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Jaewon Son, Juliette Martin, JoAnne Linnerooth-Bayer, Caroline Kramer & Somidh Saha

Governance of urban green spaces as nature-based solutions in Korea and Germany

Jaewon Son[1,2*], Juliette Martin[2,4], Joanne Linnerooth-Bayer[2], Caroline Kramer[3], Somidh Saha[1,3]

1 Research Group Sylvanus, Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT), Karlsrtraße 11, 76133 Karlsruhe, Germany

2 International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361 Laxenburg, Austria

3 Institute of Geography and Geoecology (IfGG), Karlsruhe Institute of Technology (KIT), Kaiserstraße. 12, 76131 Karlsruhe, Germany

4 Institute of Landscape Planning, University of Natural Resources and Life Sciences (BOKU), Peter-Jordan-Straße 65

1180 Vienna, Austria

*corresponding author: jae.son@partner.kit.edu

Abstract: Urban green spaces (UGS) are vital Nature-based Solutions (NbS) that support biodiversity, public health, and climate resilience. Yet, their governance faces diverse challenges shaped by governance structures, sectoral dynamics, and the growing impacts of climate change. This study compares UGS governance in Korea and Germany—two countries with contrasting systems—through 30 semi-structured expert interviews analyzed using qualitative coding. Findings reveal how centralized governance in Korea enables rapid implementation aligned with global frameworks, while Germany's decentralized model prioritizes local autonomy and EU-level policy integration, often at the cost of slower decision-making. Sectoral analysis highlights differing priorities: government actors emphasize regulatory compliance and resources, NGO focus on participation and equity, and researchers stress evidence and long-term vision. Despite structural differences, both countries share barriers such as funding gaps and policy integration challenges. These insights, contextualized through the socio-ecological systems framework, underscore the need for cross-sectoral collaboration and adaptive governance to advance UGS and NbS strategies.

1. Introduction

Nature-based solutions (NbS) emerged in the 2000s as part of integrated efforts under the United Nations Framework Convention on Climate Change (UNFCC) to tackle climate change mitigation and adaptation, biodiversity protection, and sustainable livelihood actions[1,2]. The United Nations Environment Assembly[3] defines NbS as actions that safeguard, conserve, restore, and sustainably manage both natural and modified ecosystems to address social, ecological, and economic challenges. These solutions enhance human well-being, provide ecosystem services, increase resilience, and promote biodiversity. According to the UN Global Compact[4], NbS can contribute up to one-third of the climate change mitigation needed to meet global warming targets by 2030. They are thus considered cost-effective adaptation measures, particularly for leveraging natural processes to address complex urban climate issues[5,6]. In urban areas, NbS can significantly contribute to reducing heat, improving water and air quality, and regulating floods[7,8].

Urban green spaces (UGS), a key component of NbS, are defined by the World Health Organization[9] as open areas reserved for parks and other green infrastructure within urban areas, such as gardens, urban forests and street trees. These spaces provide diverse ecosystem services that enhance urban biodiversity, support physical and mental health, and contribute to climate adaptation and mitigation[10]. However, the public's use and perceptions of UGS vary significantly across cultural and societal contexts[11,12,13]. These sociocultural differences influence how ecosystem services are valued, prioritized and ultimately governed based on policy preferences[14]. Therefore, it is essential to recognize and navigate differing perceptions of UGS benefits within specific cultural

contexts, and to consider the interests of diverse stakeholders in governance processes. Hauck et al