht. Also auch wenn man einfach dieser Umgang mit den Datenmängen und Informationen zu Flächen, aber in CAD fand ich jetzt immer sehr hilfreich.

f2: Ich mache die Vertiefung Städtebau, oder will sie machen, mache also die Kurse dazu. Und ich habe im ersten Master ein städtebaulicher Entwurf gemacht, ich weiß nicht, ob das gleichzeitig mit DDUN einbaut, oder DDUN1, ja doch ja, es war gleichzeitig mit DDUN1. Und ich fand es halt interessant, weil Städtebau ist halt immer so ein Großformat und eigentlich brauchst du so viele Informationen mit denen umgehen. Normalerweise musst du es halt selber kartieren oder selber finden oder irgendwie machen. Ich dachte es ist ein interessantes Tool um das zu machen. Und dann habe ich ja den Kurs gemacht und dann habe ich mich entschieden, im nächsten Semester auch Entwurfsstudio mit dir zu machen, um das auch noch mehr mit dem Entwurf zusammenzubringen.

f1: Ich hatte, ich bin zum ersten Mal mit QGIS, jetzt direkt mit dem Programm in Kontakt gekommen, im Studio-Semester bei einer anderen Professur für Städtebau. Da hat der Betreuer mir so eine kurze Einführung gemacht. Vor, noch vor dem Seminar. Genau daher kannte ich es halt ein bisschen, das war aber auch relativ Basic. Unter dem Thema konnte ich mir jetzt gar nicht so viel vorstellen, aber es war interessant. Der hat so eine kurze Einführung gemacht, dass wir uns mal so Städte raussuchen, so diese klassischen Dinger, die du über Open Street Maps rausziehen kannst. Das war schon sehr hilfreich.

Q: Wie waren die ersten Wochen, wenn ihr das gelernt habt?

f1: Du hast ja da so eine Anleitung geschrieben, und die war ganz hilfreich beim Nachbearbeiten. Wir haben ja immer diese vier Workshops gehabt, mit einzelnen Aufgaben für daheim. Und ich fand das jetzt nicht überfordernd.

f5: Ich finde es war noch richtig gut gemacht, das war das mit der Hausarbeit. Wenn man die jedes Mal gemacht hat, und ich finde die ersten zwei Mal, da war man das ein bisschen los, wie der Schalt, also Benutzeroberflächen und so weiter, man konnte die ziemlich gut einfach nachmachen. Und dann war man natürlich schon sehr schnell verstanden.

f2: Ich finde, das, was du mit uns gemacht hast, ist dann gut verständlich und natürlich schwierig, dann selber noch Informationen zu finden. Und wenn man dann weiterarbeitet, also außerhalb dem, was du uns beigebracht hast, ist es natürlich sehr, sehr aufwendig, um irgendwie was zu finden, um es auch richtig zu finden. Manchmal funktioniert es, dann muss man halt so lange probieren, bis es irgendwann funktioniert, vielleicht auf den Computer hoch und runterfahren. Dann funktioniert es manchmal auch. Also den Kurs selber fand ich eigentlich gut verständlich.

f7: Ja, ich finde auch, also wir haben das in Corona gehabt, das Seminar, deswegen ich erinnere mich, dass ich diese ganze Blätter hatte. Aber ich erinnere auch, dass irgendwie die ersten, ja, erste, eins, zwei Hausaufgaben, auch Dinge, die wir hatten. Ich denke, ich hatte wieder so ein extra Video-Anruf mit dir organisiert, um das zu verstehen. Aber dann, ja, ich denke, jetzt ich habe das bemerkt bei meiner Masterarbeit, weil Genoa hat, also ich habe meine Masterarbeit in Genoa gehabt und da gab, da haben sie wirklich sehr, sehr viele Daten. Nur, manche Sachen waren wirklich schwierig zu benutzen und da gibt es ein Architekt, der dann mich Video angerufen hat, um das mir zu erklären. Aber da habe ich wirklich bemerkt, dass er wusste, wie man das öffnet, aber er hat selbst noch nie mit diesem 3D-Modell von QGIS gearbeitet oder entworfen. Seine Aufgabe ist, quasi, er sammelt alle Daten, er hat eine Reihe an so Werkstudenten, mein Bruder hat auch damals da gearbeitet und sie benutzen so, zum Beispiel, sie nehmen historische Karten und sie machen, sie kartieren es und er macht all diese Art Karten.

Q: Habt ihr QGIS oder diese Forschungsmethoden nach dem Kurs mit mir weiter genutzt? Für was, in welchen Rahmen?

f1: Also jetzt für die Masterarbeit habe ich es verwendet. Das hat mir auch so ein bisschen mich die Angst hat, oder die Bedenken genommen, so ein großmaßstäbliches Thema zu wählen, weil man weiß, dass es mit QGIS nicht das Problem ist. Problematik war dann letztendlich einfach die Quellen, dass man nicht viel Daten hatte. Aber für grundlegende Sachen habe ich es, glaube ich, in jedem

Semester so weiterverwendet. Also Studioentwürfe, genau, bei der Gastprofessur in Montenegro, da haben wir dann auch kartiert und Analysen gemacht. Kartenanalysen, da haben wir das auch viel verwendet.

Q: Aber wie habt ihr das genau genutzt, war es als Sammlung von Bestandskarten, war es als Analyse dieser Karten, was anderes?

f1: Es war einfach Sammeln aus verschiedenen Karten. Also zum Beispiel, hier hatte ich dann speziell Schlösser und Burgen entlang im Adriatischen Becken, so in Italien und der ex-jugoslawischen Küste gesammelt. Und das war dann auch so aus Datensätzen, Sachen zusammensammeln, teilweise händisch eintragen.

f2: Also ich habe es generell einfach für Satellitenbilder, Schwarzpläne und so immer wieder verwendet. Und dann habe ich auch noch einen anderen Entwurf, der ging es um Reuse, um herauszufinden, ich habe einen Datensatz gefunden, wo die ganzen Bahnhöfe sind, die Güterbahnhöfe, wo Wasserstraßen sind, wo Häfen sind und so weiter. Und habe es halt so kartiert und habe dann herausgefunden, wie weit man sozusagen über verschiedene Transportwege kommt. Es war eigentlich Hochbau, aber es war nicht so wirklich Hochbau. Wir haben eine Firma entwickelt, die Reuse macht und eigentlich war der Entwurf eine Firma und dann war da ganz am Ende noch ein Gebäude.

f7: Also im Bachelor, ich habe es dann damals auch für meine Bachelorarbeit benutzt. Eigentlich war es die Markthalle, aber trotzdem habe ich die Analysen damit gemacht. Und dann im Master, ich habe das Studio bei dir gemacht und natürlich dafür habe ich das gebracht, aber dann, was für mich ein gutes Beispiel ist, ist ein städtebauliches Entwurfsstudio in Kollaboration mit Verkehrsplanern. Es werden Gruppen gebildet mit zwei Städteplaner und zwei Verkehrsplaner oder eins und man kriegt ein Areal, wofür man einen Entwurf hat. Und bei uns war das in Israel. Deswegen, wir kannten die Lage natürlich nicht, wir sind erst nach der Analyse dahingeflogen und die Sache war, wir hatten ein Problem, weil die Verkehrsplaner konnten nicht die gleichen Computerprogramme wie wir benutzen. Also kein Photoshop, Illustrator, VectorWorks, nichts. Nur QGIS. Und nur eins von unseren zwei Verkehrsplaner konnte QGIS benutzen. Und von uns Stadtplaner nur ich. Deswegen, war es interessant. Aber was ich bemerkt habe, es war schwieriger, die Daten in Israel zu bekommen, weil es gab ein Portal, aber vieles war nur... Es hieß GIS Portal, aber vieles war nur Text. Und dann hatten wir das Problem mit der Übersetzung, weil ja, es gab Google Lens und so, aber es war nicht einfach. Deswegen, wir haben irgendwann von der Stadt die Sachen bekommen, weil es ist so, dass in Israel, also in Tel Aviv, sie bauen gerade jetzt so Sachen wie Tram, U-Bahn und so, was gab, wenn wir angefangen haben, sehr wenig. Aber ich habe bemerkt, dass der Verkehrsplaner, der QGIS in dem Büro benutzt, wo er arbeitet, konnte sehr viele Sachen, die ich wirklich noch nie gesehen habe. Also die Manipulation von Daten, obwohl wir wenig Daten haben, war sehr gut. Also er konnte das wirklich gut nutzen.

Q: Du hast es genutzt, um eine Art von Sammlung der Karten zu machen, oder Analysen zu starten. Aber du hast die Daten nicht selber bearbeitet.

f7: Also wir haben angefangen –genau das ist vielleicht sehr relevant– wir haben angefangen, die Daten zu manipulieren, und dann haben wir ein sehr schlechtes Feedback von der Professur bekommen, dass sie das nicht so wollen. Also auch für meine Masterarbeit wollte ich mit Datenanalyse nicht arbeiten, weil es war so, dass die Betreuern immer lieber ein bisschen mehr Standard-Analysen wollten. Was ich aber auch interessant fand, war, dass die Art der Manipulation von dem Verkehrsplaner war ein bisschen gegen, was du immer sagst „what you see is what you get". Es war sehr, sehr schwierig zu lesen, was er kommunizieren wollte. Obwohl man könnte sehen, dass er wirklich eine Idee dahinter hatte, aber es war dann sehr schwierig, das dann so zu bearbeiten, dass wir dann das für die Endabgaben benutzen konnten.

Q: In einige Seminare habt ihr Datenanalysemethoden gelearnt. Habt ihr sie danach wieder benutzt?

f6: Tatsächlich nicht, also ich hab jetzt auch gerade überlegt, ich hab in dem Semester, wo ich das Seminar auch hatte bei dir, parallel in städtebaulichen Studio, dieses Projekt in Lüderitz, haben wir parallel in unserer Gruppe, weil ein Kommilitone, der auch dein Seminar mit dir verfolgt hat, war auch in Studio mit mir in der Gruppe, und dann haben wir da QGIS benutzt, allerdings war deshalb voll der Kontrast jetzt im Vergleich Zürich, mit Lüderitz von der Datenlage war irgendwie wirklich wie Tag und Nacht, und man hat dann bei Lüderitz schon Dinge gefunden, und da liest dann aber mehr drauf raus, sag ich mal so Angebotsanalyse, also was gibt's für Apotheken, Geschäfte etc., so ein bisschen so was man, wenn ich mich ruhig erinnere im vierten Semester, dann händisch noch gemacht hat, und auf Google dann die Sachen gezählt hat, und geguckt, wie weit es auseinander ist, also dafür ist es auf jeden Fall gut gewesen, und sonst hab ich nur eigentlich so ein bisschen eher so, sag ich mal, Spielereien vielleicht gemacht, ich hab einmal so ein ganz großes... ich weiß noch gar nicht mehr genau, ein von Google Earth-Bild, aber halt von einem großen Arial irgendwie ich glaub, 10 Kilometer auf 10 Kilometer gemacht, und dann halt in so einer hohen Auflösung gab irgendwie so ein Workroom, wie man das exportieren konnte, und dann über eine 3D-Tropografie im Modell halt drübergelegt für dann Visualisierung so aus der Luft zur Vogelperspektive, dass man dann sozusagen das Bild noch hat, aber das war jetzt eigentlich keine richtige Datenanalyse und sonst ja hab ich seitdem eigentlich nix mehr gemacht damit.

f5: Ich guck eigentlich immer direkt am Anfang mal, also auch jetzt mit die Masterarbeit, was es so gibt an Daten, den ihr was benutzen kann ich meine so Straßen, Gebäude, Bäume, wie auch immer die Grenzen auch das Open Street Map layers also sowieso klar, dass man die entkommt und dann ob man irgendwie Glück hat und noch irgendwelche relevanten Informationen findet man auch nichts zu tun da in den Semester bei dir hab ich ja auch von ganz offen, wo dieses 3D-Model mit QGIS und Rhino dann von dem gemacht, wo man die Daten eben von den Gebäude würden und so weiter hatte nur oft hat man die halt nicht...

f4: ja doch ich habe ja eigentlich schon mal so erst mal Initiativ gestartet und mal geguckt was es so gibt und sonst immer mal wieder wirklich haus, was man dann machen kann und dann kannst du dann nicht angewendet, wenn man immer geschaut hast du die Möglichkeiten auch so mit Luftbild, grünen Töne aus Luftbildern zu ziehen und dann irgendwie gucken wie der Baumstand ist oder irgendwie so Dinge da habe ich auch. Ich hatte also Videos gefunden, wo das ein Bauer genutzt hat um den Pflanzenwachstum zu kategorisieren mit Dronen und das fand ich richtig spannend aber da dachte ich sehr gut also er so befähigt, der Fahrer wusste aber ich fand die Möglichkeiten schon sehr faszinierend, was man dann machen kann wo ich mir auch dachte dass es eigentlich jede Anwendungszwecke auch für Kommunen gibt um da vielleicht mit Luftbildern irgendwelche Waldbestände zu analysieren zu gucken wie die Winde sind genau, aber sonst...

Q: Wie habt ihr die Zugang zu Enwurf von Analyse erlebt, wenn diese digitale Datenanalyse-Methoden mobilisiert werden?

f7: Also ich habe jetzt wirklich das ganze letzte Jahre immer bei städtebaulichem Studio bis der Masterarbeit gemacht und da ist es wirklich so, dass Analyse und Entwurf müssen in diesem Studio sehr eng bleiben. Deswegen, ich finde für mich, es ist so, dass ich analysiere sehr viel denn ich weiß was mein Konzept ist und dann, ich bearbeite die Analyse so, dass sie passen mit meinem Konzept das habe ich jetzt mit meiner Masterarbeit auch so gemacht, weil diese Storytelling war mega wichtig. Und ich denke, im Studio bei dir war auch ein bisschen so, dass wir hatten dann plötzlich diese Analyse gefunden, was wir richtig gut fanden, von dem Wasserthema und dann wir haben gedacht, okay, wir sollen versuchen das Konzept zu verbinden.

f4: bei mir war es vielleicht andersherum dass wenn man jetzt zum Beispiel ein Gebäude hat mit irgendwas beschäftigt dass man dann sagen kann, okay man kann es ja mal rumdrehen, mal gucken wo könnte das Problem sein? Trifft das Problem überall zu? und wo kann man diese Lösung dafür anwenden? also es wäre eher so, dieser Schritt andersherum: nicht von der Analyse sondern sagt, okay, ich habe jetzt hier irgendwie, keine Ahnung, irgendwas aufgestockt und diese Art von Gebäude gibt es super viel und das sind die Menge, die ich daraus ziehen kann und kann sagen, dass es da darauf anwendet

f3: Wir sammelten richtig so viele Informationen, immer mehr und mehr gesammelt... und wenn man es regelt, dann macht man das sauber auch. Ich hatte vorher noch nichts mit GIS gemacht und dann fand ich, dass irgendwie... Also ich war zum ersten Mal voll überrascht, als man mal schon richtig erlaublich war, und nicht nur so, ich laufe mal durch und schau mal. So, dann guckt man da so, ja, wie ist es da? Es ist hier viel los, eine Fläche hier, eine da, es ist viel los. Da fand ich zwar nicht so, oh man, sie sind wirklich zu viele Daten, hm...interessant. Ja, und ich glaube, was auch schwierig erwartet ist, eben so viel über Boden, Grünflächen, Wasser, eben Tiere, die hatten eigentlich so... Da hatte man eigentlich nicht so viel Natur vor, wenn man irgendwie so... Und dann haben wir uns gefragt, okay, und wie kriegt man das jetzt irgendwie diese Info auf einem Plan, dass man, weil wir waren auch immer hinzunehmen, wir müssen eigentlich Architektur machen.

f5: Ja, es war irgendwie schwierig, weil es war das erste Projekt im dem Maßstab die Ganze Stadt.

f3: Wir wollten ja immer, auch wenn wir so ein bisschen gestoppt wurden, weil wir wollten halt irgendwie immer „ein Haus" hinbauen oder sowas, und es war halt der andere, so irgendwie... Ja, ich glaube auch immer, dass die ein bisschen so das erste, was man macht, wenn man so Bodenhausen macht oder so, und jetzt noch linear als... von der Analyse, auch was zu kommen, und sich selbst aus.

Q: Wie sollte GIS im Designprozess implementiert werden, damit die Entwürfe von diese Datenanalyse mehr profitieren?

f2: Ich habe das Gefühl, dass bei mir, ich habe es immer sehr spät vor Ort verwendet, also das war mir eigentlich eine Bahnlinie, und so weitergesagt, war, um einen Standort für die Firma zu finden. Also ich habe analysiert, was es der Fall braucht, und nicht so großbleibend analysiert, um dann Aspekte rauszufinden. Und manchmal ist es halt schwierig, die Datensätze zu finden, die dann tatsächlich sinnvoll sind für den Entwurf, und dann auch noch, wenn man jetzt noch mal weitergeht, und das ist jetzt kein Entwurf für die Uni, sondern für die Arbeit, müssen die ja belastbar genug sein. Und dadurch, dass man manchmal nicht weiß, was ist denn der Faktor, was eine Lernfaktor hier irgendwie generiert wurde, dadurch, dass da jetzt die Straße ist, wo man weiß, dass wir sowieso befahren sind, ohne dass man irgendwelche tatsächlich den Lärm gemessen hat, was ich heute wieder schon gesehen habe, ist nicht belastbar für irgendetwas. Also da kann man dann sagen, ja, okay, da wurde jetzt die Gleise hier genommen, aber ob das jetzt genau an diesem Ort, wo ich jetzt entwerfen möchte, stimmen, dann brauchen wir so eine professionelle Analyse oder so was.

Q: Wie entwickelt sich euer Entwurfsprozess?

f1: Ich bin aber auch nicht so sicher, welche Prozesse linear sind, oder wer das so dieses, was wir im Seminar gemacht haben, so, wo du nur ein Gebiet mal zur Verfügung gestellt bekommst, dann guckst du mal, suchst dir das Problem selber, und daraus entwickelt sich dann, womögliche Projekte, oder ich habe meine These, und hab ja schon eine gewisse Vorstellung, wo ich hin möchte, und wann dann die andere ist, was jetzt, was jetzt Ziel für ihn da ist, und wie sich aus welchen Prozesse aus die Analyse noch für mich die geistige Vorstellung ist. Ich habe das Gefühl, dass es schon so dieses Linear, wenn man keine Vorstellung hat, und es ist wirklich nur, aus jedem Zwischenergebnis der Analyse, da geht man ein Stück weiter, und zum Beispiel jetzt hier, da ist ja erst auf keinen Fall eben ein Gebäude geworden, oder irgendeine andere Art zu uns lernen, eins in der Maßnahme in verschiedenen Stellen, die man auf die als Entwurfs möglich werden kann, und diese, auf diese Entwurf, oder auf diese Idee kommen wir nicht ohne.

f7: Es war so, dass für mich, für das Seminar, habe ich unserem Baumkatalog anzuschauen. Da musste ich aber die Data verknüpfen, die ich hatte, in sich selbst gewendet zu sein, mit anderen Kenntnissen, also ich musste ja von anderen Fächern, in diesem Fall ist ja Biologie, herausfinden, okay, was weiß ich jetzt über Pflanzen, über Bäumen, wie einige gut neben ein ander gut wachsen und gepflanzt werden sollten, und da habe ich das gemacht. Also ich denke, dass du brauchst die Zeit, die Daten anzuschauen, und dann denken, okay, was weiß ich überhaupt noch über solche Themen, dass ich da jetzt verknüpfen kann. Also ich denke, dass diese Linearität... Ich vermute aber schon, dass man kann eine Methode definieren kann, wie man das einfacher machen kann. Ich meine, in diesem Semester, gab es eine krasse Linearität für den Entwurf, und deswegen, auch wenn du anders anfängst, die Gruppe, die Gruppe Dynamik, bringt dann alle zu das Ergeben, dass alle eher ähnlich arbeiten.

f5: Ich weiß nicht, ob es verstehensvoll ist, ich denke, wenn es nicht so linear ist, dann können wir das eigentlich..., also erstmal müsste man sich selbst aus Klammern, aus der Kreis um, und ich glaube, das ist ein Ende, das uns motiviert. Das machen wir, das ist ein kreativer Beruf, und man will ja auch in die Gruppe.

f5: Das wäre dann wirklich immer von Schritt zu Schritt, und dann eigentlich gar nichts weiter, denken, scheuft ab, und irgendwie nur analysieren, auch ich habe das Ergebnis, ich gebe weiter, K.I., oder Software, oder was so immer. Aber, ich glaube, was aus der Analyse, was raus besteht, ist schon immer der Fall. Beim Anfangen handelt es immer ziemlich weit analysieren. Und eigentlich alles Bandsammeln, das man denkt, es könnte später interessant für einen Entwurf sein. Und dann geht man eigentlich wieder ins Explizit und mach man einen Entwurf, der auch schon aus dem heraus entwickelt ist, ist, aber ich muss nur austeilen 51:36. Man kann ja niemals alles mit reinbringen, ist wahrscheinlich aber gar nicht bestehen. Das ist, dass man sich dann sagt, ein Rausbild, die zusammenfügt und nutzt, braucht man dann meistens auch noch andere Sachen, die vielleicht in der Analysen nicht dabei waren, die mir danach regnete ich noch mal.

Q: Würde ihr es weiternutzen oder denkt ihr, dass das eurer Arbeit damit ein bisschen anders sein könntet und was benötigt ihr dafür?

f3: Ich dachte tatsächlich, dass man manchmal Analysen macht, denen man sich nicht bewusst wird. Also im Kopf sag ich mal, dass man die ganze Zeit eigentlich schon im Hinterkopf weiß, da ist eigentlich das so was wichtig. Aber man hat dann keine Datenkontakte dafür am Ende und dann hat man quasi so was, was man sich die ganze Zeit selber irgendwie gedacht hat, und dann wird man halt noch eine zusätzliche Datenmenge hat, und deswegen wird es manchmal nicht so linear. Also weil man halt war, die sich nicht für alle Dinge einige Daten hat, obwohl man sich das eigentlich gewusst ist, was an dem Ort vielleicht wichtig ist, nur man hat die Daten nicht und dann dadurch bildet es wie wenn es nicht linear wäre, aber man macht es halt eigentlich linear, aber man hat halt quasi die ganze Zeit was einfach so woanders sein muss. Und ich glaube das ist etwas, dieses menschliche wasvolle Glück um zu leben vorher noch.

f3: Wenn man in der Uni ist, wenn man gerade einen Projekt vorgegeben bekommt, dann musste ich ja gar nicht, also das Problem habe ich untergeeignet. Die ganze Zeit nach Laden, so, und dann gibt es immer so Daten, das Problem ist, dass mein Grundstück, vielleicht genau durch die Grenze zwischen Freiburg und Karlsruhe, ist eigentlich, ich muss die ganze Zeit noch mal den Datensätze runterladen und die dann immer reinmachen und dann alles fliegen und so, das nervt unter. Und ich weiß halt auch nicht, ist es dann das, was ich eigentlich brauche, so. Und manchmal funktioniert es auch nicht, ich weiß nicht warum, aber die da manchmal nicht, weil sie dann gesperrt sind, also, das ist auch, finde ich auch ziemlich doof.

Q: Was ist mit der Zeit gebrauch um es zu lernen und es zu nutzen?

f2: Allein bei diesem letzten Seminar, so ist es, da waren die Daten und die alleine schon sie zu runterladen, ich hatte keine Zeit, um die Daten so genau anzuschauen, dass ich das gewählt habe.

Also ich habe natürlich gesehen, da sind ein paar Punkte, wo seltene Daten sind, das ist wahrscheinlich nicht richtig, aber ich hatte keine Zeit anzuschauen, warum das nicht richtig ist. So Sachen zum Beispiel.

f3: Ja, oder halt auch, wenn man zum Beispiel den falschen, die falsche Projektion, also das ist ja mittlerweile nirgendwo. Und wenn es sich so denkt... HA! da sind sie ein bisschen hoch und raus, dann hat die auch so ein bisschen hoch und raus. Nee, wenn man das letzte Zündel war, an dem richtigen Ort, das war das am ersten Blick, aber es war ein bisschen verzerrten. Ja. Und dann habe ich es meinen Team-Partner geschickt. Vorher war es auch schon komisch ab. Und dann habe ich gesagt, okay, dann kommen wir da noch einmal. Weil das war wirklich, also das war eine Schmarrzwelle. Das waren ja die Geländehöhen, haben halt irgendwie mit den großen Mulden gestillt.

Q: Hättet ihr eine Art von Doppelsemester machen wollen? Also erst mal ein Seminar und dann einen Entwurfsstudio, aber beides zusammen ein ganzes Jahr entlang. Würdet ihr das machen?

f2: Ja, aber dann muss man halt mit den Studio-Wahlen ändern, dass man das so lange zusammengeht und dann so was sieht.

f6: Ich weiß nicht, aber ich glaube ich jetzt wohl wahrscheinlich nicht so ins Blaue hineingenommen, ohne vorher mal QGIS oder GIS überhaupt zu benutzen. Ich glaube dafür, oder es müsste, ja ich weiß nicht, ob uns überhaupt so gut beschreiben kann, dass jemand wirklich vorher erfassen kann und sich damit zu beschäftigen, worum es dann geht und sich dann sozusagen gleich noch für den Entwurf ein Semester festzuschreiben. Und ich glaube, ich werde jetzt nicht zum Beispiel mit dem Wagen zu tun, natürlich, mit dem Wissen.

f5: Und dann wäre es interessant, wenn man vielleicht das erste Semester auch benutzen muss. Machen, wie diejenigen machen, wo die Bäume, die Privaträume kartiert haben, dass man selber Daten selbst zu schaffen, den ersten Semester. Weil ich glaube, das ist am Ende das, was am meisten Problems macht, irgendwie, dass man dann denkt, ist es cool zu haben, dass man das dann am Anfang im kompletten Gruppenweise macht, die eine Gruppe analysiert, die den Baümestrukturen, die anderen, die andere, die andere, wie auch immer. Und man hat dann wirklich selbst geschaffene Daten, auf die man sich verlassen kann.

f2: Seit über Land, dass man nicht so sagen kann, ob man davor mit dem Entwurf auseinandersetzen kann, in dem Seminar, sozusagen die Arbeit, bei der Mastearbeit, dass man schon Gefühle in Richtung liegt, was macht man hier für den Entwurf?

Q: Wenn ihr 5 Minuten mit dem Dekan hättet, wie würdet ihm/ihr eure Wünsche bezüglich der Vermittlung dieser Werkzeuge und Methoden an der Universität mitteilen?

f1: Wirklich das Programm einführen, so wie es jetzt auch mit Rihno gemacht wird, zum Beispiel, das ich mitbekomme, den ersten Semestern haben bekommen direkt das Programm beigebracht. Das wird schon so viel helfen, dass wir dann wirklich um die Basics holen lassen und dann kann das vertiefen.

f7: Ja.

f2: Auf jeden Fall.

f5: Ich weiß, es ist überhaupt gut. Ja, wir haben auch gestern, zwei Jahre, zum Beispiel, den Dekanen oder machen die das? Ja. Wir werden ein bisschen saubern.

f2: Mir ist nachträglich eigentlich auch so, weil wir haben einen Moment da im Bachelor, dass er es schon bekannt war. QGIS wurde schon an der Uni genutzt, und dann war das nachträglich sehr viel zu spielen. Sie merken mir, dass sie das allen nicht beigebracht haben. Also nicht mal gezeigt haben, dass es das gibt. Und man weiß ja auch einfach nicht unbedingt, was es gibt. Oder man weiß nicht, wo sucht man danach. Und deshalb ist es eigentlich, der zählt euch in der Uni ein, zeigt, dass es passiert, was man dann machen kann.

f7: Ja, da hätte ich mich fragen müssen. Ich fühle mich da, weil mir diese Redaktion macht es nicht viel. So einen kommen zu dir in die Masterarbeit, ohne ein einziges Mal, um die es benutzt zu haben. Weil, bei mir waren wir zu dritt für die Masterarbeit bei Frau Engel. Also eigentlich hätte ich auch. Und eine von uns, hat sie so ganz noch nie gehört. Und dann, wir haben das hier beigebracht, aber was kann man lernen? Also ein bisschen zu spät.

f2: Das war eigentlich gut um einen Schwarzplan zu machen. Ich habe nicht so viel Zeit.

f3: Ich glaube, ich habe einmal zwölf Stunden lang so ein Scheiß-Schwarzplan gemahlen. Und so ich dann, ja, ja, ich habe ihn nicht gescheitet. Und dann, ja, raus, das ist nicht so traurig, wo ich zweiflixt war. Da war ich einfach nicht gefilmt, ich wollte nicht sagen, als wenn es eigentlich nicht angekommen wäre. Ich hätte ihn nicht leisten können.

f3: Nein, in Bachelor ist es nicht so. Da war es echt schnell nicht. Und daher finde ich es schon deutlich besser. Und ich finde auch, wenn ich so eine Hand feste, eine andere Analyse zu machen, das wäre wirklich sinnvoll. Also, ich glaube, das wäre nicht immer ein Gebäude, sondern selbst ein Gebäude. Ich glaube, es ist schon wichtig, wo es geht, wo es geht, was ist da auch noch um?

f3: Ich glaube, ich kann das nicht machen, weil mir da richtig die Daten, dass sie mal, wenn es Sinn hat, weil die sind einfach überall, die Flöten, so noch fünf Seiten, die ich nicht geben muss, jedes Mal suchen, alles durch so, wenn das enden ist, ist es gesperrt. Ich glaube auch, dass wir einen Lizenz bräuchten. Ein Lizenz, die klar machen, dass schon irgendwie an die Daten ankommt oder so. Ein Sammelding, der zumindest eine Website hat oder die anderen Website bewegen sind oder so, dass man irgendwie sich dadurch halt auch alles kommt.

f5: Ich glaube auch, dass man bräuchte die Daten und Karten von Städten, die man sonst kaufen kann, dass es da vielleicht, dass da für wir jetzt viel möglich ist, in diesem Raum. Und wenn man schon kommt, wenn man sich das nicht leisten kann, das ist schon krass, aber das sind viele Daten der Öffentlichkeit eigentlich.

f7: Was würde ich den Dekan sagen? Ich finde, also das Thema, mit dem du angefangen hast, heute ist diesen Unterschied zwischen Entwerfer und Technik. Ich finde, es ist ein bisschen cooler, weil ich meine, es ist ein bisschen was abtyrätisch. Einer hat den Bund uns jetzt absolvieren. Es wäre gut, wenn sie jetzt QGIS kennen würden, sodass es dann immer mehr Generationen von Architekten gibt, die das kennen. Weil eigentlich, wenn man jetzt arbeiten geht, und überall, wo man landet, sie benutzen das nicht so wirklich. Auch weil sie es werfen, sie benutzen es nicht. Und dann, ich erinnere mich auf viele Bäume, ich dann von dieser Gliedwilder dann abzahlen, wenn ich wusste. Deswegen finde ich dieses Thema von, das Fabrize, das ist in der Öffentlichkeit, das Existiert. Und das immer mehr, also das es akzeptiert ist, das die jungen Architekten Kommen. Und man darüber sprechen darf, dass man das benutzen könnte. Ich erinnere mich etwas, was die Erde kann, machen kann. Aber es gibt ja eine Niveau Sportwege. Und die können dann auch für ein Semesterrang etwas sein, was in diese Richtung geht. Also ich denke, ich denke, irgendwas sollte man machen, dass es nicht diese Reihen immer existiert, zwischen Leuten, die durchlösen wollen und...

f2: Es ist halt ein Werkzeug, das wir kennen wollten und auch können sollten. Und das zukunftsberichtet ist. Also wir werden es auf jeden Fall vielleicht irgendwann brauchen, wenn es auch, ich weiß nicht, erst 20 Jahre ist. Und vor allem, aber...

Q: War es für euch schwierig, eigene Methoden zu entwickeln, oder habt ihr euch dabei verloren gefühlt?

f7: Ich erinnere mich, dass es gab so einen Moment, wo ich bemerkte, dass ich richtig viel mache und richtig nahe war, bekommen in diesen Bäumenthema. Und ich hatte gedacht, jeder geht die Bekreuung, es war nicht so, es ist gesucht, um durchs Puschen, dass ich noch weiter versuche, weil das ein bisschen Thema wird. Und dann, ich erinnere mich, ich hätte dann darüber mit Kommilitonen geredet und dann, es war viel, dass er jemand gemeint hat, aber vielleicht, der Sinn ist ja, dass du was neues probierst. Ich denke, als er damals, ich hätte schon verstanden, obwohl es schwierig war für mich, aber ich konnte sehr wohl hierhin es bringen.

f6: Ja, also, ich habe es schon auch so verstanden, dass wir einfach unsere eigenen Entdeckungen und bei uns auch viel grafischer Darstellungen eigentlich entwickeln sollen, wie man es zurückkriegt. Ich kann es tatsächlich so ein bisschen andersrum mich erstellen, weil sie gemerkt hat mit diesem Schannonindex, wo ich mir gedacht habe, okay, dass der mich zu sehr einschränkt, immer das alles über den Index zu machen. Ich glaube, ich hatte schon auch, warum du es gemacht hast. Ich glaube, es war so ein bisschen, hatte ich so das Gefühl, also von den anderen, dass es so ein bisschen auch wirklich aus Thema ankommt, was du dir ausgesucht hast. Ich glaube, manche Leute hatten also zum Beispiel nie vorweisig, der hat das ja mit den Mietpreisen und so gemacht. Der hat viel mehr Schwierigkeiten gehabt, das auch über diesen Index dann damit was zu produzieren, als ich jetzt mit meinem Freiflächen-Diversitäts-Thema irgendwie. Ich glaube, ja, da steht zum Feld vielleicht auch so ein bisschen mit dem, was man dich dann aussucht, wo dann die Frage ist, okay, geht man dann vielleicht eher den Einfall? Also, vielleicht ist es als Student dann einfach, den Easy-Weg zu gehen und man nimmt halt den Datensatz, der sehr groß ist, wo man viel hat und nicht so die Motivation, sich da mega krass reinzugraben und irgendwie zig Sachen zu verbinden.

f7: Ich denke, dass es auch beim Studium gedacht hatte, war, ich habe immer den Eindruck gehabt, dass du wolltest, wirklich, dass wir etwas Interessantes und ein gutes Ergebnis haben. Und manchmal, ich habe den Eindruck, irgendwann, ich bin zum Ende gekommen von einem Seminar oder von einem Studium. Ich weiß nicht mehr weiter. Und für viele Betreuer auch. Okay, sie geben ja deine zwei Minuten, das passt. Aber wenn ihr etwas verstanden habt, dass ihr etwas besseres machen konntet, ich glaube, es ist aber auch so, dass du, wie ich dann, Beispielen gibst, Ideen gibst. Ich erinnere mich, du hattest mir die Präsentation von, wir können worden sterben, in Städte, wenn Falsch mit Pflanzen werden. Ich dachte, okay, wow, eigentlich, es gibt mehr, was man mit meinem Thema machen kann. Und ich hatte auch noch das zu versuchen. Aber ich denke schon, das war sehr viel Energie in meiner Betreuung.

Q: Ihr denkt auch, dass ihr zu viel Zeit gebraucht habt?

f2: Ich muss sagen, dass ich, wenn ich das Thema so gewählt habe, dass ich nicht so extrem viel Zeit brauche, weil ich gar keine Zeit hatte, der war meins auch relativ straight forward.

f6: Für mich war es noch ein bisschen mehr, als normal. Seminar ist uns, aber war schon okay. Aber ich fand es natürlich weiter von der Struktur, das war jetzt vorher, das ist jetzt schon gleich gut. Dann schauen wir auch ziemlich gut mit den Übungen. Also, ich finde das generell immer, wenn man natürlich ein neues Programm lernt, irgendwie, es ist, also für mich zumindest schon essentiell, dass man schafft, dann wirklich kontinuierlich da was zu machen. Und ich habe zum Glück diesmal geschafft, dass ich auch die Übungen immer gemacht habe. Manchmal wäre ich ein Kandidat jetzt dann erst mal drei Wochen liegen lassen, dann wieder auspackt und dann fängt man halt wieder beim Anfang an. Und aber so diese Strukturen auf die Anleitungen, die wir uns angegeben haben, das war schon sehr hilfreich.

Q: Gibt es etwas, worüber wir noch nicht gesprochen haben, das ihr für wichtig zu diesem Thema haltet?

f7: Was ich denke, das ist immer von der Akzeptanz. Wie ich erwähnt habe, ich denke, wenn man das Workshop macht und dann ist man auch erfolgreich damit, dann findet man, man sieht die Qualität, die man da benutzen könnte. Dann findet man das Studium für den Semester, und der Betreuung sagt direkt an, okay, mit QGIS warst du nur nicht wahr, das zu sehen. Und du verletzt machst nichts. Ich denke, das könnte sehr frustrierend sein. Ich denke, es wäre eine Diskussion auf Betreuerebene zu haben.

f1: Ich so oder nicht verwendet habt, eine Anlage braucht, baut nicht Google-Webs nach. So dann nicht nur dieses Suche lokalisieren, sondern was sie ganz weiteren nutzen. Ich finde, es ist schon immer so, wenn ich den Spruch aufmüsse, dass man so Daten nutzt, was kann man um die Ecke finden?

f7: Zum Beispiel zu dem GoogleMaps Aufzeichnen mit QGIS. Weil was für ein Arteil in des Seminars von Tel Aviv war, wir hatten, wie bei deinem Studio, jede Gruppe hatte ein Thema am Anfang. Und eine Gruppe hatte Grünräume. Aber sie haben QGIS benutzt, um wirklich eine Gruppe von Google Maps einfach zu machen. Man dachte, ja, das passt. Jetzt schauen wir mal eine Lüse auf einem E-Mail. Also ich denke, es gibt schon das Risiko, dass man wird nutzt, dass man um schneller zu arbeiten, um nicht eine Lust zu haben, die auch eine echte Interpretation der Realität ist...

f3: Ich würde es nicht als kreativ benennen, auch nicht objektiv, sondern eher um subjektive Analysen zu machen. Ich fange ja schon an damit, dass ich mir das raussuche, welche Daten eigentlich sind nicht und wenn ich mir dann die Daten anschaue, dann... Also ich schmeiß die Daten eigentlich meistens raus, wenn ich sehe, dass da ist jetzt wenig irgendwo, oder ich sage, wenn... Guck mal, das ist interessant eigentlich, dass da so wenig irgendwo ist, da fehlt vielleicht was. So eben, also ich versuchte dann schon auch, mit reinzunehmen, irgendwie eine Niveau. Und ich glaube, deswegen, das ist schon auch, dass dadurch ja so kreativ ist. Zum Beispiel mein Teampartner und ich hatten das mal, also wir hatten das krasen mit den Bodenarten, zum Beispiel, dass uns durch die Bodenarten auch gefallen ist, was mit Pflanzenarten dort dann mehr wachsen, und auch vor allem historische Erden zu gucken, den Verlauf quasi. Und ich würde schon sagen, das ist ultra subjektiv, über was wir da gemacht haben, weil wir hätten ja auch einfach sagen können, ja, also wie sieht sie da aus? Aber man hat so gesehen, wie haben sich die Böden verändert, wie hat sich die Vegetation verändert, und wie hat sich die Tiere dadurch auch verändert? Und dadurch hatten wir dann quasi die Basis für unseren kompletten Entwurf eigentlich. Deswegen glaube ich schon, dass wir da sehr, sehr subjektiv rangegangen sind, dadurch, dass wir uns schon lange über die Zeit angehen können, und ich gesagt kann, wir gucken jetzt einen Standbild an. Und ich würde auch sagen, dass man manchmal selber seine Daten subjektiv, man interpretiert ja schon sehr, aber man tut es dadurch ja schon darauf, mal lenken so, weil etwas, wo jetzt, ich will schon sagen, man kann das vielleicht auch so selber machen, man manipulieren so, dass man halt sagt, ja, wie dann, die Daten sind mir ja wichtig, das ist wichtig. Aber woher hat es die Vegetation? Ja, so, das ist aber auch das Problem der Zeit.

C.3 Interview’s question guide

Introduction

Introduce Yourself and the Research:

Briefly explain the purpose of the research.

Ensure confidentiality and anonymity.

Participant Background:

Can you briefly introduce yourself?

What is your current academic year and focus?

Have you had any prior experience with data analysis or GIS before your course with me?

1 Understanding Current Use of Data Analysis

Initial Exposure and Learning:

How were you introduced to data analysis & GIS?

What kind of training or resources were provided to you for learning these tools?

Application in Design Projects:

Can you describe a project where you used data analysis in your design process?

How do you start your design process?

What types of GIS data do you first collect?

How do you analyze this data?

Can you describe a project where you used GIS?

What specific data or GIS tools did you use?

Can you walk me through how you translated the data insights into your design?

How did your previous experiences with data analysis influence how you use GIS in your current projects?

Integration into Design Process:

At what stage of your design process do you typically integrate data analysis or GIS?

How does the use of these technologies influence your initial design concepts?

Do you find yourself changing your design based on insights gained from data analysis or GIS? Can you provide examples?

How do you think your approach to design changes when you incorporate GIS data? Why do you think that is?

What were the key moments and decisions in this project?

Describe an ideal workflow for design with geospatial data. How is the design process?

2 Impact on Urban Nature and Specul. Design

Urban Nature:

How does data analysis help you in understanding and integrating urban nature in your designs?

Can you provide an example of how GIS has helped you in planning or designing with urban nature in mind?

What types of environmental data are most useful for your projects?

How did data analysis or GIS influence your design decisions (e.g., site selection, building orientation, integration of natural elements)?

Did these technologies help address any specific challenges related to incorporating urban nature into your designs? If so, please elaborate.

Speculative Design:

How do data analysis and GIS influence your approach to speculative design?

Can you give an example of a speculative design project where these tools played a significant role?

What future scenarios or hypothetical situations have you explored using these technologies?

What types of data or functionalities within GIS software could be beneficial for your speculative design process?

3: Challenges and Limitations

Technical Challenges:

What technical difficulties have you encountered when using data analysis and GIS tools?

How do you overcome these challenges, if at all?

To what extent do you feel you have control over the use of GIS data in your design projects? Can you provide an example where you felt particularly empowered or restricted in using this data?

Data Accessibility and Quality:

How accessible is the data you need for your projects?

Have you faced issues with data quality or relevance? How do you address these issues?

Integration with Traditional Design Methods:

How do you balance the use of data and GIS with traditional architectural design methods?

Do you feel that the use of these technologies enhances or complicates your design process?

Thinking back to that project, how did you analyze the GIS data to influence your design?

Has the use of GIS changed your creativity?

How do you interpretate data objectivity?

How did it affect your time management?

Was it time saving or time consuming?

4: Improvement and Future Needs

Skill Development:

What additional skills or knowledge do you feel you need to effectively use data analysis and GIS in your designs?

How could your academic program better support you in developing these skills?

Technology and Tools:

Are there specific tools or software that you wish you had access to?

How could the existing tools be improved to better meet your needs?

Support and Resources:

What type of support (e.g., mentorship, workshops, online resources) would be most beneficial for you?

How can the integration of data analysis and GIS into the architectural curriculum be improved?

Conclusion

Final Thoughts:

Do you have any additional thoughts or insights on the use of data analysis and GIS in architectural design that we haven't covered?

Would you like to share any specific experiences or projects that highlight your points?

C.4 Interviews' transcription

The following transcriptions are presented here in the original language, as requested by each student to feel most comfortable.

C.4.1 Interview student i8

Q: Kannst du dich kurz vorstellen? In welchem akademischen Jahr bist du derzeit, und worauf liegt dein Schwerpunkt?

i8: Ich bin gerade im zweiten Semester Master. Und ich habe noch keinen Fokus ausgewählt. Letztes Semester habe ich einen Masterstudio mit städtebauliches Fokus gemacht, und jetzt mache ich gerade Hochbau. Aber ich bin tatsächlich noch einmal überlegen, ob ich meinen Fokus auf Landschaftsarchitektur oder normaler Architektur lege. Aber ich habe noch keinen Fokus gelegt, nee.

Q: Okay. Und hattest du Erfahrung mit GIS, bevor du die GIS Kursen gemacht hast?

i8: Nee, das erste Mal bei dir, im Seminar. Das war das allererste Mal.

Q: Was war das Ziel?

i8: Naja, wir haben ja die Inseln La Reunion, haben wir ja analysiert oder haben wir ja QGIS benutzt. Vor allem, weil wir ja den verschiedenen Parametern uns ja auch angeguckt haben, wie zum Beispiel die Wasserstruktur, Infrastruktur, Vegetation und alles. Und da haben wir erstmal QGIS benutzt, um die Tools kennenzulernen. Die verschiedenen Tools, die du uns beigebracht hast, also ich kann jetzt nicht jedes aufzählen, aber um ein Gefühl dafür zu bekommen, wie wir das anwenden, da haben wir ja mit OpenStreetMap und haben ja diese Seite auch mit den ganzen Begriffen, nach dem man suchen muss. Die Tiere. Genau, Tiere oder ob das jetzt was mit *'Amenity'* oder sowas. Das war ja auch von OpenStreetMap, so eine Seite, damit man die richtigen Begriffe sucht. Und wie man an Daten kommt, haben wir ja alles quasi gelernt und angewendet, erstmal bei der großen Analyse. Und es war ja so kollektiv, so dass jeder Studentin oder jeder Student ja ein Thema abdeckt zur Analyse, so dass wir dann am Ende als Gruppe von allem irgendwie profitieren können, weil wir ja ein eigenes Thema raussuchen mussten und dann hatten wir aber die ganze Basis, mit dem wir weiterarbeiten können. Das war ja das, und dann hatten wir ja jeden Thema.

Q: Das ist das erste Mal und das zweite Mal?

i8: Das zweite Mal war bei dem Stehgreif Zirkel. Da ging es ja darum, dass in Zirkel uns narrativ ausdenken, passend zum Zirkel und was mit Landschaftsarchitektur zu tun hat oder etwas, das wir dann vielleicht für später verwenden können, um Ansätze zu finden, wie wir uns einen narrativ um den Zirkel aufbauen können, mithilfe von QGIS, mithilfe, wie wir dann später vielleicht uns selber Themen erarbeiten können oder wie wir an Themen rangehen können. Das war ja so, wie ich das verstanden habe. Erst mal die Idee und dann hatten wir ja die Idee mit den Jahreszeiten und wie sich die Tiere dann, wie sich das verändert. Das war ja nur ein Tag. Die Einführung, stimmt, bei La Reunion war das sehr viel länger. Da war das in Blocks aufgeteilt. Genau, das war ja ein Monat lang. Es ging bis zu dem ersten Block, wo wir dann nur Input bekommen haben für QGIS, aber für den Stehgreif war das nur ein Tag.

Q: Wie war es für deine Kollegin, die keine Erfahrung mit GIS hatte?

i8: Sie war schon überfordert. Es war dann am Ende so, es war ja immer, dass jemand, der das schon ein bisschen konnte, wurde zugeschaltet mit einer Person, die das an dem Tag gelernt hat. Es war schon gut, dass es so eingeschaltet wurde, glaube ich. Aber das war ja schon so, dass wir dann, das war bei vielen Gruppen dann so, dass die Person, die das schon besser konnte, dann die Aufgaben übernommen hat, die dann QGIS mehr verwenden musste, weil sie hat dann zum Beispiel die Tabellen gemacht, Excel und hat noch was in Photoshop mit den Bildern. Sie hat schon noch in QGIS gearbeitet, so ist es nicht, aber sie war, glaube ich, schon ein bisschen überfordert, erst mal zu kurzer Zeit. Aber es ist ja auch ein komplexes Programm.

Q: Hast du GIS nach diesen Kursen wieder benutzt?

i8: Da gab es halt keine Daten! Ich habe es versucht, um zu gucken, was für Pflanzen es dort gibt. Und im Masterstudio war das ja auch so am Anfang, dass wir erst nur Analyse gemacht haben. Und da hatte ich zum Beispiel das Thema, mich um die invasiven Pflanzenarten zu kümmern, also zu analysieren. Und dann wollte ich das mit hier von QGIS machen, aber da gab es keine Daten tatsächlich. Vielleicht lag es aber auch daran, dass der Ausschnitt so klein war. Wobei ich das jetzt im Hochbau-Masterstudio auch mal verwendet habe. Ja, gerade eben. Aber ich habe nichts, ich habe es nicht viel verwendet.

Q: Kannst du ein bisschen beschreiben, wie hast du das verwendet?

i8: Es war einfach nur eine Analyse. Gut. Es war einfach nur um das Blum zu sagen, wir haben einen Schwarzplan gebraucht. Dafür ist QGIS richtig gut, unter anderem. Und dann haben wir es als Analyse verwendet, weil wir arbeiten mit Bestandsgebäuden, gerade für sozialen Wohnbau, und haben schon ein relativ großes Areal im Vergleich zu den anderen Studenten und so geteilt bekommen, wo wir dann sozialen Wohnbau planen müssen. Und hier haben wir schon auch einen großen Platz, den wir auch planen müssen, designen müssen. Und da habe ich es verwendet, um einfach zu analysieren, wie die Grünräume dort sind, Wasser, wie die Struktur dort ist, also die verschiedenen Layer, da ich das dafür verwendet habe, aber nicht so detailliert und tief wie den Stegreifen oder den Seminar.

Q: Welche Daten und wovon sind da rausgekommen?

i8: Es kam nicht mal wirklich Daten. Ich wollte einfach nur die verschiedenen Bereiche markiert haben, und dafür fand ich es dann ging schnell. Das war von Geofabrik. Genau, von Geofabrik und ich habe... Nein, wir hatten diesen Ausschnitt. Also wir haben in Ruppurr, am Ruppurrerschloss, ist unser Gebäude, und ich wollte einfach eine Karte haben, wo die verschiedenen Layer, wie Grünflächen, Wasser, Versiegelungsflächen, dass es einfach nur verschieden markiert ist in verschiedenen Farben, sodass ich das schneller habe. Ansonsten müsste ich es dann selber alles zeichnen, in Vectorworks zum Beispiel. Und so habe ich das schnell markiert. Aber ich habe das mit dem... Ich weiß nicht, ob das Geofabrik war, aber das war das, was wir auch im Seminar bei La Reunion gemacht haben. Aber es ging jetzt nicht so in die Tiefe, dass ich Daten bräuchte, wie zum Beispiel was für Pflanzen, was für Tiere, das habe ich da nicht gebraucht. Ich wollte einfach nur die verschiedenen Bereiche markieren.

Q: Und dann, was hast du damit gemacht?

i8: Wir haben es gebraucht, weil wir auch in den Außenraum planen müssen. Und es war gut, um zu sehen, wie wir den Außenraum auf unserem Grundstück, wie der sich einfügt zu dem Rest. Um zu sehen, wie was in der näheren Umgebung ist, an grünen Flächen, wie weit Design wird es in unserem Grundstück dafür, weil es gut einfach so ein Überblick zu haben, wie der Kontext ist.

Q: Hast du weitere Informationen gesucht, Gebäudenutzungen, zum Beispiel?

i8: Doch so, zum Beispiel hast du Bäckereien. Was gibt es da für Supermärkte in der Nähe? Was es so für Gewerbe in der Nähe gibt? Weil wir auch überlegen, ob wir im Erdgeschoss bei uns, weil das ein Riesengebäude, das ist irgendwie um 20 Meter tief und 60 Meter lang, ob wir im Erdgeschoss auch Wohnbau machen oder ob wir im Erdgeschoss nur Gewerbe machen. Und das hat auch immer mitgespielt, was es in der Umgebung gibt an Bäckereien, an Kindergärten und so was.

Q: Du hast schon ein und ein und halbes Pinup gemacht. Und was hat sich ergeben?

i8: Es hat sich dahingehend so… haben wir uns jetzt entschieden, um im Erdgeschoss durch diese Daten, die wir gesammelt haben, eine Mischung zu machen aus Wohn- und Gewerbe. Weil wir auch… es ist ein größeres Areal. Da gibt es so zwei Nachbargebäude, die sind viel größer. Die haben auch das eine, hat auch im Erdgeschoss nur Gewerbeflächen. Es sind nur Bäckereien, Kindertagesstätte, Fitnessstudio, Physiotherapie, Ärzte, Praxen. Und sonst gibt es auch bei uns in der Umgebung auch Supermärkte und gute Sachen, sodass wir gesagt haben, wir legen den Fokus. Also wir versuchen beides im Erdgeschoss, mit eins zu fügen, weil es da schon gute… gute Sachen gibt. Und… Abwenden ist noch im Entscheidungspunkt. Ja, ja, klar.

Q: Gibt es andere Sachen, die du an alles, was du extraiert hast, euch geholfen hat, um weitere Entscheidungen zu treffen, oder so?

i8: Da sitzen wir noch dran, tatsächlich. Also da gibt es ja einen Kanal, in der ihr was angrenzt, da gibt es ja auch… Wald und Gärten in der Nähe, aber wir sind da… Bisher waren wir noch zu sehr im Grundrissenkonstruktion beschäftigt, und die Umgebung haben wir halt nur mal kurz angekratzt. Und dafür habe ich dann halt nur QGIS verwendet, einfach nur zur Analyse zu gucken, was es da alles gibt. Aber wir müssten den Außenraum… ist noch mal ein extra großes Thema, wo wir das Auto mal planen, aber da sind wir noch nicht so.

Q: Und wenn du das nicht genutzt hättest, wie hättest du das gemacht?

i8: Da hätte ich auf Google Earth oder Maps verwendet, hätte geguckt, was es da gibt. Also gut, wir haben ein Lageplan, haben wir schon, oder hätte ich halt alles händisch halt markiert. Also Schritt für Schritt hätte ich das so gemacht, ich hätte das Screenshot gemacht von Maps, hättest dann skaliert auf mein Lageplan, und hätt mir dann alles händisch markiert. So, wenn ich das am Ende halt auch schön ästhetisch haben wollte, hätte ich das so gemacht. Man kann auch ein Open-Street-Map, kann man ja auch sich Karten geben lassen, oder schwarzplanen, aber ich finde dann ästhetisch halt nicht so, und deswegen hätten wir das dann alles händisch gemacht. Und mit QGIS geht das sehr schnell.

Q: Und inwiefern denkst du, dass die ganze Entscheidungsprozess geändert, weil du das so gemacht hast? Ihr seid die Einzige, die GIS genutz habt, oder?

i8: Mhm, durch mich, ja. Ich denke mal, das ist jetzt noch schwer zu sagen, wie gesagt, weil bisher wurde es immer kommuniziert, dass der Außenraum, dass der städtebauliche Kontext ein großer Fokus sein muss im Entwurf bisher, dass es nicht nur um den Wohnbau geht, also nicht um das Haus, sondern auch um den Kontext, aber bisher in den Pinups und in den Betreuungen war das eine ziemlich untergeordnete Rolle, obwohl das davor immer anders kommuniziert wurde. Deswegen weiß ich das nicht. Also ich kann mir schon vorstellen, dass es am Ende später, ich weiß es nicht, vielleicht macht es am Ende dann einen Unterschied in der Qualität, aber vielleicht auch nicht, weil letzten Endes die Daten, die ich benutzt habe, oder die Sachen, gibt es in Maps. Es ist aber schneller mit QGIS.

Q: Vielleicht ist es vollständiger?

i8: Das weiß ich nicht, ja, wird man dann sehen, aber die Sache ist halt, dass fast alle Gruppen anderen Ort haben, kann man es schwer vergleichen. Wir haben nicht alle das gleiche Gebäude oder auch nicht den gleichen Kontext. Also muss man später mal sehen, aber auf jeden Fall geht es schneller, das ist schon ein riesen Vorteil. Also wie gesagt, und dann hat mir letzte Woche wir hatten zwar mal hintereinander Pin-up gehabt und dann haben wir es erst mal hinten angestellt, weil wir es sonst zeitlich nicht geschafft hätten. Aber bisher, weil wie gesagt, in Betreuungen war der Außenraum jetzt nicht so ein krasses Thema, weil es bei allen erst noch ein

Konzert in Entwurfsfragen ging und um den Wohnbau an sich. Aber wie wäre das später, safe noch brauchen, ja.

Q: Wie ist der Einfluss von QGIS in dem Entscheidungsprozess für euch gewessen?

i8: Na ja, wir haben zum Beispiel, auch als ich da analysiert habe und vor allem auch den Kontext außerhalb unseres Grundstücks, ähm, fanden wir dann, na ja, die Sache ist die, wir haben ein sehr tiefes Gebäude, uns auch sehr lang und wir haben nur einen Treppenkern. Das heißt, wenn wir wollten versuchen, die ganzen Wohnungen mit diesem Treppenkern zu erschließen, das ist halt schwierig, weil wir wollten keinen weiteren Treppenkern machen, weil sonst nehmen wir die Fläche weg und dann wollten wir den Laubengang machen an den Stirnseiten, das geht okay und dann haben wir uns kurz überlegt gehabt, ähm, Balkone vielleicht noch an den Laubengang dranzuschließen für Nutzfläche noch zusätzlich und dann dachten wir so, ne, durch die Analyse haben wir tatsächlich gemerkt, dass der Platz ein großes Potenzial hat, allein schon wegen dem Kontext in dem er liegt hat, so planen, so dass wir dann keinen Nutzfläche den Gebäuden haben für Balkone, sondern dass es ein geteilter gemeinschaftlicher Platz draußen ist und dem müssen wir halt dann schon so umplanen und dafür ist die Analyse dann schon sehr gut. Es geht ja schon so Hand in Hand, also es hat schon krassen Einfluss auch auf das Gebäude an sich, macht man da Balkone dran oder macht, ist es da nur ein Laubengang oder ist es ein Laubengang mit Nutzfläche, weißt du was ich meine und das ist ja schon auch noch mal Einfluss auf die Kubatur vom Gebäude und da ist QGIS zum Beispiel ja natürlich sehr hilfreich weil wir da den Außenraum sehr gut analysieren können.

Q: Was würdest du machen, wenn alle Daten, die du dich wünschst, zu Verfügung geben?

i8: Okay ähm boah schwierig das ist keine einfache Frage... Ich weiß vielleicht kann ich daran anknüpfen ich überlege auch jetzt schon wie ich meine Master Thesis was für ein Thema das hat aber vielleicht kann ich ja das als Beispiel. Ich überlege vielleicht meine Thesis im Master ein Projekt in Marokko vielleicht zu machen, zu nehmen und da muss ich ja sehr viel analysieren und da ist ja QGIS sehr hilfreich hoffe ich und ich hab mit zum also es war nur hingespinnt ich hab mir das noch gar nicht im Detail richtig überlegt es war nur schnelle Gedanken aber ähm in Marokko sind ja es gibt ja Städte wie Casablanca oder Tanger die sind ja schon wirtschaftlich sehr starke Städte in Marokko und wenn man andere Städte sich anguckt ähm die sind immer die sind gerade langsam bekommen die so einen Aufschwung und ich finde es interessant vielleicht zu untersuchen oder auch so ein Szenario sich zu überlegen wie sich die Städte ähm in den nächsten 10, 15 Jahren entwickeln können aber dennoch ihren traditionellen Charakter beibehalten, ich weiß es nicht und ähm da könnte ich ja QGIS vielleicht so verwenden dass ich ähm äh ja die Daten auch von der Vergangenheit also wenn ich mir so angucke eine Stadt wie Tanger wie es sich in also keine Ahnung wie es vor 50 Jahren aussah und wie es sich dann in den nächsten 10 Jahren verändert hat und versuchen das zu adaptieren auf auf ein anderes Stadt die jetzt auf dem Stand ist wie Tanger vor 50 Jahren weißt du was ich meine aber ähm keine Ahnung weißt du was

Q: Dafür wurdest du historische Karten oder historische Bilder suchen?

i8: ja ja auf jeden Fall. Ich würde gerne was analysieren: die Altenwohnungsgebäude die Altenwohnungsgebäude die Altenwohnungsgebäude also klar die traditionellen Altenwohnungsgebäude ne die so was würd ich dann analysieren wie es sich halt dann wie die sich in dem städtebaulichen Kontext vielleicht dann verändert haben in den wie gesagt ich habe mir jetzt nicht so krass Gedanken gemacht aber es ist auch keine einfache Frage.

Q: Wie wirst du in Marokko deinen Fokus auf urbane Natur umsetzen, und wie kann geografische Datenanalyse dir helfen, die Natur besser zu verstehen?

i8: naja ich kann nur also mit meinem Standwissen jetzt würde ich es halt so versuchen zu analysieren und anzuwenden wie ich das jetzt in dem Seminar oder Stehgreif gelernt habe aber ich weiß, dass ich bis jetzt nur an der Oberfläche gekratzt habe mit dem Seminar und dem Stehgreif und dann siehst du, ich hätte es nicht gemacht aber der hatte schon das ist okay ich hätte da schon die also so hätte ich jetzt zurückgegangen die Natur hätte ich erstmal geguckt was für Pflanzen es gibt es dort und dann hätte ich auch mit da wird ja auch immer da gelegt seit wann die Pflanzen dort gesichtet wurde vor allem wenn ich ein iNaturalist wird es ja zum Beispiel auch immer als gelistet wann wo die Pflanze da zum Beispiel gefunden wurde oder gesehen wurde aber ich würde mich ja nochmal online informieren dann könnte ich mal mal gucken was es gibt da für invasive Pflanzen so würde ich erstmal versuchen die Natur zu verstehen also auf Pflanzen zu holen und klar dann gibt es natürlich auch das Wassertema es ist gerade auch sowieso ein hochaktuales Thema in Marokko Wasser vor allem Wassernot ja so was

Q: Wie hast du GIS in dem Stegreif von Zirkel benutzt?

i8: Wir konnten ja dadurch ja ganz gut untersuchen wie die Tiere wie der Aufenthalt der Tiere innerhalb des Jahres in den verschiedenen Jahreszeiten wurde am stärksten ist oder welche Gattung von Tier sich wo am meisten aufhält das konnten wir mit den Daten ja ganz gut untersuchen da haben wir auch geguckt wie halt in den vier Jahreszeiten wo sich der Adler am meisten aufhalten wo die gesichtet wurden wo es die ganzen in anderen Vögeln gibt die Insekten das ist das was wir untersucht haben in dem Stehgreif und das haben wir dann aufgezettelt in verschiedenen Gattungen oder in der Familien der Tiere und hast ja dieses Netz gegeben

Q: Wie könntest du den nächsten Schritt für deinen Entwurf überlegen, besonders im Hinblick auf invasive Pflanzen, und gibt es Ansätze, die dich dabei inspirieren könnten?

i8: ich muss auch ehrlich zugeben ich wusste ich konnte bisher war es immer in den Stehgreifen dass wir uns narrativ ausgesucht haben und dann hast du ja als vor allem beim Stehgreif hast du gemeint wir sollen uns was überlegen was wir später als Entwurf machen können aber dieses Verknüpfen hat mir sehr schwer gefahren also ich könnte auch jetzt tatsächlich nichts sagen wie ich diese Daten oder das was wir untersucht haben wie ich das in ein Entwursthema übersetzen könnte diese Verknüpfung wird mir schon schwer. Ich finde QGIS ist sehr hilfreich auch vor allem um irgendwo anzufangen irgendwo um einen Ansatz zu finden oder um Analysen zu machen aber mir fällt es dann doch schwer diese Verknüpfung zu machen

Q: Ist diese Schritt schwieriger als wenn du die Analysen einfach nur händisch

i8: Neee mir das liegt nicht daran dass es am Computer oder händisch ist mir fällt es vielleicht einfach an Kompetenz oder weiss nicht aber mir fällt es dann schwierig z.B. das Stehgreif was wir gemacht haben mit einem Zirkel finde ich das schön aus aber ich wüsste jetzt nicht wie ich das in ein Entwurf oder was ich da rausziehen könnte für ein Entwurf würde ich mich, da tue ich mich schon schwer.

Q: Hast du gesehen ,wie deine Kommilitonen das benutz haben?

i8: Ich verstehe schon dass es dann helfen kann aber bei einigen Themen ist es leichter bei anderen vielleicht schwerer aber ich wüsste bei dem was wir explizit gemacht haben mit wie die ganzen Tiere, klar wo die Tiere sich aufhalten und wie die in den verschiedenen Jahreszeiten sind kann man natürlich sagen okay in den Jahreszeit möchte man hat vor ein Pavillon in dem Park zu errichten oder was weiß ich und dann hat man die Tiere in dem weiß was ich meine aber das ist das erste was mir so einfallen wird aber ich finde bei unserem expliziten Thema fällt es mir schon schwer mit zu überlegen wie könnte ich das irgendwie in einen Entwurf interpretieren oder weiterdenken

Q: Und wenn du nicht mehr einen Entwurf als Architekt machen solltest sondern einen Entwurf als Landschaftsarchitekt weil das dir interessiert ?

i8: Ja genau so... auch ja ...mir fällt es ja ich meine ... was macht man da jetzt als Landschaft Architekt im Schlosspark das ist schon fertig gebaut den ganzen Welt ist fertig gebaut wir müssen nicht in nichts mehr bauen und wir wollen nicht am Schloss Zirkel ist das schon schön muss man nichts mehr ändern nee als Landschaft Architekt weiß ich weiß ich nicht also mir fällt einfach diese Verknüpfung schwer glaube ich aber es war auch wie in Städtebau auch damals diese Verknüpfung von wenn man die Analyse fertig hat wie man die Analyse dann interpretiert in irgendeine Richtung , in ein Konzept, diese Schnittstelle, finde ich fällt mir persönlich schwer das in Architektur zum Beispiel habe ich das Problem nicht. Da bin ich sehr schnell

Q: Wie nutzt du denn QGIS oder wie würdest du es gerne benutzen?

i8: Vor allem hatte ich erstes Arbeiten mit einem Bestand und im Zirkel auch aber du denkst das ist der Bestand das ist ja auch gut das ist auch Bestand aber ich glaube da ist es wieder was anderes weil ich während dem Entwurfsprozess vor allem Gebäude diese Analyse benutze und nicht quasi die Analyse um dann als Startpunkt in einen Konzept. weil mein Konzept habe ich ja schon ich benutze es nur um als Unterstützung zu argumentieren benutze ich da Nutzflächen am Balkon am Laubengang oder nicht

Q: Denkst du das zum Beispiel dein Entwurf von Parc de la Villette sich auch ändern wurde wenn...

i8: ...ich das QGIS genutzt hätte? mein Entwurf mein Entwurf war sehr gut schwarz ich glaube der Entwurf an sich hätte sich glaube ich ich weiß nicht ob er sich geändert hätte weil ich mich tatsächlich wir mussten ja sehr viel analysieren im Par de la Villette und auch mit der Analyse unser Konzept bearbeiten so war das damals wenn man hat aber letzten Endes hat jeder von uns aber ich glaube nicht so viel mit der Analyse was gearbeitet und ich glaube nicht dass es bei mir explizit ist was was verändert hätte.

Q: Welche Art von Daten wären für dich wichtig ?

i8: Meinst du generell ich glaube das ist ja schwierig weil es kommt doch immer darauf an was man da gerade braucht ja oder was man da jetzt hat also am besten ist natürlich alles zu haben. Aber ich also was man da jetzt was man da braucht es kommt immer darauf an

Q: Und für Natur in deine Masterstudios?

i8: Da haben wir es tatsächlich sehr lange gesucht aber nichts wirklich geführt wir haben versucht es uns damit zu sagen du bist halt zusammen zum Schuss dann zu rein. da haben wir versucht den Bodenbass herauszufinden da kamen wir wir haben nichts gefunden Topografie aber das hatten wir dann haben wir dann schon hinbekommen zu den Pflanzen verschiedenen Pflanzenarten wir hatten eine PDF mit ein paar von haben wir bekommen aber das war auch sehr oberflächlich glaube ich, kann mich nicht mehr erinnern da wäre es schon gewesen wenn das detaillierter geworden viel detaillierter wäre. und ja . Gebäudepläne

Q: Mit was wurdest du spekulieren? Mit der Bevölkerung? Mit der Natur? Mit der Gebäude? Mit was?

i8: Alles geht ja schon Hand in Hand Menschen, Natur Gebäude. Das ist halt die Sache ich finde vor allem im Land wie Marokko wenn ich jetzt zum Beispiel an die ganz kleinen Städte und Ortschaften denke wo es noch wo zum Beispiel auch viele Berber noch leben die sind. Riffgebirge sagt das was und da kommt meine Familie her ursprünglich und die Menschen lehnen da schon noch sehr abgeschieden teilweise ein bisschen aber es gibt gerade so ich habe gelesen es gibt zum Beispiel Investitionen von Qatar oder Dubai oder China tatsächlich wo die da in das Land investieren was ich nicht gut finde aber okay oder gibt es schon Bestrebungen das zu einem Dubai 2.0 zu machen. Furchtbar. und weil Dubai hat nichts mit Kultur nichts mit Kultur zu tun und ich fände es halt schon gut zu überlegen wie kann man wie lässt sich dieser Fortschritt diese städtebauliche oder technologische Fortschritt denen die halt vorhaben wie lässt er sich bewerkstelligen aber trotzdem im Hinblick dass die Kultur und Tradition halt nicht verloren geht, weißt du was ich meine ? Und da spielt ja schon die Menschen dort eine sehr zentrale Rolle weil die sollen ja nicht gentrifiziert werden oder sonst irgendwas da wissen alles nur so verschiedene Punkte die ich so im Kopf habe aber ich finde es schon interessant damit was zu machen aber wie die zusammenkommen wie gesagt so weit habe ich noch gar nicht überlegt ich habe ja noch 2 Semester Zeit.

Q: du hast gesagt du willst diese Art von Dubai 2.0 nicht welche Art von Szenarien könntest du dich vorstellen?

i8: ja das muss man halt genau untersuchen also klar du bei 2.0 nicht aber was käme dann stattdessen und das ist ja das was man dann sich überlegen muss weil wenn man sich Golfstaaten anguckt zum Beispiel die haben ja alle so einfach nur Hochhäuser nicht schön und es sieht alles so künstlich aus und die haben halt viel Geld und Hauptsache wenn man baut da irgendwas bisschen grün und künst und künstliche Inseln was weiß ich aber dann zu überlegen okay was gibts denn was anderes also das ist ja das was man dann untersuchen muss weißt du aber vielleicht ist es eine sackgasse.

Q: Warum findest du den Link zwischen Analyse und Entwurf einfach, überlegst aber trotzdem etwas in größerem Maßstab?

i8: weil ich finde das ja schon interessant ich finde ja schon das Thema sehr interessant was ich als es war ein großer Maßstab ist aber sehr interessant, und nur weil es mich schon erfällt heißt nicht dass ich das nicht mache.

Q: Welche Schwierigkeiten hattest du, als du versucht hast, mit GIS weiterzuarbeiten – oder eben nicht?

i8: Zum Beispiel jetzt in La Reunion da hatte ich jetzt mein Thema das mit den Pilzen aber ich wusste ja erst am Ende dass das was rauskommt mit Pilzen das habe ich ja während dem Arbeitsprozess hatte ich das ja gar nicht auf dem Schirm sondern erst als ich die Sachen ausgewertet und kategorisiert habe in dieser Liste mit Daten weißt du noch ob du dich noch erinnerst eine undefinierte Gattung oder Mensch hat sich herausgestellt dass es alles Pilze waren und es war das was ich ja dann hatte am Ende von den Karten ursprünglich wollte ich

Q: Aber was wären deine Probleme, deine Schwierigkeiten?

i8: Also bei La Reunion tatsächlich hatte ich viel weniger schwergetan also habe ich mich gar nicht schwer getan muss ich ehrlich sagen weil ich einfach die Daten das war eine große Excel Datei mit den mit der Vegetation und ich wollte es erst mal nur sortieren nach Order und dann hatte ich ja es war einfach nur ein Zufall glaube ich war ja gesehen dass es diese undefinierte Order gab und dann habe ich halt nur gesehen dass dich ja schon so ein Muster halt auf der Karte halt einfach nur ergibt und nachdem ich dann geguckt habe kam heraus dass es Pilze sind die noch undefiniert oder nicht klassifiziert sind von Researchern da hatte ich gar keine Schwierigkeiten.

Beim Zirkel hatte ich Schwierigkeiten aber auch nur glaube ich da hatte ich es auch mit anderen drüber aber auch nur weil wir uns das am Kopf davor so kompliziert gemacht haben weil du mal meintest wir sollen uns ein Narrativ überlegen wie hast wir dass wir mit Hilfe des Themas was wir uns überlegen später auch einen Entwurf mitnehmen kann ich glaube das war dann das Problem weißt du was ich meine ? weil wir uns dann überlegt haben was könnte man später für einen Entwurf daraus machen uns ist nichts eingefallen dann haben wir Thema abgehakt. bei La Reunion bei dem war es ja nicht so das war ja macht irgendwas am Ende kam ja einfach mal so und könntest du dir überlegen da was weiter zu machen. aber wenn man im Vorfeld schon das dem Kopf hat ich muss jetzt ein Thema suchen damit ich später damit dann haben wir uns so haben wir uns schwerer getan.

Q: Du meinst graphisch?

i8: das war ja auch ein Problem, das war ja auch ein Problem, ja klar das war auch nicht schön. das war nicht schön. ja -du musst mal ausdrucken und gucken und alles. Das kann sein doch grafisch war das auch ein Problem das stimmt. Am Ende fand ich es gut ganz am Ende bei der zweiten Abgabe fand war ich zufrieden. Beim ersten fanden wir selber nicht gut aber wir hatten keine Zeit das ist auch wir dachten uns irgendwann es ist ein neuen Stegreif.

Q: denkst du das hättest dir noch was gefällt oder denkst du dass du etwas gerne lernen wolltest und dir helfen könnte?

i8: es gibt ja in diesem was ich gerne viel mehr vertiefen würde wo ich auch gerne verstehen würde wie das wirklich besser klappt und wie das geht von workflow. wir hatten dieses Buch das lag hier letztem Semester als ich hier Studio gemacht habe ich weiß nicht wie das Buch heißt aber es lag bei uns immer rum es waren alles so verschiedene Maps von der ganzen Welt mit verschiedenen Daten ich glaube es waren auch alles mit QGIS gemacht es war ein sehr schönes Buch ähm und es war grafisch es sah alles mega schön aus und ich mag das so Karten wo jeder Punkt nicht so willkürlich ist sondern die ganzen Punkte nicht willkürlich weil das willkürlich ist dass alles so einen Sinn hat dass jeder Punkt auf so einer Karte einen Daten halt hat das finde ich ja gut jeder Punkt hat einen Wert ein Wert hat. und das war in diesem Buch fand ich das sehr schön und da gab es ja auch bei einem anderen Projekt von irgendeinem Studenten das hast du uns mal gezeigt das ist auf dem Oliver mit diesem Raster mit den verschiedenen Größen und Kreisen. das hat auch alles die hat das würde ich gerne sehr gut können .aber ja das wäre jetzt das Erste was mir so auch einfällt

Q: wie denkst du dass wir das besser in den ganzen Studium integrieren könnten? denkst du dass wir es dass du das zu spät gelernt hast ?

i8: ich will mal jetzt im vierten Bachelorsemester schon lernen können. Ich finde es auch viel zu spät ich habe es ja erst im siebten in dem Seminar gelernt dass er ja nach meinem Bachelorthesis und ich jetzt für die Bachelorthesis wäre es so hilfreich gewesen aber ich finde man sollte das schon im Bachelor schon fester Bestandteil im vierten Semester wenn man sowieso stellbar macht schon gut auch im Seminar also ihr macht es ja im Studio wahrscheinlich, oder? könnt ihr auch in dem Seminar machen

Q: Gibt es etwas das ich dich nicht gefragt habe und dir wichtig ist oder gibt es vielleicht etwas es gibt gar nicht um das und ich wollte unbedingt uns sagen dass das ganz schwierig war?

i8: Nein

C.4.2 Interview student i9

Q: ¿Puedes presentarte? ¿En que curso estás? ¿Haces alguna especialidad en concreto?

i9: Ahora curso Master, este es mi tercer Entwurf. Quiero especializarme en construcción.

Q: ¿Tenías experiencia previa en GIS, antes de hacer este curso?

i9: No. Después lo he usado en dos. En el primero, que sí sirvió bastante porque en Amsterdam, y en Amsterdam hay muchos datos.

Q: Intenta explicar un proyecto, a lo mejor el de Amsterdam, en el que utilizaste análisis de datos dentro de tu proceso del proyecto.

i9: Bueno, el proyecto se trató de volver a utilizar un garage, un parkhouse, bastante grande con el tema de biodiversidad. Y en los datos encontramos, bueno, muchos geodatos de los animales y las plantas, y el recorrido de los animales. Y eso nos ayudó en el proyecto para saber, por ejemplo, un poco random, pero ¿cuál es el recorrido de los murciélagos? ¿Dónde poner los nidos o cuál es la dirección exacta donde se pueden poner tales plantas o exactamente qué plantas hay alrededor, qué plantas dañan, qué plantas no, y todo eso lo hicimos primero en el análisis. Y los resultados lo usamos. Ese fue, claro, mi primer estudio de maestría que le hice.

Q: ¿Cuáles son los datos que recopilasteis? ¿Qué datos teníais?

i9: En específico, bueno, la verdad, bastantes de las geolocalizaciones de animales de... bueno, recorridos, no sé si es exactamente de los animales, sino de sus migraciones. En verano, cuáles están, en invierno, de plantas, sobre todo, tipos de árboles también. Geolocalizados, claro. Y para saber dónde poner qué árbol es dentro de la zona del proyecto. Bueno, los edificios, claramente, y también nos ayudó el saber el uso de los edificios cerca.

Q: ¿Esto es donde lo teníais? ¿Dónde los encontrabais?

i9: De OpenStreetMap. Una combinación de OpenStreetMap, pero Amsterdam también tenía una página de Geodaten, pero al final no pudimos obtener todos los que queríamos porque eran un poco más estrictos. Tenemos que enviar una carta de la universidad para que nos dieran permiso, pero ahí habían muchísimos más que hubieran sido útiles, pero simplemente no pudimos.

Q: ¿Pero haría más que los que encontrasteis aquí en Karlsruhe, por ejemplo?

i9: Había más específicos. No sé si acá encuentra el recorrido de una especie de ave. En específico, ya había 100 especies de aves, diferentes tipos de zorros. Por eso digo, en ese proyecto fue el que más lo usamos y creo que no muchos grupos tenían el acceso. Y nos preguntaban también. ¿Cómo lo tenéis?

Q: Y claro, los demás no lo tenían.

i9: En ese grupo no.

Q: ¿Y cómo analizasteis los datos? Una vez recopilasteis todo, ¿cómo hicisteis el análisis?

i9: Primero lo pusimos todo en el programa y veíamos dónde se encontraban los aspectos importantes, los temas. Y dependiendo de eso, hacíamos zoom en ciertas partes y lo analizábamos más en el programa de CAD. Y los resultados, por ejemplo, del sur está por, no sé, el sol crece tal planta y es una planta importante para Amsterdam. Entonces lo tomemos en cuenta para el siguiente paso.

Q: Me interesa mucho el proceso del proyecto. ¿Recuerdas si una vez que empezaste a tomar ciertas decisiones, seguíais incorporando cosas de GIS? ¿O lo usasteis sobre todo al principio y luego ya tenéis más claro cómo iba a ser el proyecto? ¿Hasta qué punto lo usasteis? ¿En qué momento lo usasteis?

i9: Al principio, de todas maneras, más intensivo. Pero en algún punto teníamos que parar porque con muchos datos no teníamos que tomar ciertas decisiones. Y bueno, solo son cuatro meses que tenemos tiempo para hacer. Ya para los últimos dos meses, creo que ya no usábamos él.

Q: ¿Y los usasteis, pero los dos primeros sí?

i9: Sí, pero a veces era solo para nosotros. No siempre tomábamos decisiones en base a eso, pero nos ayudaba al menos a no tomar otras decisiones. Si pensábamos en algo, nos damos cuenta que no tiene sentido, gracias a los datos. Pero no necesariamente nos traía todas las respuestas que necesitábamos.

Q: ¿Y puedes explicar un poco en qué se convirtió ese proyecto?¿Puedes nombrar más momentos en los que crees que acabasteis utilizando GIS para definir aspectos del proyecto?

i9: Sí, estoy pensando que eso fue hace bastante, dos años, tres años. Sé que tuvimos en cuenta el recorrido de las aves para poner los nidos en las paredes. Y fuimos concretando solo el decir qué tipo de ave, por ejemplo, que lo obtuvimos de QGIS. No puedo acordar ahorita algo más específico. En el proyecto de hora en Freiburg, o sea, también lo estamos utilizando mucho.

Q: ¿Y cómo lo utilizas? ¿Qué datos encuentras? ¿Qué datos has usado?

i9: Bueno, los usos, el uso de las superficies, si es gewerbe, o handel, o wohnen, flächen...

Q: ¿De dónde los obtuvisteis?

i9: De Freiburg. Tiene su página Freiburg, si hay muchos datos. Y nosotros estamos analizando primero los usos, porque el proyecto se trata de cómo proyectar la ciudad en el "ring", cómo podríamos unir más, o cuál sería un concepto para el crecimiento de Freiburg. Y primero analizamos qué usos hay adentro de la *"Innenstadt"* y qué usos hay afuera, y era mucho más rápido con QGIS, que con Freigis, la plataforma de la ciudad. Y pudimos darnos cuenta que afuera hay muchas funciones que nos interesan y tratamos de unirlas.

Q: ¿Usaron GIS los otros estudiantes?

i9: No. Ah, y nosotros lo usamos sobre todo para las zonas verdes, porque ahí están definidas que es *"Waldgebiet"*, o diferentes tipos de verdes que no te has encontrado cuando lo buscas solo en Google o en Freiburg.

Q: ¿Qué cosas están cambiando del proyecto porque tengáis acceso a todo estos datos?

i9: Para el análisis, de hecho, para llegar al concept plan, sí fue bastante importante porque nosotros decimos en esta parte, afuera hay "Gewerbe" o "studentische Wohnheim", hay muchos estudiantes que van en la parte de adentro, hay muchos estudiantes en Wohnheim, y la conexión depende del usuario o el uso. Y de ahí salió el concepto de esta parte del ring para nuestro proyecto.

Q: ¿Podrías intentar explicar como es vuestro workflow? El proceso de lo que habéis empezado, a dónde estáis y a dónde queréis llegar, intenta explicar ese proceso.

i9: Con esos datos hemos analizado qué zonas vacías encontramos y dependiendo de lo que lo rodea, estamos viendo cuál sería un uso que puede llenar ese vacío que tenga en cuenta el contexto. Y después lo que sigue es diseñar exactamente esa zona, pero aún seguimos usando QGIS. Sí, sobre todo porque también tiene que ver con el planeamiento del transporte. Ahorita estamos trabajando en eso exactamente, en colaboración con ingenieros de transporte.

Q: ¿Y cómo os comunicáis con ellos?

i9: Ellos también usan QGIS.

Q: Y los alumnos que no saben usar GIS, ¿qué hacen? ¿Cómo intercambian información?

i9: No sé, pero nuestro estudiante de Transporte nos mandó su QGIS con las ciclovías, incluso donde están los puntos de carga eléctrica para cargar los coches, las *"Umweltzonen"*...

Q: ¿Y todo eso te lo mandaba por GIS?

i9: Sí, incluso un plano de la zona donde se supone que... Sí, porque eso está mejor de limitar ahí. Todo lo sacamos de QGIS. Y de base a eso también estamos organizando nuestro barrio sin autos.

Q: Entonces, no sé cómo podríais trabajar con él, sino...

i9: No, nosotros tampoco.

Q: ¿Y lo que no sé cómo lo hacen los otros?

i9: Nosotros somos un equipo de tres personas con experiencia en GIS porque seguimos uno de tus seminarios. Por eso es que estamos siempre en QGIS ahora. Sí.

Q: Para el proyecto de Amsterdam, has dicho muy claro cómo lo usabas para los temas de naturaleza, porque si no, esos son más difíciles el mejor de encontrar. Y de repente para el de Freiburg también me dices, bueno, y para las zonas verdes, ¿GIS es especialmente más necesario para lo natural?

i9: Bueno, ahora los animales, sinceramente no sé en qué otra plataforma encuentras, o puedes usar los datos disponibles por las ciudades. Pero la zona verde diría que sí es importante, es algo que ahorita mismo nos estamos enfocando en las zonas verdes. Pero lo tenemos de referencia.

Q: ¿Y hay alguna manera en la que se integre la parte de naturaleza dentro de la ciudad, o dentro del proyecto que estáis haciendo ahora?

i9: Sí, siempre es un propósito final, creo que todos los grupos.

Q: Pero ¿hay algo como un poco particular en lo que estáis haciendo?

i9: Ah, bueno, sí, biodiversidad. Obtuvimos los datos de los *"Biotopverbund"* y nos dimos cuenta que en la parte del Schloss, justo... Bueno, ahorita hay un proyecto que se está haciendo en Freiburg, que es el túnel, que va a ser una promenade de arriba, entonces hay un gran parche verde ahí que... A lo largo del Dreisam. Y nosotros vamos a continuar ese parche, digamos, hacia arriba. Pero sí, *"Biotopverbund"*, lo estamos teniendo en cuenta para poner las zonas verdes donde tiene sentido. Pero aún no hemos llegado a ese punto.

Q: ¿Qué más datos sobre naturaleza o medioambiente han sido importantes para vosotros, que hayáis encontrado o que hayáis buscado?

i9: Bueno, aparte de todo el ráfico, que también.... Ah, agua, por supuesto. Primero, analizar dónde están los cuerpos de agua en la ciudad, porque a veces no es tan fácil verlo por Google. Y sobre todo los... Bueno, en Freiburg, en realidad, hay bastantes cuerpos de agua que están fuera del centro de la ciudad. Y el Dreisam. No tenemos el *"Baumkataster"*, en Amsterdam también era así de completo como en Zürich. Bueno, parecido, no sé si más o menos. Pero, sí, hasta altura y ancho.

Q: Vamos a hablar de especulación ¿Has trabajado con una especulación después del seminario de GIS? ¿Has vuelto a trabajar con algún diseño muy especulativo?

i9: El de Amsterdam. Es especulativo.

Q: ¿Y cómo influye trabajar? ¿Cómo consigues especular a través de los datos?

i9: Creo que... A ver, con los datos, continuamos el proyecto y llegué a un punto en donde tomamos decisiones en base a nuestras especulaciones: puedo saber dónde poner los nidos de animales. El proyecto era un *"reverse zoo"*, al comienzo. Eso era nuestra especulación, pero fue cambiando a algo menos ambicioso, porque era muy loco. O sea, tener a los animales libres y a las personas encerradas. Así comenzó porque pasaban muchos animales, pero al final no fue así. Bueno, pero eso os llevó a hacer una primera especulación, que era liberamos los animales, encerramos las personas, y luego eso evolucionó, esa primera especulación, evolucionó hacia un proyecto. Sí.

Q: ¿Cómo? ¿En qué se convirtió?

i9: Al final terminó siendo... un conjunto de terrazas. Hicimos más grande la superficie, pero tratamos de dejar espacios libres y diferentes niveles. Sí, o sea, la forma cambió, pero igual... Es un poco difícil de la especulación llegar a un proyecto.

Q: ¿Lo has usado de alguna otra manera?

i9: Es que solo he usado en esos dos proyectos después, me parece.

Q: Tus compañeros de proyecto este año también tiene experiencia en GIS, y cada uno desarrolló un tipo de investigación particular con GIS. ¿Volvieron a usarlo como en el primer curso?

i9: No.

Q: Dime qué problemas has tenido o te has encontrado.

i9: Bueno, no sé si es algo tonto, pero a veces, al crear las capas, me olvido de guardarlas y después tengo tantas capas que no sé cuál tengo que volver a guardar y cierro el proyecto y todo se perdió. Bueno, el layout, a veces no es tan fácil de crear o que se vea estético en general. Además, a veces, pero eso no sé si es problema de QGIS, los edificios no concuerdan al 100% la ubicación de los edificios en otros planos. Y cuando les exportamos como DWG... explota.

Q: Háblame del tiempo que se necesita o de qué se usa, o cómo te parece que el tiempo que se invierte es adecuado para el resultado que se obtiene.

i9: Sí, es rápido solo. Lo difícil de veces es buscar los datos necesarios porque creo que al principio descarga los datos que encuentras y toma más tiempo filtrar. Pero si ya sabes y tienes experiencias en el programa, creo que obtienes resultados rápidos a usar en QGIS. Pero si... Para allá al final, digamos, no sé... Sí, probablemente inviertas más tiempo. Pero se depende qué tan detallado lo quieres.

Q: ¿Cómo superas un poco todos esos problemas? Los de las capas, los del tiempo, todos...

i9: Yo a veces no cierro el programa. No lo cierro. Lo tuve abierto por uno... o dos meses. Es que ya llegó un punto donde... Nunca pude en mi lado. Tengo cuatro copias de la misma capa con un nombre diferente, porque creo que intenté cortarlo, superponerlo con algo, pero... No borré la capa anterior, y por eso es que no cierro mi laptop, porque no sé cuál es el correcto, y estar clickeando para ver cuál es.

Q: ¿Hacer eso limpio lleva más tiempo?

i9: Sí, sí, definitivamente.

Q: ¿Y hasta qué punto crees que tienes más control del diseño?

i9: Ah! En el análisis, sobre todo. Sí. Yo diría que sí. La primera semana ya teníamos la imagen de Freiburg con todas sus partes, digamos. A veces más, todos los grupos se enfocaron en una zona más pequeña. El proyecto es el centro de la ciudad y el ring. Nosotros vimos toda la ciudad y nos elogiaron eso. Que buena idea, que tengan en cuenta todo Freiburg. Incluso lo avanzamos más hasta de Dreilandeck. Obviamente lo filtramos y algunas cosas las hicimos más fáciles porque era imposible poner 8 verdes. Pero... Sí, sobre todo en el análisis y creo que ya después depende de... las capacidades de uno para seguir avanzando con los datos.

Q: ¿Y cómo haces un poco como equilibrio entre diseño tradicional?

i9: Bueno, es verdad. La verdad ahora estamos dibujando sobre los planos A1 que imprimimos. Bueno, ahora estamos dibujando porque estamos siguiendo una escala más pequeño, pero creo que va a llegar a un punto en donde solo vamos a trabajar con ArchiCAD.

Q: ¿Cómo de accesible veías los datos a los que podías llegar?

i9: Bastante, en Freigis hay muchos, diría yo. Yo siempre me quejo, pero...

Q: Y te parecía que a veces había problemas como con la calidad de los datos?

i9: Sí! A veces la geometría era un poco rara, que no es muy perfecta. Y también... faltaron ciertas cosas, ¿no? O sea, por ejemplo, en Amsterdam tenías los animales y en Freiburg uno los tienes. En Freiburg la tabla de... atributos no tiene nada. Hay pocos. O sea, el mundo está claro, pero de ahí los otros edificios, ¿no? Me acuerdo que en Karlsruhe podíamos filtrar mucho más rápido.

Q: ¿Y crees que usar GIS mejora el proceso o que complica el proceso de diseño?

i9: La mejora... que creo que lo mejora. Pero hasta cierto punto, si nunca paras de analizar datos, nunca terminas el proyecto. Pero... como un... empujón, digamos.

Q: ¿Y te parece que ha cambiado la creatividad?

i9: La creatividad, al usar los datos? No diría que ha cambiado la creatividad. Al menos no, en mi caso.

Q: ¿Crees que hubieses hecho el mismo proyecto en Amsterdam sin GIS?

i9: Ah, no. Creo que no. Hubiéramos tomado otro... otro... otra ruta, no sé. Igual, el proyecto nunca lo llevamos a terminar, terminar, porque nos fue un tiempo, pero... sí, supongo que sí.

Q: ¿Te hubiese hecho falta GIS en tu primer pryecto urbano?

i9: Sí. A lo mejor... es que también fue un semestre online. Entonces era un poco difícil.

Q: ¿Te parece que hay algo que se pueda hacer mejor?

i9: Bueno, creo que GIS lo usan sobre todo los que hacen urbanismo... Creo que es importante también tener una pequeña instrucción, que se ponga como herramienta. Ah y es gratis también, al menos, QGIS...

C.4.3 Interview student i10

Q: Kannst du dich kurz vorstellen? In welchem akademischen Jahr bist du derzeit, und worauf liegt dein Schwerpunkt?

i10: Also ich bin jetzt fünftes Semester von Master, ich mach grad meine Mastervorbereitung und noch einen städtebaulichen Entwurf und eigentlich fokussiere ich mich eher auf Städtebau.

Q: Hattest du Erfahrung mit GIS, bevor du meinen Seminar gemacht hast?

i10: Nein.

Q: Wie hast du GIS wieder benutzt und wo?

i10: Also ich hatte auch ein städtebauliches Seminar. Es ging so, so ein Fahrrad, wie kann man statt Karlsruhe sicherer für Fahrradfahrer gestalten. Und da habe ich auch mit Kommilitonen zusammengearbeitet, die auch GIS von deinen Kursen könnten. Und wir haben richtig viel QGIS auch benutzt dafür. Das war ein Seminar. Und dann haben wir auch QGIS benutzt. Und also im Seminar selber haben die auch QGIS gezeigt und so. Aber wir konnten schon die Basics, was eigentlich ein Vorteil dann war. Und meine zwei Kommilitonen haben sogar den so gezeigt, wie man es nutzt.

Q: Wenn, gezeigt?

i10: Den Dozenten. Sie haben die Sachen gesagt, ja, aber das haben... Ja, genau. Also die zwei sind schon deutlich so besser als ich im QGIS. Ich muss auch sagen, zum Beispiel, wenn ich jetzt sehe, was ich gemacht habe: also ich glaube schon, dass meine Skills jetzt deutlich besser geworden sind. Und generell haben wir es jetzt auch für Studio benutzt, viel. Also erst mit zwei Kommilitonen die auch QGISvon deinem Kursen können. Auch generell Freiburg gibt es voll viele Daten online.

Q: Wie war die Einführung zu QGIS von anderen Fachgebiete?

i10: Es war sogar weniger als ein paar Tage. Ich glaube, das war so zweimal. Okay. Ja, aber halt so eine Stunde jedes Mal, vielleicht kurzer.

Q: Was können die Studierende nach der Einführung machen?

i10: Ich bin mir nicht ganz sicher. Also wir müssen schon ein paar Sachen einfügen und so. Aber können, würde ich nicht sagen. Und der Dozent hat auch gesagt zu uns, dass es etwas zwischen Chaos und Genie war. Aber ich glaube, das liegt auch daran, dass wir sofort so es ausprobieren möchten. Und alle drei wollten sofort irgendwie dran arbeiten. Und bei denen ist es irgendwie mehr so... geleitet.

Q: Wie hast du QGIS in deine Entwurfsstudio genutzt?

i10: Für den Masterentwurf in Amsterdam haben wir es benutzt. Das ist für Studio, was wir eigentlich benutzt haben, glaube ich, hat es uns voll viel geholfen, weil es ist reine so Analyse, und wir haben Sachen überlagert und dann auch so Verbindungen zwischen den Sachen gefunden. Und zum Beispiel, wir hatten letzte Woche ein Gespräch mit der Stadtverwaltung, und die haben gemeint so zu uns, die räumlichen Verbindungen, die wir geschafft haben, ergeben voll Sinn, was sie ein bisschen wundert, dass wir so ein gutes Verständnis für die Stadt in so einer kurzen Zeit geschaffen haben. Und ich glaube, das liegt auch wirklich nur an QGIS, und dass wir Sachen so ausprobiert haben, überlagert haben, und geschaut, wo sich Sachen überschneiden und so. Ja, es hat uns eigentlich voll weitergeholfen. Und generell aus dieser jetzt Analyse haben wir komplett unser Konzept entwickelt, und das eigentlich mehr oder weniger steht. Jetzt muss man so ausarbeiten. Aber so die Bereiche, wie wir es gestalten möchten, kommt gerade aus der Analyse aus QGIS dann.

Q: Welche Daten habt ihr dafür geholt?

i10: Ja, also meistens von dieser Freigis, also die Webseite, die haben echt viel: Nutzung, Biotopen, Wasserflächen, weil da gibt es im Freiburg so diese Bächle und so. Das war auch alles angezeigt. Gebäude, Schwarzplan haben wir draus gezogen. Luftbild. Auch eigentlich generell so, was wir als Vorlage benutzt haben, haben wir in QGIS also vorgemacht, und es dann ins ArchiCAD reingezogen, zum Beispiel so die Linien, Gebäude und so.

Q: Wie habt ihr dann diese ganzen Daten analysiert?

i10: Also ich glaube, da gab es nicht so wirklich einen Anfang. Es war eher so, okay, lass einfach alles einmal ausprobieren. Und dann hat man schon so Verbindungen gefunden, zum Beispiel wo Verkehr richtig viel war. Da gibt es auch, die haben auch so Lärmkarten und alles. Dann kann man zum Beispiel vergleichen mit der Biodiversität, dass da so ein Schnitt entsteht. Und auch zum Beispiel Gebäude für Gemeindenutzung. Das könnten wir auch aus QGIS, aus der Analyse, aus diesen Tabellen rausnehmen. Und dann haben wir gesehen, wo es mehr konzentriert ist, wo es zum Beispiel fehlt. Und dann haben wir zum Beispiel vorgeschlagen, dass an einer Stelle so ein Gemeindekaffee entstehen kann. Und die von der Stadtverwaltung haben auch so gemeint, ja, das ist irgendwie voll plausibel, dass es dort steht.

Q: Wie haben die andere Gruppe diese Arbeit gemacht?

i10: Also ich glaube, ich finde persönlich, dass man voll den Unterschied zwischen unserer Gruppe und denen gesehen hat, weil wir konzentrieren uns auf den Stadtring. Und alle haben eigentlich die Analyse nur in Stadt gemacht. Ich glaube so Google Maps oder so ganz grob. Und wir haben die ganze Stadt analysiert, in gleichen Zeitraum. Und das ist schon ein Unterschied.

Q: Denkst du, dass die Qualität der Informationen die gleiche war oder anders?

i10: Ja, ich glaube von der Qualität war es teilweise auch besser. Also es war halt mehr Informationen. ich finde, wir hatten halt Informationen, die andere nicht hatten. Und ja, die auch hilfreich waren, z.B. so.

Q: Aber alle Studierende hatten die Nutzungen. Ihr habt vielleicht alles viel ausführlicher.

i10: Ja, das habe ich mit mehr gemeint. Also nicht, ja, genau. Und halt im gleichen Zeitraum. Und das war auch voll so das Lob, dass wir die ganze Stadt betrachtet haben.

Q: Was war der nächste Schritt, nachdem ihr die Orte identifiziert habt?

i10: Also wir haben jetzt so Orte identifiziert und haben diesen Orten dann Themen vergeben, z.B. wir haben eine Achse gefunden, wo richtig viele Unigebäude sind und dann durch diesen Innenstadtring entsteht eine Lücke an dieser Achse und dann war so unsere Idee, dass man innerhalb vom Ring die Straße reduziert oder die Verkehrsschwäche reduziert und dann kann man dort weiter mit Lernräume schaffen oder so coolen Flächen für Studenten in die Richtung was und dann haben wir innerhalb vom Ring verschiedene Orte mit Nutzungen.

Q: Wie war der Übergang von der Analyse zum Entwurf?

i10: Ich weiß nicht warum, aber diese Semester lief richtig so smooth. Wir sind wirklich von der Analyse, haben wir sofort Patterns erkannt, wo Sachen entstehen können, was kann da entstehen und daraus hat sich dann auch direkt das Konzept entwickelt eigentlich.

Q: Und in dem Entwurf in Amsterdam?

i10: In Amsterdam, ich weiß gar nicht, wir haben halt auch so Biodiversität und wo gibt es so welche Arten von Tieren und so, aber ich erinnere mich ehrlich gesagt nicht so genau, das war auch mehr als ein Jahr, ich weiß nicht mehr so.

Q: Hattest du das Gefühl, dass da es vielleicht ein bisschen schwieriger war?

i10: Ja, das war ein bisschen schwieriges Semester. Ja, das war ein ganz schwieriges Semester. Aber ich würde jetzt nicht sagen, dass es so ein Professor liegt. Ich glaube, es ist einfach eine andere Entwurfsmethodik und andere Art, wie man es angeht, als was wir vielleicht am KIT machen und alle waren so ein bisschen überfordert mit so was sollen wir jetzt eigentlich machen. Also, ich glaube, unser Konzept und Entwurf an sich war gut, aber ich denke, da hätte man mehr machen können. Ich war nicht zufrieden mit dem Entwurf. Ja, aber ich hatte schon das Gefühl, wir hätten es besser machen können. Immer. So nach und nach.

Q: Kannst du ein bisschen sagen, ich habe verstanden, welche Daten du genutzt hat oder ihr genutzt habt. Kannst du ein bisschen beschreiben, welche Tools oder was habt ihr benutzt?

i10: Also, eine, so hat es gesagt, wir haben überlagert, war es noch. Gibt es Sachen, die ihr noch benutzt habt? So, ja, eigentlich weniger. Also, dass wir jetzt wirklich so QGIS wie ich ausgenutzt haben, weniger. Es war halt eher so für die Informationen dann. Und wie gesagt, so Schwarzplan, generell kleine Luftbild haben wir es genommen. Ja.

Q: Hat die Erfahrung mit GIS und Datenanalyse deinen Entwurfsprozess verändert?

i10: Ja, ich glaube generell von diesem Analyse-Teil habe ich mittlerweile nicht so Angst. Oder ich finde es halt nicht so eine große Herausforderung, wie früher damals, weil das war immer so Google, was gibt es da, Google Maps und so. Das geht relativ schnell jeztz. Ist so, ja ist so.

Q: Vielleicht jetzt mehr strukturiert? Vorher hattest du nur Infos von Google, aber…

i10: Ja, das ist eher so tausend Sachen. Und es war irgendwie… Ich habe auch oft auch das Gefühl bei Städtebauentwürfen, es ist auch so, dass die Analysen oft ähnlich sind. Und das kommt halt daraus, dass alle die gleichen Quellen und so benutzen. Und dann mit so Open-Street-Maps und QGIS hat man dann schon größere Auswahl.

Q: Vielleicht habt ihr auch größere Auswahl an grafische Darstellungen, oder nicht? Hilft das auch an der Darstellung? Es ist nicht nur was du bekommst, sondern was du bekommst, du kannst das ein bisschen…

i10: Ich muss zugeben, da bin ich nicht so gut. Ich glaube, das hat eher mein Kommiliton gemacht.

Q: Und was siehst du, dass er gut macht?

i10: Ja, da kennt sich halt so aus, wie man so diese ganzen... wie es halt grafisch gut aussehen kann. Das habe ich halt selber damals im Seminar nicht gemacht. Und ich glaube auch so bei QGIS ist es für mich eher... Ich habe vieles nicht selber ausprobiert, aber ich weiß, dass es geht so. Und ich weiß, wenn es jetzt dazu kommt, dass ich hier selber machen muss, dass es auch einen Weg gibt. Mein kommiliton sagt immer zum Beispiel: ChatGPT.

Q: Nützt du das auch?

i10: Ja, schon. Also ich habe es erst seit diesem Semester so wirklich aktiv angefangen zu nutzen. Das ist schon wild wie das.

Q: Wie war deine Erfahrung, als du mit dem Coding in meinem Seminar angefangen hast?

i10: Es war ein bisschen anstrengend, weil es war was ganz Neues. Ich habe es auch nie gemacht und ich musste auch voll viel auf Reddit und so suchen. Also es gab nicht ChatGPT. Es wäre jetzt ganz anders gewesen. Ich musste auch teilweise einen Kommiliton, also ich Kommiliton, aber jemand der Informatik studiert, habe ich auch so ein bisschen nachgefragt wegen Python, wie was ich machen soll. Ich habe da auch ein bisschen Hilfe bekommen. Aber generell, ja, es war schon hart. Also ich habe da auch viel Zeit investiert. Viel.

Q: Wie war das? Wie hast du dich gefühlt da?

i10: Ich habe mich wie ein Profi gefühlt, das war schon cool. So im Python und dann geht der Code nicht und da muss man was anderes ausprobieren und so. Das war schon irgendwie cool.

Q: Es war auch gefühlt, aber du warst nicht frustriert. Oder nicht die ganze Zeit.

i10: Eigentlich hat mir das Seminar voll Spaß gemacht. Es war viel Aufwand auf jeden Fall, ruckblickend. Und ich glaube, jetzt wird es auch viel schneller gehen. Aber eigentlich war es, ich habe voll viel gelernt. Aber es hat auch mit meine Kommilitone viel Spaß gemacht. Weil wir würden dann so jede Woche treffen, die Übung zusammen machen und so. Es war Corona-Zeit noch.

Q: Hat sich dein Entwurfsprozess durch die Nutzung von GIS verändert? Denkst du, dass der Amsterdam Entwurf wäre das gleiche ohne GIS gewesen? Oder Freiburg?

i10: Nee, irgendwie nicht. Weil ich glaube, wir haben irgendwie voll viele Erkenntnisse. Einfach rein aus der Analyse, einfach rein Informationen, die wir bekommen haben, hat auch wirklich den Entwurf so richtig festgesetzt, weißt du? Also, ich weiß, ich glaube nicht, dass wir die Informationen, die wir jetzt haben, dass wir die hätten, ohne dass wir QGIS benutzt haben, rein über Google Maps und so. Ja, und klar, man kann auch über Freigis und so, kann man sich die Karten anschauen, aber man kann die halt nicht überlagern und so. Und das ist halt der Vorteil dann. Ich kann mir vorstellen, das war jetzt halt nicht in Freiburg, dass man so eins zu eins, irgendwie Korrelation zwischen Sachen gefunden hat. Aber ich kann mir schon vorstellen, dass es Entwurfe gibt, wo man dann so Sachen findet, wie zum Beispiel, was du so gezeigt hast. Zum Beispiel hier ist ein Parkplatz, hier ist, dass man so was, ja. Ich mache jetzt auch zum Beispiel für meine Masterarbeit, möchte ich ja was in Bosnien machen. Und da war mein erster Schritt zu schauen, ob es so Daten gibt, aber leider...

Q: Wie würde für dich ein idealer Entwurfsprozess aussehen, bei dem GIS nahtlos integriert ist?

i10: Ich glaube, mittlerweile wäre für mich... Also klar, man schaut sich erst mal so ein bisschen über Google Maps und so Sachen an, aber so der erste Analyse-Schritt wäre für mich immer QGIS. Einfach so die Daten aus Open Street Maps, so was es gibt. So runterladen, in QGIS reinladen, ein bisschen anpassen, Farben und so. Und dann schauen, was gibt es alles, was kann man davon nutzen? Weil klar, man hat richtig viele Daten, aber man muss es ja auch ausfiltern. Und dann schaut man halt weiter. Ich weiß nicht, ich finde, es ist nie so eine gerade Linie. Es ist halt immer, man geht zurück. Man kann das ja auch jetzt, zum Beispiel. Es ist immer noch so, okay, vielleicht müssen wir doch noch ein bisschen was schauen, was gibt es dort und so.

Q: Wie würdest du den Moment zwischen Datenanalyse und Konzeptentwicklung idealerweise gestalten?

i10: Wir hatten alle Zugriff zu diesem FreiGIS, aber man kann es halt nicht überlagern, das kommt vor der Nachteil so. Du hast diese ganzen Informationen und so, aber du siehst es nicht direkt, wo sich Sachen zum Beispiel zusammenkommen, weil, ja, vielleicht kannst du es auch so ins ArchiCAD und so wieder reinladen, das ist zu viel Aufwand und das geht halt in ein paar Klicks. Und Idealfall wäre klar, dass man aus dieser Analyse und dass man etwas findet, was vielleicht nicht sofort offensichtlich ist. Das wäre die Idealfall, weil dann, darauf kann man dann auch sein Konzept aufbauen, eigentlich.

Q: Wie hat diese Datenanalyse dich geholfen, die Rolle von Natur in der Stadt besser zu verstehen?

i10: Ich muss zeigen, so wie im diesen jetzt Projekt, also Natur revitalisieren ist schon, aber es ist nicht so ein Fokuspunkt gerade. Es war Fokus in Amsterdam, aber ich gesagt, ich habe gerade keine Ahnung.

Q: Nenn ein Beispiel: wie hat GIS dich geholfen, um mit der Natur zu planen?

i10: Man schaut sich, zum Beispiel auch einfach so ein Baumkataster, da, weißt du. Das ist ja auch voll hilfreich und man kann schauen, welche Arten wo es gibt. Und wie kann man das dann weiter nutzen? Das fängt auch vom Projekt ab. Aber ich weiß nicht genau. In Amsterdam waren es auch so Tiere, die wir dann gefunden haben.

Q: Welche anderen Daten kannst du dich vorstellen? Du hattest in meinem Seminar Flickr benutzt. Hast du das wieder benutzt?

i10: Nee, eigentlich nicht. Eigentlich kann ich mir das auch so für meine Masterarbeit irgendwo vorstellen, weil ich wollte das kulturelle Erbe thematisieren und so was ist kulturelles Erbe. Das kann eigentlich schon mit Bildern ganz gut werden.

Q: Welche Daten könntest du dich gut vorstellen für Natur?

i10: Also wir haben schon so Baumkataster genutzt, Tiere, Migrationen. Naturbilder. Ja, stimmt, Bilder haben wir auch. Aber jetzt nur bezogen auf Natur.

Q: Ihr habt viel mit Natur in der Stadt gearbeitet, besonders in Amsterdam.

i10. Ja, das stimmt schon, ja.

Q: Denkst du, dass die gesammelten Daten und deren Analyse viele Entscheidungen in eurem Entwurf beeinflusst haben?

i10: Ja, schon. Ich weiß, es war so, wir haben das irgendwie Fledermäuse durch dieses Parkhaus gehen, durch QGIS, so eine Migrations-Dings gefunden. Und dann haben wir uns einen Entwurf darauf irgendwie so gebildet, dass es auch so Aufenthalts, halt so Häuser, ja, wo sich Fledermäuse aufhalten können. Ja, das war so ein Beispiel.

Q: Wie stellst du dir vor, geografische Datenanalyse zu nutzen, um spekulative Szenarien zu entwickeln, wie zum Beispiel in Freiburg, wo ihr an einem autofreien Quartier arbeitet?

i10: Ja, das war eigentlich ganz cool, dass man so sagt, ja, könnte man schon machen. Obwohl ich muss auch sagen, wir machen jetzt im Entwurf arbeiten, wir mit Verkehrsplanern, und die benutzen auch eigentlich alle QGIS.

Q: Was machen die anderen Studis, die kein QGIS können, und die auch mit Verkehrsplaner arbeiten müssen?

i10: Die schauen zu. Es war wirklich, ja. Ich weiß, die Gruppe gegenüber von uns, die zwei Mädchen kennen sich nicht mit QGIS aus. Und der Verkehrsplanner hat ihnen auch so Sachen gezeigt, aber ich glaube, der fehlt auch so ein bisschen Überzeugung, wie stark das Tool ist. Ich glaube, die haben es so ein bisschen überspielt. Aber ich weiß, wir saßen noch im Studio, ja, guckt, hier kann man so vieles, und lernt Karte, und dies und das, und diese.

Q: Außer diese Autofrei, hast du mit deinen anderen Projekten mit Spekulationen gearbeitet?

i10: Nein, ich nicht. Aber es ist cool, ich habe es nie so gesehen. Danke schon. Eigentlich kann man darauf auch ein Konzept auffahren.

Q: Welche technischen Probleme und Herausforderungen hast du beim GIS-Nutzung gefunden?

i10: Also ich fand es immer so anstrengend, aber ich finde es immer noch anstrengend. Manchmal crasht es einfach. An der Session. Oder manchmal lädt es so stundenlang. Und was noch? Ja, oft ehrlich gesagt, ich weiß nicht so. Ich weiß, dass es geht, aber ich weiß nicht wie, und ich glaube, das war oft so ein ... Ich habe jetzt keine Lust drauf. Aber dieses Semester hat sich das bisschen durch Nico auch verändert, weil der mir auch so gesagt hat, ja, ChatGPT. Und dafür alles findet man eigentlich im Weg. Ja. Aber ich weiß, früher war das so ein bisschen, auch als wir das Seminar gemacht haben, war es ein bisschen anstrengend, weil es war auch schwer, also es gibt ja diese Forums und so, aber bis man das findet ist es schon eine Zeit weg.

Q: Kannst du ein Beispiel nennen, bei dem du dich besonders "empowered" gefühlt hast, weil du GIS nutzen konntest und dadurch mehr Kontrolle über deinen Entwurf hattest?

i10: Eigentlich war es so in Amsterdam, weil wir waren die Einzigen im Studio, die es benutzt haben, und der Dozent war auch schon so eher überzeugt. Also das war so ein Moment, ja, das war cool. Aber auch jetzt in diesem Studio, also wir haben voll das Lob bekommen, weil wir in der gleichen Zeit die ganze Stadt analysiert haben, während andere deutlich kleinere Fläche gemacht haben. Und dann, wenn man so in den Plänen einfach sieht, ist das schon ein Unterschied. Und ja, wir bekommen ... auch letzte Woche haben wir wieder Lob bekommen, dass es die ganze Stadt war. Weil ich finde es auch wichtig, die ganze Stadt zu betrachten, wenn man schon einen Entwurf in der Stadt macht, weil es so nicht nur so. Auch im Studio über den Amsterdam Parkhaus, was auch immer so für uns ... so, lass es ausprobieren, lass es ausprobieren, da gibt es noch mehr und so. Da haben wir auch ... wir haben so geschaut, wie Licht, Lichtreflektion auf Fassaden und so, Fahrräder, Fahrradfahrer ... beeinträchtigen können. Dann haben wir auch so Lux gemessen, also entlang der Straße. Und das haben wir dann auch ins QGIS reingemacht, haben so Heatmaps erstellt. Heatmaps, von dem Lux, den wir gemessen haben.

So, wo gibt es mehr? Ah, okay. Oh. Ja, und wir haben es halt immer einfach ausprobiert. Und in dem anderen Seminar war es halt … auch so richtig viel schreiben, war ein bisschen anstrengend. Aber … und die anderen haben sich immer auf diesen Theorieteil fokussiert und bei uns, was eher … lass es uns ausprobieren. Es war halt eher so, forschen, was forschen.

Q: Q: Denkst du, dass dieses Tool euch auch geholfen hat, einen eher explorativen Ansatz zu verfolgen?

i10: Ja, aber das, was du jetzt gesagt hast, das sehe ich jetzt eigentlich schon deutlich. Ja, also immer, wo ich mit QGIS gearbeitet habe, was so … lasst es ausprobieren, was es gibt. Ja, schon. Dass man nach hinten was sucht. Im seminar haben wir ein Kommentar von der Dozenten, wo sie gesagt haben, das war ein Chaos, aber auch so Geniearbeit. Weil wir haben einfach alles ausprobiert, so tausend Sachen. Und da gab es keine Struktur. Aber ich fand, unser Projekt war am innovativsten. Und der Professor von dem Amsterdam Studio hat selber gesagt, das hat bis jetzt keiner es so ausprobiert oder geforscht hat. Ich habe aber oft keine gute Struktur, dass muss ich zugeben. Auch meine Teampartners. Aber irgendwie findet man immer den Weg. Und ich finde auch aus diesem Chaos kommt dann was Gutes.

Q: Wie einfach kommst du an die Daten, die du für deine Entwürfe benötigst?

i10: Also soweit die Entwürfe, die wir gemacht haben, z.B. Amsterdam Freiburg, gab es richtig viel, was man nicht nehmen kann. Ich bin jetzt gespannt, wie es ist für Balkan und Bosnien und so. Ich habe es noch nicht ausprobiert. Ich bin wirklich gespannt, wie ich das mache für meine Masterarbeit.

Q: Findest du schwierig, an der wichtigen Daten zu kommen?

i10: Ich finde mittlerweile nicht mehr.

Q: Wie kohabitieren beide Ansäzte, klassische Entwurfsprozesse und GIS-Datenanalyse?

i10: Der Anfang war halt immer QGIS und dann sagt man irgendwann okay, lass mal jetzt schauen, das was wir haben, wie können wir es umsetzen und wirklich damit dann so klassisch entwerfen.

Q: Du hast vorher auch erklärt, „wir hatten alles Sachen angeschaut und dann wir hatten Patterns gesucht. Wir hatten versucht zu verstehen, was gibt es, dass es unsichtbar war und es ist jetzt sichtbar".

i10: Ja, das meine ich so mit diesem, das war so der Analyse Teil für schauen wo, wo ist was, wo findet man was und mit dem, weil ich finde, man kann mit QGIS auch richtig schnell sich ein bisschen viel verlieren. Irgendwo muss man auch stopp sagen. Und ja, deshalb man analysiert, findet Paterns und so, aber dann muss man auch sagen, okay, das reicht jetzt.

Q: Denkst du, dass der Übergang zwischen Analyse und Entwurf für Studierende, die QGIS nutzen, einfacher oder schwieriger ist, und wie hast du das in Freiburg erlebt?

i10: Wir haben mehr analysiert als die anderen. Also im Sinne von, ich weiß nicht genau, wir haben schon analysiert und dann ein bisschen uns auf den Entwurf fokussiert, aber dann haben wir wieder die Analyse und so. Während andere so ein richtig clean cut gemacht haben. Aber man fragt sich dann schon, haben die was aus dieser Analyse gezogen oder war das jetzt einfach nur so ein Entwurfsteil? Während ich denke schon, dass aus unserer Analyse sich der Entwurf entwickelt hat. Und ich weiß nicht, ob das bei Städtebau oft ist dieser Analyse Teil nicht so. Ich habe oft so das Gefühl und deshalb finde ich, dass die Analyse vielleicht oft auch ähnlich aussehen, dass Studenten das einfach machen, weil es eine Aufgabe ist und nicht, weil man aus dieser Analyse was zieht. Und wir haben analysiert und überlagert und geschaut, was gibt's und das Konzept hat sich daraus entwickelt. Aber dann muss man es halt weiter entwickeln und das bedeutet vielleicht muss man dann wieder einen Schritt zurück machen, aber dann macht man halt 2 Schritte vorne.

Q: Warum denkst du, dass das der Fall ist?

i10: Ja, ich glaube einfach, weil es mit dem Tool einfacher ist diese Korrelation zu finden die man sich nicht nutzt.

Q: Hat der Nutzung von GIS deine Kreativität geändert? Falls ja, wie?

i10: Schon. Weil ich weiß halt, dass soviel das möglich ist. Weißt du, man kann viel das machen und so. Und dann hat man auch Lust, das auszutesten. Man weiß, es dauert, bis man es hinbekommt und so, aber es ist nicht unmöglich so. Und ich glaube, dann hat man auch Lust es einfach zu machen, weil man so weiß, okay, das ist jetzt nicht ein 1000 Jahre langer Prozess, sondern das schafft man schon.

Q: Wie interpretierst du die Objektivität dieser Daten?

i10: Stimmt, ich habe es eigentlich nie so wirklich hinterfragt. Ja, also Anfangs schon, da hab ich, als wir noch das Seminar gemacht haben, da hast du uns auch gesagt, da eher, ja.

Q: Du hattest aber deine Bias in meinem Seminar gecheckt. Wie gehst du damit jetzt um?

i10: Ja, ich glaub Anfangs bei dem Projekt war das schon ein wichtiger Punkt. Aber jetzt später dann hab ich's eigentlich nicht so hinterfragt, weil die Daten auch selber so von der Stadt kommen. Und dann hinterfragt man's auch nicht. Aber es ist eigentlich ein guter Punkt.

Q: Denkst du, das GIS hilft mir der Zeit?

i10: Ja, deutlich

Q: Du hast super viel Zeit investiert für den ganzen Coding, wenn du das gemacht hast.

i10: Ja, aber das war damals. Wie gesagt, ich habe das Gefühl, ich habe jetzt kein Seminar bei dir und ja, damals war es schon anstrengend. Ich habe auch viel Zeit investiert, aber es war jetzt nicht, also nicht anstrengend in negativer Art und Weise. Wenn ich mit meine Kommilitonen drüber rede, sagen wir auch so, ja, für Seminar war deins richtig viel, viel was wir machen mussten. Aber im Nachhinein ich würde es nochmal machen. Weil ich habe einfach richtig viel da ausgenommen und ich finde, dass die Zeit nicht verschwendet war oder so, genau das Gegenteil. Und es hat jetzt den Entwurfsprozess oder den Anfang von dem Entwurfsprozess für mich deutlich erleichtert oder auch die Zeit gekürzt, die ich vielleicht vorher dafür gebraucht habe.

Q: Ist es anders jetzt?

i10: Ja, klar. Viel. Denkst du, ich muss auch sagen, ich benutze ja auch so QGIS, aber wir benutzen ja auch so Sachen wie ok, wir schauen es nochmal an, den Google Maps vielleicht so genauer, was ist da und so. Also es ist halt immer so ein Hin und Her, aber es hat schon den Entwurfsprozess für mich geändert.

Q: Gibt es bestimmte Dinge, die du noch lernen möchtest, um deine Nutzung von QGIS und deine Entwürfe zu verbessern?

i10: Ja, ich glaube, ich sollte mich schon so eine Woche ein bisschen hinsetzen und wieder mein Wissen auffrischen. Ich habe es auch, wie gesagt, bemerkt, so einige von meiner Kommilionen, die sind ja viel weiter als ich und so. Und ich glaube, dass wir das machen, weil es hilft viel weiter. Aber es gibt vieles, die ich noch lernen muss. Aber ich muss sagen, ich finde es cool, zum Beispiel, was mein Team Partner bei deinem Seminar gemacht hat. Der Projekt, der hat mir sein Portfolio gezeigt. Es ist schon geil, solche Sachen ins Portfolio reinzumachen.

Q: Denkst du, dass wir das anders beibringen sollten? Wie könnten wir das besser integrieren, damit es besser für euch oder mehr hilfreich sein könnte?

i10: Ja, ich finde es generell schade. Ich finde die Fakultät ist ein bisschen veraltet, so was Technologie und so angeht. Ich meine jetzt klar, durch DDF ist der Einzelnein benutzt man es mehr. Aber ich finde, das sollte man schon auch in Bachelor irgendwo lernen, wie man es benutzt. Weil das voll das hilfreiche Tool nicht nur für Städtebau, aber auch für Architektur und so. Du bist eigentlich der Einzige an der Fakultät, der sich so richtig dafür einsetzt. Auch teilweise in einer andren Professur. Aber ich finde, was sie uns gezeigt haben, hast du bei uns im Seminar vielleicht der ersten Stunde gezeigt.

C.4.4 Interview student i11

Q: Kannst du dich kurz vorstellen? In welchem akademischen Jahr bist du derzeit, und worauf liegt dein Schwerpunkt?

i11: Ich mache den Schwerpunkt in Städtebau und ich bin im 4. Semester Master.

Q: Hattest du Erfahrung mit GIS, bevor du meine Kurse gemacht hast?

i11: Nein.

Q: Wie hast du GIS danach benutzt?

i11: Also, nach der Exkursion vom Masterstudio, da haben wir schon ein bisschen Informationen gesammelt, einfach so Besichtigungen und so weiter. Und da haben wir versucht, die analytische Seite von alles Mögliche, also, dass alles, was nicht nur das Boca Bay war, sondern auch das Adriatisches Meer. Und halt eben Biodiversität, den Verkehr mit Schiffen, alle Städte in der Nähe, Natur, die Bevölkerung, demografische Daten. Aber das war schwierig, da waren nicht viel Data dafür. Es gab so Statistik und so Sachen, aber nichts, was man wirklich auf Gis nutzen könnte. Ein paar Sachen räumliche, über Biodiversität oder so was gab es, aber das war nicht wirklich viel. Das war schwierig, aber trotzdem für die, dass alles, was Open-Street-Maps ist, so Wege und Topografie, tatsächlich auch viel über Topografie konnten wir rausfinden, auch mit Google Engine, also alles, was mit Satelliten funktioniert, das war okay. Da konnten wir auch viele Wasserflüsse, auch so nicht direkt Flüsse, sondern Wasserwege von dem Werk, Ströme rausfinden, genau, aber dann sonst war das eigentlich alles. Das war auch ein sehr verlassenes Gebiet, also da ist nicht viel in der Nähe, weil diese Tunnel waren in der Peninsula, was einfach nur die Tunnel sind, und sonst gibt es nichts eigentlich, also da hat es leider nicht weitergeholfen. Also Open-Street-Maps, alles, was da steht, die Land-Uses, auch die Nutzung von den Häusern, also die typische Open-Street-Maps-Data, das hat auf jeden Fall geholfen, da könnten wir sehen, wo Landwirtschaft passiert, was überhaupt benutzt ist, oder ob es vielleicht, da gab es auch eine Kirche oben oder ein altes Zentrum.

Q: Wie habt ihr das analysiert, oder wie habt ihr das betrachtet, was habt ihr damit gemacht?

i11: Wir haben eigentlich den Plan erstellt, und zusammen mit dieser Statistik haben wir ein bisschen das Konzept ausgearbeitet. Also was funktioniert da, was für eine Nutzung man die Tunnel geben kann, wie genau man die erreichen kann. Aber wie gesagt, die Informationen von GIS waren nicht so hilfreich, weil es zu wenig Data war. Und weil es ist keine Stadt, wo wir gearbeitet haben, sondern es war ein Punkt, genau. Das Thema waren diese Tunnel, die nicht benutzt sind, und stehen da seit den 70er Jahren. Und wir müssten selber irgendwie eine Idee um die Umnutzung von dem Tunnel denken.

Q: Gab es dann einen Unterschied zwischen die, dieGIS nutzen köönnten, und die, die nicht?

i11: Das Ding, wir haben als Vertiefung eine Analyse über das Boka Bay in alle möglichen Formen. Weil wir wollten eine richtige Map oder eine Karte von über das Boka Bay und über das Adriatische Meer machen. Und da haben wir uns eigentlich, also da haben wir alle Data zusammen gepackt. Jeder hatte ein Thema und jeder hat für sich so das Thema ausgearbeitet und dann haben wir alles zusammengefügt. Und ja, also da war auf jeden Fall die Leute, die GIS nutzen konnten, haben das schneller geschafft, oder haben halt geholfen, an den anderen irgendwie an die Informationen zu kommen. Viele Leute waren am Anfang auch sehr verloren, weil sie haben versucht, irgendwie anders Infos zu finden. Und das war so gut wie unmöglich, super viel Aufwand. Aber dann durch Gespräche haben wir uns ausgeholfen und dann hat es geklappt.

Q: Gibt es dann einen anderen Projekt, wo du GIS verwendet hast?

i11: Also ich glaube jetzt in Freiburg, das ist mein drittes Entwurf, davor kannte ich das nicht. Also das in Montenegro war das zweite. Und gleichzeitig habe ich ja den GIS-Kurs mit dir gemacht. Gleichzeitig zu Montenegro. Deswegen dann habe ich eigentlich keinen anderen Entwurf, aber für Seminare, so analytische Sachen. Und für das Entwurf jetzt haben wir das auf jeden Fall richtig viel benutzt, für die ganze analytische Seite. Und das macht alles viel einfacher. Es gibt Schwierigkeiten, wenn man nicht die Data findet. Zum Beispiel in Freiburg gibt es das FreiGIS. Die haben sehr viele Data, aber die kann man nicht nutzen. Ich kann die nur anschauen. Ja, also das ist alles sind Bilder. Also man kann das schon importieren, aber man kann das nicht verändern oder anpassen. Dann mussten wir selber viel noch nachzeichnen oder so was. Man kann sie nicht als PDF exportieren, sie sind alle Bilder, die man auch koordinativ orientiert sind, aber man kann das... Ich habe gemerkt, in deinem GIS-Seminar, da konnte man wirklich alles nutzen und alles so für Ändern anpassen und so für sich selbst einfach das Nutzen, was einfach nur Sinn macht. Das ist echt super.

Q: Und dann, welche Art von Daten habt ihr gefunden, und wie habt ihr dann sie analysiert?

i11: Also wir haben das Projekt, was wir jetzt entwickelt haben. Es geht um Nutzung von verschiedenen Bereichen von der Stadt. Also das haben wir wirklich so sehr präzise definiert, was für eine Nutzung, wo überall in der Stadt gibt und wie diesen Bezug von Nutzung zu Nutzung gibt. Also diese Verbindung, weil es geht um den Stadtring und den Stadtring ist nur eine Straße und da ist sonst nichts und es ist sehr viel Fläche. Also wir haben sehr gut analysieren können, wo was sich fokussiert, und wie können wir diese eben verbinden. Und genau also das hat uns mega viel geholfen. Also auch zum Beispiel einfach nur die Nutzung jeden Gebäudes. Das hat schon sehr viel geholfen, ob da gewohnt wird oder Gewerbe oder Uni-Gebäude. Also konnten wir diese Flächen definieren und aufteilen.

Q: Und dann habt ihr von dieser Analyse ein Konzept gestellt?

i11: Also wir haben durch die Analyse gemerkt, dass sich verschiedene Flächen in der Stadt in verschiedenen Nutzungen aufteilen und wir haben währenddessen also so relativ gleichzeitig gemerkt, einfach aus unserer Ideen, was wir schon hatten wegen der Besichtigung und alles haben wir schon ein bisschen gleichzeitig das Konzept entwickelt, dass diese Barriere von der Straße gebrochen werden sollen. Aber ja, diese Informationen haben uns geholfen zu definieren, wo und was oder wie diese Barriere gebrochen werden soll und was wichtig ist.

Q: Wo seid ihr jetzt? Habt ihr schon ein Konzept?

i11: Ja, wir haben das Konzept. Wir zum Beispiel reduzieren, also wir erhalten erstmal die einen. Also ja, der nächste Schritt, jetzt sind wir auf den Punkt, also wir haben ein Konzeptplan, wo eingegriffen werden soll und wo nicht, was soll erhalten oder so nur leicht verändert werden und wo sollen wirklich einen Plan gemacht werden. Und wir entwickeln gerade ein Masterplan für das eine Gebiet davon, von unserem Konzeptplan und eben, so ein bisschen mehr im Detail zu gehen und das zu klangen.

Q: Wie denkst du, dass diese ganzen Datenanalyse, die ihr gemacht habt, die Datenacquise, Datenanalyse und die weitere Schritte, die ihr gemacht habt, durch die es den Wurfprozess geändert hat?

i11: Ich glaube, seit ich GIS kenne, habe ich gemerkt, dass es alles, dass dadurch man einen sinnvollen Weg für einen Entwurf finden kann und nicht einfach denken und spekulieren, sondern wirklich eine sinnvolle Analyse machen kann und damit so wirklich alles argumentieren kann und auch simplifizieren kann dieses Konzept finden, weil wenn man diese Infos sammelt, das ergibt sich von alleine, dass man findet auch hier, das macht Sinn da und also durch die Arbeit, Informationen sammeln und ein bisschen wissen, wo man hin will oder dann ergeben sich diese Spots von alleine.

Q: Die Idee von Reduktion interessiert mich. Wie siehst du diese Reduktion oder wie hast du das erlebt? Warum siehst du das alles, sich reduziert?

i11: Man hat am Ende zu viele Informationen, aber ich glaube, wenn man die Recherche macht und diese Information sammelt und schon ein bisschen weißt, was man machen möchte oder so ein bisschen das Gefühl hat, das stimmt nicht, da hilft auch die Besichtigung von der Ort zum Beispiel, da hat man schon so, also man hat schon ein Gefühl, das gefällt mir nicht, das sollte geändert werden und dann weiß man auch, wonach man suchen muss oder was in welche Richtung die Analyse gehen soll. Aber dann hat man nicht zu viel, sondern das, was man braucht, und so ist dann die Arbeit auch reduziert.

Q: Haben deine vorherigen Erfahrungen mit GIS beeinflusst, wie du jetzt entwürfst?

i11: Ja, auf jeden Fall. Also ich habe das Gefühl, als ich mein Master angefangen habe, war ich noch etwas verloren und jetzt, seitdem habe ich einfach viel gelernt, um dieses Prozess von einem Entwurf zu entwickeln. Ich habe das Gefühl, dieses Semester kann ich, ich kann das alles in Übung setzen und gucken, wie es hin geht, weil ich habe schon gelernt, wie es funktioniert, wie das in dem Prozess von einem Wurf laufen kann und jetzt setze ich das gerade in Übung und bis jetzt ist das Ergebnis ganz gut.

Q: Was war der Feedback von deinen Betreuer?

i11: Das war sehr gut. Sie haben erstens das Konzept gemocht und wir hatten auch ein Gespräch mit der Stadtverwaltung aus Freiburg, wo wir unseren Konzeptplan präsentieren konnten und sie haben auch gesagt, dass das Konzept an sich ist sehr gut und wie wir das alles verteilt haben, also diese Nutzungssektoren, Gebieten, wo wir eingreifen, machen auch komplett Sinn, wie wir sie verteilt haben und welchen Sektor was für eine Nutzung oder was für ein Thema haben soll.

Q: Nutzt du GIS eher ganz am Anfang, oder gibt es andere Momente, wo du das einführst?

i11: Ich glaube, ich würde gerne, weil es ist wieder ein Thema von Data Zugriff, weil ich glaube, so um die ganze analytische Pläne zu erstellen und so modifizieren, auch bis zum Konzeptplan oder so, wäre es sehr hilfreich, wenn man die ganze Data anpassen könnte, wie man möchte, aber leider war das jetzt nicht der Fall, sonst wäre es auch viel schneller gegangen. Also jetzt müssten wir auf CAD alles nachzeichnen, umfärben, vieles ausprobieren und auf QGIS kann man das viel schneller machen. Also kann man alles kategorisieren, alles ein bisschen schneller anpassen, am Ende hat man das fertige Plan, was wir auch in den Seminar oder Stegreif gemacht haben.

Q: Ist dein Designprozess anders, weil du GIS-Datenanalyse verwendest?

i11: Ja, ich glaube schon, weil man dann viele sich ignorieren würde. Man würde nur spekulieren und vielleicht wäre es auch ein großer Aufwand wirklich, diese Analyse ohne diese Data zu machen. Und dann versucht man wirklich einfach, also sich das einfach zu machen und vergisst man viele Sachen oder lässt man viele Sachen.

Q: Ist es jetzt vollständig?

i11: Nee, das auch nicht. Das ändert sich auch die ganze Zeit. Also in Zürich zum Beispiel war viel besser. Da hatte ich zumindest das Gefühl, dass es aktuell ist und das wirklich vollständig ist. Aber wir haben auch teilweise gezeigt, dass da manche Infos fehlen oder dass manche Infos nicht stimmen.

Q: Aber ich sage nicht vollständig von der Datensatz, sondern vollständig dein Ansatz.

i11: Man fokussiert sich trotzdem auf das Thema, was man arbeitet und dann sucht man sich die Infos zum Thema beitragen.

Q: Was hat dann man gewonnen?

i11: Ja, vielleicht einfach, der Aufwand ist weniger trotzdem. Ich glaube auch, also jetzt ist natürlich nur ein Entwurf, man hat nur drei Monaten, um da dran zu arbeiten und man muss es wirklich schnell und gut machen. Aber wir haben jetzt an der Stadtverwaltung einen Besuch gemacht in Freiburg und sie haben uns gezeigt, so die Arbeit, was sie machen und wie die Planungen so funktionieren. Und sie haben genug Zeit eigentlich. Sie können sich so viel Zeit nehmen, sie wollen, um wirklich an etwas zu arbeiten. Und da kann man wirklich so alles, so vollständig, wie möglich analysieren, denke ich, dass es am Ende etwas Sinnvolles ergibt.

Q: Hat deine Kreativität sich geändert durch den Nutzen von geografischen Daten?

i11: Ich glaube, da spielt nicht nur das Data eine Rolle, sondern auch das Kenntnis, was man sonst hat, das, was man lernt. Das meine ich jetzt auch, natürlich habe ich das GIS gelernt, aber ich habe auch vor diesem Semester viele andere Seminaren, wo auch andere Themen angesprochen werden. Und ich glaube, das ist einfach nur ein Tool dafür, aber zusammen mit diesen verschiedenen Tools kann man auch kritisch damit umgehen und diese Data auch ein bisschen kritischer sehen und überlegen, ob das, was die Data sagt, auch Sinn macht oder in welchen Weg man die Data nutzt. Also das kommt dann alles zusammen für ein Projekt.

Q: Wie denkst du, dass diese Datenanalyse dich helfen, um besser zu verstehen, um besser zu *integrieren, was ist der Rolle von Natur in den Städten in der Architektur? Wie hilft das dir?*

i11: Also das hilft natürlich zu sehen, wo und wie sich die Natur auch verhält und ich glaube, dass wieder zusammen mit anderen Sachen, was man lernt, also nicht nur das GIS, sondern auch wie, also was landschaftlich auch passiert oder wie sich das kombiniert. Ich glaube, das hilft wieder zu verstehen, was man aus der Data oder aus dem GIS sieht und auch so ein bisschen zu bewerten, wie man damit umgehen kann.

Q: Wie hat die Nutzung von Datensätzen eure Planung mit der Natur beeinflusst, verglichen mit bloßer Beobachtung vor Ort?

i11: Ich glaube, das sieht man auch sehr gut. Wenn man eine Besichtigung macht, geht man vielleicht ein Tag, vielleicht zweimal, oder so. Und dann klar macht seine Notizen und man denkt, hier gibt es Bäume und in den Bäumen leben Tiere, also da sind Tiere oder auf der Wiese, da sind bestimmt auch Tiere oder da sitzen Leute, heute sitzen hier Leute, aber man weiß nicht genau, wo sie sich treffen, z.B. das war hilfreich mit den Bildern, weil es ist ein sehr touristischen Ort, viele Leute machen Bilder auf diesen Garten und dadurch, dass es am Wald ist, macht man auch viele Bilder von Tieren, aber das war z.B. interessant zu sehen, es gab keine Bilder von Tieren in den Wald und in den Wald ist logischerweise viel Biodiversität, weil es sehr ruhig ist und viel Natur, aber auf der Wiese oder um das Wasser waren die meisten Bilder und deswegen meine ich, man muss auch so ein bisschen kritisch drüber nachdenken, also da kann man nicht sagen, hier sind keine Bilder von Tieren, also da gibt es keine Tiere, das macht wieder auch keinen Sinn, aber das hat z.B. wieder geholfen zu sehen, das sind selten Menschen, das war ja unsere Thema auch, wo treffen sich Natur und Menschen und wenn es weniger Bilder da gibt, es ist komisch, dass die Touristen oder die Leute die Bilder hochladen, auch nicht in den Wald gehen, wenn sie Tiere fotografieren wollen oder Natur fotografieren wollen und das war eben so dieses, ja, Diversitätsthema: wo gibt es viel Interaktion zwischen den beiden und ja, ich glaube, so hat das geholfen, also einfach diese Karte zu haben, wo man drauf gucken kann und ein bisschen überlegen kann oder ja, das bewerten zu können.

Q: In diesem Beispiel oder auch in anderen, welche GIS-Tools habt ihr genutzt?

i11: Das war interessant von dem Seminar wegen Shannon Index, also wie Diversitätsindex, das haben wir benutzt, weil das ja auch zum Thema gefasst hat und ich glaube, das war es eigentlich.

Q: Was war dein spekulative Scenario in meinem Seminar?

i11: Also ich hatte das Thema die unversiegelte Flächen oder nicht gebaute Flächen und da hat man natürlich gesehen durch den Blockbau und so weiter, wie viel Fläche eigentlich abgegrenzt ist, aber nicht bewahrt und mein Thema war, wie könnte man diese Fläche umnutzen, zum Beispiel ein Thema von Innenhöfe im Blockbauten, was passiert, wenn man diese Innenhöfe umnutzt oder einfach eine Nutzung gibt, um nicht nur ein leeren Raum in der Stadt zu sein.

Q: Hast du mit anderen Formen von Spekulation gearbeitet in dem Montenegro Entwurf?

i11: Ich glaube, ich muss überlegen in Montenegro…, ja klar, also da war die Spekulation, wir haben am Ende so eine Art therapeutisches Zentrum gemacht, wo Arbeitstherapie ein großes Teil wäre und Arbeitstherapie war in Form von Seaweed-Anbau und da war die Spekulation natürlich wie diese, also zum Beispiel diese Nutzung, auch die Wirtschaft vom Land helfen könnte oder auch wie die, einfach so ein Thema zu haben, so Arbeitsmöglichkeiten auch innerhalb vom Land, die Bewohner so ein bisschen aufhalten würden, weil da haben wir auch durch die demografische Daten gemerkt, dass viele Leute auch emigrieren, aufgrund von Arbeit oder Studium oder so weiter, weil es sehr turistisches Ort war und dadurch die Städte komplett leer sind, also Außersaison und ja, also das war auch unseren Ziel ungefähr, diese Aspekte zu fördern.

Q: Aber dazu ist denn eine Spekulation mit Natur.

i11: Klar, natürlich auch Natur, ja, also Seaweed ist ja auch, das war auch eine Begründung für das Seaweed, weil Biodiversität erhalten und das Boka Bay ist es auch sehr verkehrbelastet von Schiefe und das würde auch so ein bisschen einen sicheren Ort für, also innenwasser, für Fische, für allgemeinen Wasser.

Q: Habt ihr bestimmte Daten für diese Seaweed gefunden oder nicht unbedingt?

i11: Ja, da haben wir eine große Analyse, tatsächlich auch viel mit ChatGPT gearbeitet. Also erstmal natürlich analysiert, was dort wachsen kann durch Wassertemperatur, was auch ein Thema war, von was wir über GIS herausfinden konnten, genau welche Seaweed, wie dieses Seaweed wächst, wie lange das dauert, wie viele Fläche das braucht, wie viele Volumen.

Q: Nützt du ChatGPT auch für QGIS manchmal? Wie nutzt du das?

i11: Eigentlich immer, also ich vergesse es ja oft einfach, wie man irgendwas macht und dann frage ich, also ich schreibe einfach auch ChatGPT. Wie mache ich das? Ich habe eine Tabelle mit diesen Daten, ich will diesen Daten reduzieren oder das simplifizieren oder genau, wie mache ich ein Buffer, wie mache ich ein Clip oder so ganz simple Sachen, was ich immer vergesse.

Q: Auh, um neue Tools zu lernen?

i11: Ja, ja, also auch manchmal schreibe ich, weil ich denke so was muss möglich sein auf GIS. Und dann frage ich, ich möchte das und das machen? Wie mache ich das oder wie komme ich da hin? Und das gibt einfach so ganz einfach beschrieben, step by step, wie man das in GIS kann.

Q: Hattest du schon in meinem Seminar benutzt?

i11: Ja, aber ein bisschen denke ich, um Code zu schreiben. Aber ich glaube... Seltener, aber wenn zum Beispiel um Infos aus von Data, was man nicht hat, frage ich manchmal erst mal ChatGPT, ob man das findet oder wie man das findet oder wie man das erreichen kann oder auch mit Google Engine, manchmal sind auch die Codes einfach in andere Sprache und dann hilft das schon oft auch.

Q: Kannst du ein konkretes Beispiel für eine Funktion in QGIS geben, die du genutzt hast oder nutzen würdest?

i11: Ja, zum Beispiel ganz einfach manchmal so ein Durchschnitt berechnen von verschiedenen Daten aus der Tabelle oder genauso manche Data einfach zur Seite zu lassen und nur diese Data zu simplifizieren oder so was, oder zusammenfügen von zwei verschiedener Layer oder so.

Q: Hast du das Gefühl, dass diese Herangehensweise dir wirklich weiterhilft?

i11: Ja, auf jeden Fall. Es dauert sehr lange, bis man zum Punkt kommt, wo das klappt. Leute, die das nicht nutzen, denken, dass man stellt eine Frage und da kommt eine Antwort. Ja, ist alles aber... Man muss verfeinern.

Q: Welche technischen Herausforderungen hattest du bei der Nutzung von GIS?

i11: Manchmal, ich glaube zum Beispiel, zu finden, wie man, also zum Beispiel Plugins, da steht, dass es ein Plugin gibt, aber diese Plugins zu nutzen, ist manchmal sehr kompliziert, dass man nicht versteht, wie sie funktionieren oder wie genau man diese Data erreicht, was man braucht. Nicht immer so gut. Okay, was... Das hauptsächlich.

Q: Spart die Nutzung von GIS deiner Meinung nach Zeit, oder dauert es eher länger?

i11: Ich glaube, wenn man weiß, was man macht, es ist auf jeden Fall viel schneller. Wenn nicht, dann denkt man sich oft auch, warum habe ich nicht einfach selber das gemacht? Vor allem, weil man oft auch lange Data sucht und nichts findet und weitersucht.

Q: Aber das ist an der Suche von der Quelle, von den Datensatz.

i11: Ja, aber nee, ich glaube... Ich glaube, durch die Hilfe von ChatGPT, ist es viel einfacher, weil ich muss nicht überlegen oder suchen, wo was ist und wie ich was mache, sondern ich kann es ganz schnell fragen und schreiben. Und klar, manchmal klappt es nicht sofort, aber am Ende ist es trotzdem weniger Zeit, als das Versuchen selber zu machen.

Q: Bist du der Einzige, der fragen zu ChatGPT stellt?

i11: Ich habe mit ein paar Leuten geredet und sie machen das selten. Die meide haben mir gesagt, dass du bist der König. Ja, genau, weil ich habe es auch oft gesagt, einen Kommilitonen, die versuchen, was zu machen. Ich sage es immer so, wenn du mit Gis arbeitest, nutzt einfach gleichzeitig ChatGPT. Das macht alles einfacher. Man muss nicht viel denken. Man kann einfach alles schneller machen. Ja, meine Projektpartnerin von Montenegro macht gerade eine Masterarbeit und sie hat mich gefragt, ob ich zum Beispiel die Scripts habe von dem Seminar, was wir jetzt gemacht haben. Und ich hatte sie nicht mehr, aber ich habe sie gesagt, wenn du was brauchst, sag mir Bescheid oder sonst frag einfach ChatGPT. Das kannst du ganz schnell.

Q: Was kannst du jetzt besser dank zu GIS?

i11: Ich glaube, das ganze analytische Teil ist viel besser. Viel höher und viel aussagekräftiger als davor. Und es funktioniert auch schneller dadurch. Ich habe seit deinem Seminar tatsächlich auch gemerkt, dass es mir sehr Spaß macht, so den analytischen Teil und also mich interessiert nicht so sehr das Entwurf selbst, sondern dieses Lösungen finden oder Problem lösen. Und damit, also dafür arbeite ich sehr gerne auch mit GIS, seitdem, weil ich weiß, ich kann einfach so alles zusammen oder ausarbeiten, dass sich das alles darstellt und analysieren, bewerten und so weiter, ist dadurch einfacher und sinnvoller oder das bringt zu bestimmten Punkt.

Q: Hattest vorher auf die ganze Fläche einer Stadt gearbeitet?

i11: Nein, also das größte Projekt, was ich gemacht habe, war im Bachelor, das war ... Studio-Kontext. Genau, Städtebau-Studio in Darmstadt. Das ging um eine Straße, das ist schon trotzdem einige Kilometer und das war das größte Maßstab, was ich ...

Q: Fühltest du dich wohl oder war es okay? Fühlst du dich jetzt wohler?

i11: Ich fühle mich jetzt auf jeden Fall wohler, weil man die Stadt einfach anders betrachtet oder anders sieht. Zum Beispiel in diese Gruppierung oder nicht Bezirk, sondern so ... Gestern auf der Vorlesung kam der Begriff dafür. Fast wie Clusters, die zusammen zu erkennen sind. Ja, und man nimmt das so wahr und nicht nur als eine Straße oder eine ganze Stadt, sondern eben diese so Vierteln ungefähr, die sie so aufbauen.

Q: Wie kombinierst du GIS mit traditionellen Methoden, und macht es den Entwurfsprozess für dich einfacher oder schwieriger?

i11: Ich finde es viel einfacher, weil man eine Begründung hat. Man spekuliert nicht nur das, was ich mache, sondern man kann das richtig begründen, warum, wie, wo, was.

Q: Fühlt es sich sicherer?

i11: Ja, und ich habe das Gefühl, das ist auch das wichtigste in einem Projekt, also dass der Kontext stimmt. Hast du auch vorhin gesagt, das Kontext ist wichtiger oft als den Entwurf selbst, da stimme ich auch zu.

Q: Wie verbindest du traditionelle Entwurfsmethoden mit GIS, und wie findest du die richtige Balance zwischen beiden?

i11: Ich glaube, dass das ganze QGIS oder analytische war die Grundlage und zum Beispiel, das haben wir nicht vor lange, vor ein paar Wochen haben wir den Plan ausgedruckt, es gibt ein Skizzenpapier draufgelegt und gesehen, das ist da und das macht ziehen, das fällt hier oder so können wir das ergänzen und dann in eine traditionelle Art, so das Konzept entwickelt. Aber das ist der Grundlage. Aber mit die Begründung da und die Grundlage und dafür haben wir auch einen sehr starken oder sehr guten Feedback bekommen.

Q: Hättest du dir gewünscht, GIS-Kompetenzen früher zu lernen, und wie denkst du, hätte das deinen Lernprozess beeinflusst?

i11: Also ich glaube, ich will das mir schon wünschen. Zum Beispiel dieses Städtebauentwurf, was ich in Bachelor gemacht habe, bis sogar auch die Bachelorarbeit, also das war das Thema schon vorgegeben, aber da haben wir nur schon eine Entscheidung getroffen und daran gearbeitet, aber ohne richtige Begründung, so ungefähr. Also ich glaube, das ist ein Thema, was man schon zusammen mit Städtebau lernen sollte, dass es dazugehört, auch alles zu betrachten und nicht nur zum Beispiel zur Städtebaugeschichte, wie die Städte aufgebaut sind, sondern wie die Städte funktionieren. Die versuchen zu verstehen, genau. Und zum Beispiel, das habe ich auch gemerkt, ein Seminar von IESL, diese Pflichtseminar für den Schwerpunkstädtebau, dass auch viele politische und soziale Aspekte da auch zusammengehören zu einem Städtebau und nicht nur wie die Häuser stehen und wie die Straßen.

Q: Gibt es GIS-Funktionen, die du gerne noch lernen würdest oder die du nützlich finden würdest?

i11: Also zum Beispiel alle Piktos, alle solche Sachen, die auch die Analyse erklären, kann man auch mit Gis viel einfacher, viel schneller erstellen.

Q: Gibt es etwas, die du nicht kannst und die du hast gesehen an andere Architekten?

i11: Da kommt wieder das Thema, dass ich weiß, so was ist möglich und so was kann man machen mit Gis, aber ich weiß nicht, wie und dann, also das ist genau, dann komme ich genau dazu. Man lernt immer weiter.

Q: Und hattest du diese, weil du sagst, du machst Schwerpunktstädtebau, hattest du das vom Anfang, vom Master vor?

i11: Nein. Ich habe den Master angefangen, nur um den Master zu machen, und ich wusste nicht genau, was ich nach dem Studium mache.

Q: Und genau das, das hat das ein bisschen aufgewacht?

i11: Genau, ja. Und ja, wegen eben so ein bisschen, weil ich gemerkt habe, das ganze Kontext, so soziales politische Kontext, habe ich gemerkt, das interessiert mir. Und dann auch mit dem Thema, also mit dem Seminar in Zürich habe ich gemerkt, wie, also, dass mir einfach Städtebau gefällt, und dass mir das Spaß macht. Und eigentlich, das ist, was ich machen möchte, und nicht Architektur. Und ja, also, das hat auf jeden Fall meine Motivation auch komplett in dem Studio geändert, weil ich war davor nicht so begeistert von, von dem Beruf überhaupt.

C.4.5 Interview student i12

Q: Kannst du dich kurz vorstellen? In welchem akademischen Jahr bist du derzeit, und worauf liegt dein Schwerpunkt?

i12: Also, ich bin in vierten Semester von meinen Master und ich mache ein, ja, diese Vertiefung von Städtebau. Also, dabei kommen wir automatisch die Stadtplaner im Titel.

Q: Ja, okay. Und hattest du Erfahrungen mit GIS, bevor du meine Kurse gemacht hast?

i12: Nein.

Q: Hast du GIS in deine nächsten Kursen benutzt?

i12: Für Studio, für Analyse schon. Also für die Karten für Landschaftsarchitekturstudio.

Q: Wie hast du mit den Daten in deinem Studio-Projekt angefangen und welche Art von Analyse hast du durchgeführt?

i12: Also eigentlich, was ich mache für Analyse, das ist mehr dieser Schwarzplan. Und dann ich, also ich habe nicht QGIS als, also ich habe nicht Daten da eingefügt, sondern das war nur die Basiskarte sozusagen und dann habe ich damit gearbeitet in Illustrator und Photoshop. Also das war eigentlich nur ein sehr gutes Tool, also ein einfaches Weg, so ohne zu viel Arbeit, diese Schwarzplanen zu kriegen.

Q: Hast du andere Daten auch ausgesucht?

i12: Nein, da habe ich keine so Datenanalyse gemacht.

Q: Und wo sonst hast du noch GIS benutzt?

i12: Eigentlich, ich dachte, dass ich, ich werde QGIS auch an der Arbeit benutzen, das mache ich noch nicht. Eigentlich, was ich jetzt mache, das ist, ich sammle die Daten, was man einmal in eine Excel-Tabelle reintut, damit man das benutzen kann mit QGIS. Also ich mache dieser minus zwei Schritt, weil wahrscheinlich die wussten auch selbst nicht, was also QGIS ist und wie man das benutzt. Deswegen haben die in den kleinen Einzeige angegeben, dass ja, wenn man auch jemand an der QGIS kann, ich habe das noch nie berührt, seit ich da arbeite.

Q: Du hast dich beworben für eine Stelle, wie war die Beschreibung deiner Aufgaben?

i12: Ja, die Stadt Karlsruhe hätten gerne ein Werkstudent in, der oder die dann mit QGIS umgehen kann. Aber eigentlich, was wir benutzen da, also das ist wertig ist, das ist auch so ein Datensystem, also ganz ähnlich, aber das ist mehr so ein, also die benutzen das mehr wie eine Archiv von Daten. Database und nicht als, ja nicht als Quelle für Analyse oder so etwas.

Q: Und dann, was ist deine Funktion, du sammelst das für den Gartenbauamt.

i12: Genau, genau, ja. Und was ich jetzt mache, ich besuche die Kleingartenanlagen und eigentlich, ich schaue die Bäume an und also nach Kategorie, es gibt eine Art von Kategorie, wo er nicht achten soll, und diese Bäume soll ich aufnehmen und die Dimension aufnehmen, wenn ich das identifizieren kann, der Baumart, wo das ist, so auf eine Karte einzeichnen und welche Daten, schreibe ich noch auf, ja, ob es mehrstämmig ist oder nur ein Stamm gibt, genau. Es gibt auch... Baumkrone. Genau, also die Dimensionen, was interessant sind, die der Stammumfang, die Höhe der Krone.

Q: Wie machst du es mit der Höhe?

i12: Schätzung, es ist fast alle so schätzend. Genau, und das wird einmal in ein Dataset dann eingebaut.

Q: Hast du GIS in andere Kurse benutzt?

i12: Nein, weil die anderen Seminare und Entwürfe konstruktive Fokus hatten.

Q: Hast du vor, GIS oder geografische Datenanalyse in deiner Masterarbeit zu verwenden, und was ist das Thema deiner Masterarbeit?

i12: Ich werde hoch, wahrscheinlich etwas in Marokko planen, weil mein Mastervorbereitung oder also schrichtlicher Teil vom Masterarbeit hatte das Thema erdbebensicheres Bauwesen in Marokko und dieser Wiederaufbauprozesse und wie man erdbebensicherer mit lokalen Baumaterialien bauen kann, beziehungsweise mit Lehm und Holz und diese Sachen, genau.

Q: Was wäre für dich ein idealem Prozess, wenn du das vielleicht nutzen wurdest und du denkst, dass du das nutzen könntest? Weil du musst Städtebau, das musst ein Städtebau-Fokus haben.

i12: Ja, ja, obwohl in Frankreich die wollen immer, dass wir bis ins Detail gehen, also das wird beide Seiten haben. Also ich hoffe, ich habe noch nicht recherchiert, aber das wäre sehr gut, wenn ich dein QGIS für diese Analyse-Prozesse benutzen könnte, beziehungsweise nur so die gesellschaftliche Daten wären sehr interessant. Also zum Beispiel, also was für Gruppenwohnen, also Altersgruppen oder auch so was für Beschäftigung haben sie, genau. Und ja, eigentlich solche Sachen wären sehr interessant. Auch wahrscheinlich, also... und auch vielleicht so... Ich weiß nicht, wie viel Data man für so Baumaterialien hat. Ach ja, also für Erdbeben-Sachen, also für Erdbeben-Sachen wäre das auch sehr nützlich, so wo sind die Erdbeben? Also wo die sind, und wo gab es schon? Also zum Beispiel das... Also zum Beispiel das wäre auch sehr interessant. Aber ich habe noch sehr wenig Gedanken dafür gemacht, was für Programm oder was...

Q: Welche Daten wären für deinen Entwurf wichtig und wie würdest du sie nutzen?

i12: Also wenn, also nach Altergruppe, vielleicht also das Programm dann identifizieren, was man da so nützlich machen könnte. Oder auch diese andere so gesellschaftliche oder Social Science Data wäre auch sehr interessant, zum Beispiel so, okay, also gibt es da genug Arbeit oder soll dieses Programm etwas mit neuen Arbeitsplätzen zu tun? Oder das ist mehr so ein Programm, was so eine Kita ist? Also so was, ja, was für Nutzungsmuster ich dann einplanen würde, was nicht so, also damit das auch im Kontext gut reinpasst, weil sonst es gibt, ich denke, es gibt sehr viele so Ideen, so sehr viele sehr mainstream Ideas, die gar nicht, also ein Nutzung, was nicht so viel auf die Kontext reagiert.

Q: Möchtest du die Daten nutzen, um indirektere oder verborgene Ideen zu entdecken?

i12: Ja

Q: Glaubst du, dass GIS auch nach der Analysephase noch für die Planung und Prognosen *genutzt werden kann?*

i12: Also, vielleicht, ich habe auch daran gedacht, dass bei der Analysephasen so, das kann so ein schöner Trend auszeichnen, wenn man zum Beispiel, okay, wenn man zum Beispiel am Klima denkt, dass okay, wie war die Temperaturen von dieser Grundstück, oder nicht nur Grundstück, sondern diese Stadt oder dort, und dann wie wurde das, wie war das in 90er, 2000, bla, bla, bla und so weiter und so fort, und das kann dann so ein zukünftlicher Trend-Line aufzeichnen, was dann helfen kann, zum Beispiel nicht nur beim Lokalisieren, sondern auch inwiefern soll das darauf reagieren, dass das Klima auch so wandeln wird, und wie kann dann dieses Gebäude dafür vorbereitet sein, dass man so mehrere Zickeln, also mehrere Lebenszickeln, dieses Gebäude hat, und nicht nach 50 Jahren sagen die, also okay, das war ein schönes Gebäude, aber jetzt, also das ist nicht mehr gemessen für unser Klima oder für unser Leben, genau, also das kann auch so beim Prognosen helfen, genau.

Q: Wenn du ein eigenes Stadtplanungsbüro in Karlsruhe hättest und Zugriff auf umfangreiche Datensätze, wie würdest du diese für deine Entwürfe nutzen?

i12: Also man soll es sich da rein denken. Also was man, ich denke, das kann, also gut, das kann man sehr gut benutzen für, also für zum Beispiel, damit man diese Nutzungsmischung dann gut machen kann. Zum Beispiel, man kann das gut anschauen, also welche Nutzungen in der Stadt sind.

Q: Stell dir vor, du bist Stadtplaner und erhältst von der Stadt den Datensatz, den du gerade erstellst. Wofür denkst du, könntest du ihn nutzen?

i12: Also zum Beispiel, aber das ist nicht für Planung, sondern mehr für Verwaltung, so wichtig, dass, wo man dann bauen kann, weil ich nehme hauptsächlich alte Bäume auf, die schon einen bestimmten Stammumfang haben, das heißt, die haben so eine bestimmte Größe und die sind auch geschützt, also es gibt so Ausnahmen, man kann die fällen lassen. Genau, aber normalerweise, ich würde sagen, okay, also es gibt sehr wenige Fälle, wo ich da Genehmigung geben würde, dass die das fällen lassen, also das soll das sehr gut argumentieren, oder ich würde die Voraussetzung geben, dass okay, also man soll auf dem Grundstück damit bauen, also man soll damit denken, also das wird so ein gestalterisches Element dann in der Zukunft werden, genau, wie ein, ja ein Baustein oder so etwas, genau. Und sonst…. ja, weil die, also eigentlich die Dimension sind so, man kann auch damit dann die, also wenn man sehr weit geht, man kann auch das gut einschätzen, wenn man zum Beispiel die, also der Schattenwurf sieht, also wie viel Kühlungseffekt diese Bäume haben und dann kann man, okay, es gibt viele mehrere Aspekte, zum Beispiel wie inwiefern dieses Gebiet versiegelt ist, also das hat auch so ein Einfluss drauf, aber also man kann mit dieser Aspekte sehr gut den Mikroklima von einem Platz oder vor allem eine Straße dann einschätzen und das kann auch dann gliedern, also welche Maßnahmen da nützlich würden, dass man das, dass man die Mikroklima in der Stadt so sehr bequem kriegt oder behält.

Q: In meinem Seminar, wie hast du die Datenanalyse in deinen Entwurfsprozess integriert, insbesondere in Bezug auf Natur in der Stadt? Wie hast du GIS genutzt, um Szenarien zu entwickeln?

i12: Also die, ja, die Höhepunkte wurden dann identifiziert, wo die Kronendurchmesser die Höchste ist. Nein, die Diversität von Kronendurchmesser. Also nicht die, das heißt nicht die größte Bäume waren so betont auf der Karte. Und dann habe ich, ich habe diese Höhepunkte genommen und dann, ich hatte mir das Ziel gesetzt, dass ich dann so eine grüne Flur mache, also mit mehren so Punkten, wo man mehrere Kronendurchmesser hat, weil ich habe dann auch, also analysiert, dass Kronendurchmesser hängt von Baumalter ab, von die Pflegeweise und so weiter und so fort. Und dann, ich hatte das Ziel gesetzt, dass okay, also vielleicht wäre das sehr interessant, wenn man von dieser Orte mehr geben würde, weil die sind dann auch, also diese Orten sind dann auch mehr, also nachhaltig oder nicht nachhaltig, sondern mehr resilient, weil es gibt, wenn es nicht nur ein Baumart ist und nicht nur ein Baumalter, das gibt so ein Garantie irgendwie, dass es, wenn er so länger hält und wenn ein Invasion von Insekten kommt, die werden wahrscheinlich vor einem Baumart schädig sein, aber die anderen werden überleben. Also das gibt so ein Garantie irgendwie, also in meinem Lektüre, also in meinem Verständnis und das Ziel war dann diese kleine grüne Insel, dann viel, also mehr von dieser grünen Insel dann machen. Okay. Und damit man auch so ein Spaziergang, also ein Weg hat irgendwie, wo man diese Stepstones dann durchgehen kann.

Q: Würdest du das Analyse bezeichnen?

i12: Ach, die, die ganze Prozess? Ich würde sagen, das ist eine Mischung von Analyse und Annahme. Also das ist, also es gibt diese zwei Sachen zusammen. Also es gibt ein persönliches Verständnis, was mit den objektiven Daten kommt. Objektiv können wir nie sagen, aber so, das ist so eine Mischung von den beiden, würde ich sagen. Weil das ist nur mein Verständnis, dass, dass man diese Diversität braucht, damit diese kleine Stepstones oder grüne Inseln dann resilient werden. Also das ist etwas, was ich von den Daten raus gelesen habe, als Planer. Also das ist ein bisschen die Marriage, die Hochzeit von den beiden Seiten, also Quantität und Qualität sozusagen. Also ich habe ein Qualität für die Quantität dann. Das ist eine sehr, das ist keine klare Linie zwischen Analyse und Endpunkt. Das ist immer so Hand in der Hand.

Q: Inwiefern haben die geografischen und objektiven Daten deine subjektiven Designentscheidungen beeinflusst?

i12: Ja, tatsächlich ist es passiert. Also von der, zum Beispiel von der Logik, wo die aktuellen Standorte sind von den Höhepunkten. Ja, also das hat schon gegliedert. Weil den, also wer den Standort findet und von der neuen grünen Insel würde ich sagen, weil ja, weil eigentlich da gibt es schon eine Logik. So meiner Höhepunkte waren immer bei den Friedhöfen hauptsächlich, also nicht nur. Und dann, also wenn man die zusammen vernetzt, also oder zusammen verbindet, dann man sieht diese schonen Gestaltete Logik in der Stadt und drauf kann man schon die neuen Standorte basieren. Also ja, damit man nicht nur so individuelle Akupunkturen oder so Packet-Barts werden, sondern das kann so dieser Spaziergangs-Effekt dann oder diese, ja, dieser Weg, diese grüne Weg dann gestalten.

Q: Hast du danach mit Spekulative Szenarien gearbeitet?

i12: Das habe ich nur in Zürich benutzt.

Q: Inwiefern haben dir objektive Daten geholfen, spekulative Szenarien da zu entwickeln?

i12: So, da kann man einfacher so verbildlichen, wo die Qualitäten und die Potenzialen sich das verstehe. Verbildlichen so illustrieren? wo sind die Potenzialen in der Stadt oder wo sind zum Beispiel die Diversität schon hoch, wo man keine Maßnahme braucht? Also das gibt so ein Überblick davon, welche Orte dann ein Entwicklungspotenzial haben.

Q: Was macht für dich den Unterschied zwischen einem normalen und einem spekulativen Entwurf aus, und welche Rolle spielen Daten dabei?

i12: Ich will sagen, dass die sind eben so wichtig für den beiden.

Q: Inwiefern sind sie wichtig für den spekulativen Entwurf?

i12: Also das hängt davon ab, was man als Ziel damit hat, weil ich hab das Gefühl, dass diese spekulativer Szenarien sind auch sehr interessant, wenn man gar nichts weiß von der Umgebung und das kann zum Beispiel in einer ganz anderen Perspektive aufskizzen, was dann inspirieren kann, die Leute, die viele konkrete Daten von dem Kontext haben und die wissen ganz klar, okay, das kann nicht funktionieren im bye bye bye, weil ich hab im Kopf, dass diese, also das wäre da nicht nützlich oder so möglich sein.

Q: Könnte das neue Perspektive aufmachen?

i12: Ja, aber also ich sehe der Wert von spekulativen Szenarien, dass man also gar nicht oder wenig berücksichtigt, was der Kontext da ist. und ein Entwurf ist immer sehr kontextsensibel für mich. Und spekulatives Szenarium mit Daten, das ist inzwischen, also wenn man die Daten kennt, das ist nicht sehr space out, also das ist nicht so außerirdisch, also für mich das bringt ein bisschen diese zwei extremen Seiten so zusammen. Aber für spekulativer Szenarien, ich würde sagen, dass ich sehr nutzvoll oder sinnvoll, weil man so sagt, okay, also sehr wenig, also die wenigste Information hat von der Umgebung.

Q: Welche technische Probleme oder Herausforderungen hast du mit GIS erlebt?

i12: so manchmal funktionierten gar nicht die Formula, die ich angegeben habe. Und manchmal, ich hatte gar keine Idee warum, weil also für allen hat das funktioniert, auch für Mac User. Also ich hatte das Gefühl, dass Mac das ein bisschen schwieriger ist, vielleicht nicht. Es war am Anfang beim La Reunion, was auch manchmal schwierig war, also die Daten zu bekommen. Und was immer so eine große Herausforderung ist, zu finden, wofür das so genau nützlich für mich wird. Also diese, ja, diese Gedankenreise von Quantität zu Raumqualität, weil eigentlich wir, also für Planerinnen, es ist sehr wichtig, dass wir in Qualitäten denken, mehr als in Quantitäten. Und diese Verbindung zwischen den zwei, also das ist so ein, ja, eine Gedankenreise, was man uns so ausfinden soll. Und das war immer eine Herausforderung. Oder wenn ich wusste, zum Beispiel, okay, was möchte ich beweisen und was möchte ich prüfen, zum Beispiel die auf La Reunion, diese Energy-Ding, das okay, also ich wusste, ich will Standort dafür Solaranlagen suchen und ich wusste, welche Daten ich brauche, aber ich hatte nicht die Daten. Also man hat, man hat immer ein oder die andere, aber es ist sehr, also es ist nicht offen, dass man beide hat. Ja, weil zum Beispiel in La Reunion, ich hatte, ja, ich hatte eine Idee, was ich machen möchte und was für Räume ich suche und ich wusste auch die Qualitäten, aber dafür hatte ich kein Daten. Zürich war das mir umgekehrt. Ich hatte die Daten, aber sehr lange wusste ich gar nicht, womit ich mache. Also diese, da gibt es auch eine Brücke zwischen den zwei.

Q: Wie gehst du damit um, diese Herausforderungen zu lösen, besonders in Bezug auf das, was du gerade erwähnt hast?

i12: So manchmal, wenn man in Fall A ist, wenn man die räumlichen Qualitäten kennt oder was man weiß, wofür man sucht, welche Daten man sucht, dann es ist so eine Frage, von Zeit, was man da reinsteckt, wie viel man auf Internet sucht und wie viel gute Adresse man hat. Und in dem anderen Fall, das ist mehr so gezielte Recherche in Bezug auf den Aspekt oder Daten, da, dass etwas man hat.

Q: Hat dir die Nutzung von QGIS Zeit gespart oder eher mehr Zeit gekostet? In welchen Situationen war es hilfreich, in welchen eher nicht?

i12: Also eigentlich, die Dinge, was man in QGIS macht, die sind nicht so lang, wenn man das gut kennt, aber das ist mehr die Datamining, was viel Zeit gebraucht, würde ich sagen. Aber ich will sagen, vielleicht die Zeit, was ich mit den Nutzung von QGIS gespart habe, das habe ich in Datamining eingespielt.

Q: Liegt das Problem beim Data Mining eher daran, dass die Daten schwer zu finden sind, oder gibt es auch Qualitätsprobleme bei den vorhandenen Datensätzen?

i12: Nein, ich würde sagen, ob die existieren irgendwo oder nicht. Also wahrscheinlich existieren irgendwo, aber ich habe keine Zugriff oder dass sie nicht öffentlich sind, weil die sind so sensibel Daten.

Q: Wie kann man quantitative Datenanalyse mit traditionellen Designmethoden wie Zeichnen und räumlicher Planung sinnvoll verbinden? Hast du Ansätze oder Ideen, wie das gut integriert werden könnte?

Q: Ich denke, das ist sehr wichtig, auf welcher Detaillebene das benutzt, weil ich kann mir das schwierig vorstellen, dass es zum Beispiel auf der Ebene, also Maßstab von einem Grundstück, das nimmt. Da denke ich nicht, dass QGIS ist nützlich, also die Verwendung so begründet ist. Aber wenn man schon zum Beispiel in größerem Maßstab denkt, zum Beispiel Standortfindung oder auch zum Beispiel diese klimatischen Sachen, da ist es sehr sinnvoll, das zu integrieren. Obwohl, wenn ich zurückkomme zu meinem Beispiel von den Bäumen und Mikroklima, da könnte das zum Beispiel auf einer kleineren Ebene sinnvoll sein, das zu benutzen. Wenn man zum Beispiel den Schattenwurf anschaut und so weiter. Also da könnte das für kleinere Maßstäbe auch nützlich sein.

Q: Kann die Nutzung von GIS die Kreativität irgendwie ändern, verbessern oder beeinflussen?

i12: Wenn man sich davon distanziert, dass es objektiv ist, also wenn man diese kritische Einstellung hat zu den Daten und ein bisschen Distanz, davon nimmt dann, ich würde sagen, also man braucht diese gesunde Distanz, weil sonst man fühlt sich eingeschränkt, dass okay, ich habe diese Daten und Daten sind immer mit dieser sehr empirischen und ‚*scientific*' ist. Wissenschaftliche Einstellung dann zusammengebunden, aber eigentlich, dass kann gut funktionieren, wenn man sich für sich die Freiheit lässt. So, ich denke, so viele würden sagen, ja, das ist zu, also nur Ingenieure werden das benutzen, auch ich habe einige Kumpel, die das benutzen und die haben gesagt, ja, diese Plattform ist gar nicht für Architekten gedacht und so. Aber ich denke, also uns würde damals auch Photoshop und die andere Gestaltungsprogramme vorgestellt, so ArchiCAD und Revit und diese Sachen, also mein Professor hat Ihnen mal gesagt, okay, also das ist nur ein Tool, aber bitte nicht so benutzen, wie das der Bibel wäre, weil es gibt viel mehr, so zum Beispiel Wandarten, viel mehr Möglichkeiten, was dieses Programm nicht anbietet. Also bitte die gestaltigen Freiheit nicht aufgeben, nur weil dieses Programm die Grenzen hat. Und ich sehe das ebenso beim QGIS, dass man soll nur im Kopf halten, es ist viel komplexer als, dass so in den Daten gezahlt wird. Also, ja, deswegen denke ich, dass, also viele würden sagen, dass es geschränkt, also, dass diese Brille bloßen, also wir können das auch so gestalterisch…, diese Designbrille nennen, dass diese Brille so ein bisschen, also der Horizont klein macht, aber ich denke nicht, dass es so ist. Also ich denke, das ist eigentlich das Gegenteil, also das macht das eigentlich größer, weil man hat einen globalen Überblick von vielen Daten, was man sonst nicht bekommen könnte mit anderen Gestalt, also mit anderen Designtools.

Q: Wie könnte die Lehre hier an der Uni verbessert werden, insbesondere in Bezug auf den Umgang mit GIS und der Verbindung zwischen quantitativer Analyse und räumlicher Qualität? Hättest du dir einen anderen Support oder eine frühere Einführung gewünscht?

i12: Also ich denke, dass, wenn ich die pädagogische Planung von KIT denke, das kann schon nützlich sein, wenn das beim Städtebauvorlesung kommt, oder ich weiß nicht, was die da haben, weil ich fand es sehr sinnlos, dass wir dieses Programm gekannt haben, aber sonst diese Brückenbau zwischen Quantität und Qualität, das denke ich, das ist total angemessen, dass das erst in Master kommt, weil, also für ein Schwarzplan zu machen, das ist sehr gut, wenn die Bachelor das auch schon kennen. Aber diese Brücke zu bauen, wenn man sehr wenig von Qualität weiß, dann, man kann, das kann eine Gefahr sein, dass man eins zu eins die Daten übersetzt und gar nicht auf mehrere Ebenen denkt, und da sehe ich ein Gefahr zum Beispiel, ja, also für ein Schwarzplan würde ich das zeigen, aber diese kritische Betrachtung von Daten, ich denke dafür braucht man schon Erfahrung im Planung und braucht man auch, also ja, man braucht so ein Kennwissen von der Architektur.

Q: Sollte GIS stärker in den Entwurf integriert werden, z. B. als eigenes Modul über ein Semester hinweg, damit es praxisnäher und nutzvoller wird?

i12: Ja, also ich kann das sehr gut mir vorstellen, dass es so ein Modul ist, wir hatten einige Module, was so Entwurf integriert waren, zum Beispiel, das hat mir so Entwurfsorientiert oder Entwurfsbezogen, etwa so Energieplanung hatte ich und Tragwerksplanung, diese zwei Module hatte ich immer, und das war so nebenan betreut mit der Entwurf, was wir gemacht haben, also ein Semester lang. Und das wäre auch ganz interessant für QGIS, würde ich sagen, wenn man das ein Brother-Modul wäre.

Q: Parallel?

i12: Ja, genau. Entwurfsintegrierte-Tragwerksplanung und Entwurfsintegrierte-Energieplanung, oder so etwa. Es war am TU Berlin, aber das ist auch ein deutsches System. In Bachelor. Ja, wir haben ganz viele so Geschwisterkurs, auch ich denke auch für Städtebauer, das ist immer so nebenan betreut, also parallel betreut, und das ist ganz sinnvoll, würde ich sagen.

Q: Gibt es etwas, dass du in deinem Kopf hast, oder Sachen, die Kritik oder Aspekte, die für dich wichtig sind, und die wir heute noch nicht betrachtet haben, oder etwas, das …

i12: Also nur, wovon ich auch so Gedanken gemacht habe, so kurz vorher, dass zum Beispiel diese, also dass man mit sehr einer großen Menge von Daten sich beschäftigt, dass, also das zeigt, wie diese verschiedene Layers und wie diese verschiedene Datensets so ein, so ein Interkonnektivität dann, also die stehen immer in Zusammenhang, und wenn man von einem Einwissen wegnimmt, dann ja, die andere, das ist wie ein Spinnennetz eigentlich, und man so sehr aufmerksam damit umgehen, damit man diese globale Überblick nicht vergisst, weil ja, es gibt so Spezialisierungen, also spezialisierte Planerinnern, das ist auch ultra wichtig, aber dass man diese Überblick hat, das ist sehr wichtig als Planer, würde ich sagen, und auch das, ja, also dass man die Quantitäten mit Qualitäten zusammen denkt, und nicht nur eins oder der andere, sondern das kommt immer zusammen. Okay, also man kann nicht sagen, dass Qualität kann gemessen werden, aber die Aspekte, die die Qualität beeinflussen, das kann schon gemessen werden.

C.4.6 Interview student i13

Q: Kannst du dich kurz vorstellen? In welchem akademischen Jahr bist du derzeit, und worauf liegt dein Schwerpunkt?

i13: Also ich bin jetzt im fangen jetzt quasi das zweite Masterjahr an und mein Fokus ist eigentlich schon auf Hochbau ausgerichtet. Ich habe bisher zwei Semester gemacht, Quartiersplanung und einen Hochbau, also es hat sich im Endeffekt über wählen, die ich nicht bekommen habe und so tatsächlich mehr im Städtebau wiedergefunden, aber mein persönlicher Fokus liegt mehr auf dem Hochbau.

Q: Könntest du GIS nutzen, bevor du meinen Kurs gemacht hast?

i13: Tatsächlich nicht, aber ich habe es seitdem auch weiter benutzt, das auf jeden Fall.

Q: Wie hast du es weitergenutzt?

i13: Also das war ein städtebauliches über ein Thema in Namibia und wir sind am Anfang ziemlich schnell mit QGIS eingestiegen, um im ersten Schritt Plandaten zu erhalten, von Höhenlinien über Straßen so Basics aus QGIS rauszuziehen, aber im selben Schritt quasi QGIS und die Informationen zu Läden, Freizeitangeboten und so weiter abzugleichen mit Google Maps, um einfach eine möglichst große Grundlage in der Analyse für uns zu schaffen. Da ging es vor allem dann, wie gesagt, auch um Höhenlinien, wo wir noch verschiedene Zwischensteps gemacht haben, um wirklich gute Daten rauszuziehen, auch später für den Modellbau. Wir sind dann nicht so viel in Datenanalyse eingestiegen, aber quasi Rohdaten und Analyse Daten für uns für den Entwurf zu gewinnen.

Q: Und andere Sachen wie Gebäude, Straßen oder so, wo habt ihr das bekommen?

i13: Tatsächlich haben wir das alles in QGIS selbst importiert, ich glaube über das Geoportal, was du uns auch mal gezeigt hattest. Und die Daten waren für das, was wir vorhatten, zu dem Zeitpunkt auch ausreichend.

Q: Und die andere Gruppen, was haben die anderen dann gemacht?

i13: Also wir haben uns auch in dem Semester ziemlich viel untereinander ausgetauscht unter den Gruppen. Eine andere Gruppe hat tatsächlich über den Internetportal sich Kartendaten gekauft für einen Ausschnitt, da die Kommunikation noch nicht so gut war, aber im Endeffekt haben wir quasi eine Basic-Datei erstellt und haben die auch im Studium miteinander ausgetauscht.

Q: Und die anderen? Schlussendlich haben alle eure Karten benutzt?

i13: Ja, ich glaube Schluss schon, ja.

Q: Gab es nicht eine GIS-Einführung?

i13: Ja, stimmt, hatten wir auch, ja: wie erhaltet man die Basic-Daten von QGIS und exportiert die für das CAD-Software.

Q: Habt ihr neben den grundlegenden Datensätzen noch andere Quellen oder Datenarten genutzt, wie z. B. Social Media oder alternative Datensets?

i13: Ich glaube in dem Semester nicht. Da haben wir uns wirklich auf die Basics beschränkt.

Q: Habt ihr den Entwurf klassisch begonnen oder hattet ihr die Möglichkeit, alternative Methoden wie die Analyse von Vielfältigkeit zu nutzen?

i13: Nee, ich glaube da sind wir wirklich ziemlich klassisch an den Entwurfsprozessen dann reingegangen.

Q: Und dann hast du das wieder in deinem Erasmussemester benutzt?

i13: Ja, in Norwegen habe ich es auch benutzt, da haben wir auch von der Professur CAD Datenschutz zur Verfügung gestellt bekommen, aber um es teilweise auch abzugleichen und teilweise auch andere Daten zu bekommen, also einfach eine Datei, wo ich mehr dran manipulieren konnte, habe ich auch wieder mit QGIS gearbeitet und mir vor allem benutze ich es inzwischen eigentlich für Höhenlinien und das abzugleichen mit der Position von Gebäuden und das quasi als ersten Step auch zu nutzen, um in Modellbau zu gehen.

Q: Wenn du sagst, dass du kannst das besser manipulieren, was meinst du?

i13: Teilweise exportiere ich die Datei dann in Rhino und zerlege halt die Höhenlinien vorher in QGIS schon in unterschiedlich Layer und wenn man jetzt zum Beispiel eine Rohdatei als CRD bekommt, sind ja keine Höhendaten quasi mit den Linien verknüpft in den meisten Fällen in der DWG und ich benutze QGIS oft dann um zum Beispiel den verschiedenen Höhenlinien und verschiedene Farben zuzuordnen und dann in der Kombi von Rhino und Grasshopper die Daten halt quasi weiter zu verarbeiten, also dann teilweise mit einem Grasshopper Plugin quasi auch Cutter Dateien zu erstellen und so weiter und dafür ist es halt für mich angenehm, wenn ich die, wenn ich quasi noch mehr Background-Daten wie zum Beispiel die Höhen habe in QGIS und ja, da halt einfach auch.

Q: Könntest du das vorher machen?

i13: Nee, also das, wie gesagt, ich habe vorher ja noch nie QGIS überhaupt offen gehabt und es ist für mich inzwischen ein gutes Tool, um ja, um ein Projekt zu starten und ja, quasi meine Basic-Daten zu bekommen, die ich, wo ich weiß, wo sie herkommen, wo ich irgendwie Vertrauen drauf habe, oft haben wir ja zum Beispiel im Bachelor einfach eine Datei bekommen, wussten überhaupt nicht, kommt die jetzt von irgendeinem Betreuer, kommt die vielleicht von der Stadt, wo wir arbeiten, auch teilweise Layer-Strukturen, wo man ja keine Dokumentation zu hatte, was bedeuten jetzt teilweise einzelne Linien, teilweise sind in DWG-Dateien, gehen ja auch Linien verloren, wo man sich nie hundertprozentig drauf verlassen konnte und mit der Dokumentation, die hinter QGIS steckt, weiß ich bei den meisten Fällen, was jetzt die einzelnen Layer bedeuten, wo die Daten herkommen und habe ein besseres Gefühl für die Rohdaten, um damit dann quasi meine eigene Datei zu starten.

Q: Wie war deine Erfahrung mit dem Seminar, insbesondere der Prozess von anfänglicher Unsicherheit beim Finden der richtigen Daten bis hin zu einem klareren Verständnis und Fortschritt?

i13: Also am Anfang war es auf jeden Fall so, wir hatten ja quasi die Übungen und sind da gut reingestartet, um das Programm kennenzulernen und dann kam der Step, wo man ja quasi auf seine eigenen Daten mit seinen eigenen Daten arbeiten sollte und der erste Step zu verstehen, wie du Dokumentationen von den einzelnen Städten auch funktioniert und wie die Datensetze funktionieren und so, da habe ich am Anfang mit gestruggelt und das hat gedauert, bis ich da wirklich auch reingekommen bin. Auch für mich irgendwie zuordnen, welche Daten brauche ich jetzt? Ich war am Anfang, glaube ich, auch sehr überwältigt von der Menge an Daten, die Zürich zum Beispiel zur Verfügung stellt. Man hat da einen riesen Katalog, scrollt sich dadurch und muss dann irgendwie im Kopf für sich klarmachen, was sind die Informationen, die man sucht und ab einem Moment, wo ich dann mich irgendwie klarer festlegen konnte und verstanden habe, wie die Datensetze und die Dokumentation davon aufgebaut ist und dass ich zum Beispiel auch Informationen aus Datensätzen komplett rauswerfen kann, um den ganzen Verarbeitungsprozess zu beschleunigen und so. Das Arbeiten mit den Datensätzen, als ich das mehr verstanden habe, dann ging es auch schneller, also dann hatte ich auf einmal auch Fortschritt und was ein gutes Gefühl war und dann ging der Prozess auch insgesamt schneller, würde ich sagen.

Q: Was war das Endprodukt deiner Arbeit, und wie siehst du den weiteren Prozess, der aus deinen Ergebnissen hervorgeht?

i13: Ja, ich würde tatsächlich sagen, das Endprodukt ist nicht wirklich ein Endprodukt, das wäre quasi der Startpunkt für eine tiefer gehende Recherche oder eine tiefer gehende Analyse. Ich glaube, es ist quasi wie so ein interesting finding. Es ist ein Startpunkt, um irgendwie zu verstehen, wie sich die Typologien verteilen und dass die Typologienverteilung teilweise auch oder massiv Auswirkungen hat auf die Diversität von Bewohnergruppen und wie die Bewohnergruppen quasi in der Stadt verteilt sind. Ich glaube, das war so das Hauptendergebnis von meiner Arbeit damals. Und ich glaube, aus diesem Ansatz könnte man auch quasi Strategien für eine gute Stadtentwicklung ableiten, aber bis zu dem Punkt, dass ich Strategien vorgeschlagen habe oder dass es dann quasi ein Next Step war, bis dahin kam ich bei dem Projekt und dann war es nicht, würde ich sagen.

Q: Wie siehst du die Beziehung zwischen der Objektivität von Datensätzen und der Spekulation, besonders in Bezug auf die mögliche Verzerrung der Daten?

i13: Ja, was wir ja auch schon im Seminar besprochen haben, ist ja auch, dass die Daten oft quasi ein Bias haben, dass sie halt aus irgendeiner Sicht aufgenommen werden, was sich aber teilweise in den Daten halt nicht widerspiegelt. Das ist ja auch dann inzwischen ein großes Thema bei AI, wie die an trainiert wird, dass halt Datensätze verwendet werden, wo man im Endprodukt quasi nicht nachvollziehen kann, wie die Daten aufgenommen wurden oder wie sie entstanden sind. Und ich glaube, mit den Daten zu arbeiten ist auf jeden Fall ein guter Ansatz, um irgendwann zu einem Szenario zu kommen, weil man ein größeres Bild auf quasi ein kleineres Spektrum runterbricht. Und ich glaube, das ist schon ein erster Schritt, um zum Beispiel Szenarios oder Spekulationen aufzustellen. Ich glaube, aber was du uns auch in dem Seminar vermittelt hast, ist auf jeden Fall, dass man dem nicht 100 Prozent vertrauen darf, dass halt immer ein Bayes auch mitschwingt und dass man sich nicht 100 Prozent drauf verlassen darf.

Q: Hat die Nutzung von QGIS oder das Seminar deinen Entwurfsprozess beeinflusst, besonders in Bezug auf Aspekte wie Diversität oder das Überprüfen von Zielen in späteren Entwurfschritten?

i13: Also ich glaube, mein Entwurfsprozess an sich nicht, aber der Einblick darin und auch der Einblick im Seminar schon. Also ich verwende jetzt nicht QGIS, um eine Datenanalyse zu machen, aber zum Beispiel der Aspekt der Diversität oder dass man in einem späteren Entwurfschritt Sachen nochmal rekapituliert und quasi überprüft, erreiche ich die Ziele, die ich mir vorher gesetzt habe. Oft habe ich das jetzt nicht über Daten gemacht, weil, also konkretes Beispiel, wir haben in Norwegen, hatten wir auch noch parallelen Theoriekurs, der sich damit beschäftigt hat, Wertschöpfungsketten zu analysieren und in unser Projekt mit einzubinden. Und wir mussten quasi dann auch ein spekulatives Szenario aufstellen, das parallel zu unserem Entwurf quasi gewachsen ist. Und am Ende sollten wir dann quasi ein Case aufmachen, wie man das überprüfen kann. Und ich glaube, in früheren Semestern wäre ich damit überfordert gewesen oder hätte irgendwie nicht gewusst, wie man das angehen kann, aber durch die Art und Weise, wie wir auch über Diversität gesprochen haben und wie wir auch teilweise, zum Beispiel wie wir über einen Shannonindex gesprochen haben und so weiter, hatte ich irgendwie mehr das Gefühl, okay, auch wir als Architekten können irgendwie überprüfen, was unser Handeln in einem späteren Schritt bewirkt. Das haben wir nicht in QGIS angegangen, aber wir haben quasi ein Basic Algorithmus entwickelt, wie wir unsere unsere Ziele später in einem Schritt überprüfen könnten. Und die Art und Weise, dass man quasi auch auf Daten oder auf messbare Ergebnisse irgendwie zurückgreift, um zu gucken. Man hat zum Beispiel drei Szenarien und welches von den Szenarien erfüllt am ersten die Ziele, die man sich vorher gesetzt hat. Dieser Ansatz hatte ich halt vor deinem Seminar jetzt noch nicht in unserem Studiengang und das hat auf jeden Fall auch ja schon irgendwie eine Tür geöffnet, wo ich da dagegen irgendwie offener bin.

Q: Wie habt ihr QGIS genutzt, um die zukünftige Entwicklung und Interaktionen zwischen verschiedenen Nutzergruppen zu modellieren, und wie habt ihr Algorithmen angewendet, um die Diversität dieser Interaktionen zu projizieren?

i13: Wir haben die Anzahl von Interaktionen, also wir hatten verschiedene Benutzergruppen. Wir haben an der Stelle gearbeitet in der Stadt zwischen Flughafen, Militärgelände und Stadt. Und alle drei Partner sind momentan im Wachstum. Aber interagieren nicht miteinander. Und dann haben wir viele Orte der Interaktion quasi identifiziert und haben in einem Modell quasi projiziert, wie viele Interaktionen an verschiedenen Orten stattfinden. In einer gewissen Planungsphase quasi unseren Step oder unsere Interaktion quasi hinzugefügt und haben versucht, ja, zu projizieren, wie viele Interaktionen zwischen den Nutzergruppen passieren, wie divers die Interaktionen quasi sind. Das war so die Basic Idee hinter dem Algorithmus.

Q: Welche wären die Probleme und die Limitationen, die du bei GIS gefunden hast?

i13: Je nach Standort auf jeden Fall die Datenzugänglichkeit. Das ist auf jeden Fall ein Thema, zum Beispiel, ich finde auch immer hier in Deutschland, es wird, selbst wenn man quasi als Student ankommt und Daten anfragt, wird oft damit argumentiert mit Datenschutz und darf man alles nicht rausgeben. Das ist auf jeden Fall ein großer Step. Das fand ich beeindruckend, wie zugänglich die Daten zum Beispiel in der Schweiz waren. Teilweise für mich auch Verständnis von, ich würde jetzt mal bezeichnen als Informatik, weil mit QGIS kann man dann ja auch wirklich noch viel mehr mit Datenverarbeitung wirklich arbeiten, wo ich einfach gestrandet war, also zum Beispiel einer von meinen Mitbewohnern. Ich hatte Wasseringenieurwesen studiert und QGIS war immer sein Tool für alles und hat Hochwasserüberschwemmungsglied mit QGIS berechnet und dann habe ich ihm gezeigt, woran wir arbeiten und er war so, ja okay, ihr macht so Basics in Datenverarbeitung. Das finde ich auf jeden Fall interessant, weil es ja schon irgendwie ein mächtiges Tool da auch mehr zu können. Ich würde sagen, das sind so die zwei großen Punkte.

Q: Spart es Zeit oder andersrum?

i13: Auch viel Zeit in der Verarbeitung. Also, ich weiß noch im Seminar, teilweise lief mein Rechner für eine Verarbeitung die Nacht über durch. Das ist halt, ich glaube, das ist dann auch so der Schnittpunkt zwischen IT, wenn man quasi weiß, irgendein Algorithmus funktioniert besser als der andere und wie man irgendwie seine Arbeitsprozesse auch optimieren kann, dass der Laptop quasi besser mit klarkommt, dann funktioniert es glaube ich auch wieder besser. Ja, Verarbeitungszeit war es bei mir vor allem. Also, wie lange ich teilweise auf QGIS einfach nur gewartet habe und saß da und konnte nichts anderes machen. Ja, also Research war halt am Anfang viel, wie ich schon gesagt habe, in die Datensätze reinzukommen. Da habe ich viel Zeit investiert und dann im Endeffekt bei Datenverarbeitung was mehr die Seite, man wartet auf dem Laptop.

Q: Wusstest du genau, was wir im Seminar machen werden?

i13: Ich glaube, ich habe es am Anfang noch nicht so verstanden, wo es hingeht, aber ich fand es sehr interessant und ich hätte es... Also, ich fand es am Ende, glaube ich, interessanter, als ich es am Anfang erwartet habe.

Q: Wie denkst du, dass GIS und andere Technologien dir helfen könnten, alternative Entwurfsmethoden zu entwickeln, und wie siehst du ihren Einfluss auf den traditionellen Entwurfsprozess?

i13: Also, ich bin mir noch nicht sicher, wie ich irgendwie noch mehr in Entwurfsprozess wirklich integrieren kann, weil der Entwurfsprozess ja einfach was ist, was wir sehr klassisch, würde ich sagen, an unserer Uni lernen und man quasi über Jahre irgendwie in seinem Workflow ankommt. Und ich finde, Entwurfsprozess ist immer so etwas Delikates und wenn man da so ein bisschen zu viel quasi dran rumfuscht und seinen Ablauf irgendwie zu viel ändert, dann kann es auch sehr, sehr nach hinten losgehen. Ich glaube, es kann mir sehr in der Vorbereitung und quasi in der Nachbereitung helfen. Im eigentlichen Entwurfsprozess habe ich noch nicht gesehen, wie ich es irgendwie persönlich integrieren kann.

Q: Du hast gesagt, dass du könntest deine Ergebnisse prüfen, deine, du modellierst also das.

i13: Genau, in einem Zwischenschritt auch mal, was ja, also ich sehe es in dem Punkt nicht quasi als Teil von meinem Entwurfsprozess, aber zum Beispiel als Überprüfung von der Iteration oder.

Q: Wann denkst du, dass wir das euch beibringen sollten? Wäre es besser vorher, wäre es besser oder es ist gut, wie es ist oder wie es bei dir war?

i13: Ich finde es, glaube ich, schon sehr interessant, auch wenn es im vierten Semester schon mit reinkommt, weil ich erinnere mich daran, wie wir einfach stundenlang da saßen zwischen Maps und Illustrator oder CAD hin und her gewechselt sind und haben zum Beispiel einfach die Locations von Supermärkten übertragen, was mir nix gebracht hat für irgendwie meinen weiteren Werdegang. Und ich glaube, dass ein so frühen Zeitpunkt zu integrieren, kann auf jeden Fall interessant sein. Ich finde es bemerkenswert, wie viel mehr irgendwie technische Hilfsmittel inzwischen auch im Bachelor vermittelt werden, sei es so auch im CRD-Bereich mit Rhino, Grasshopper. Also ich habe das Gefühl, die Bachelor Studenten überholen uns so ein bisschen, was irgendwie die Technikaffinität angeht. Ich finde aber auch, da braucht es halt immer so ein bisschen Feedback-Loop auch. Aber ich kann mir das als Tool im vierten Semester, glaube ich, sehr gut vorstellen. Ich glaube, man sollte das dann aber in einem, nach einem Jahr oder so, irgendwo noch mal quasi mit reinbringen, um zum Beispiel über so Sachen wie BIAS auch noch mal ausführlicher zu reden, weil wenn es irgendwie so ein Selbstläufer wird, finde ich es manchmal auch ein bisschen schwierig.

Q: Hast du noch zusätzliche Gedanken oder Erkenntnisse zur Nutzung von Datenanalyse und GIS im architektonischen Entwurf, die wir noch nicht besprochen haben?

i13: Also ich fand es ein sehr interessanter Einblick in was, was ich vorher halt noch nie gesehen habe und ich glaube, es wird auf jeden Fall auch ein Teil sein, den ich irgendwie so in meinem Workflow immer mittrag und das fand ich auf jeden Fall sehr interessant und deshalb, ich bin auf jeden Fall froh, dass das mir dann so gewählt.

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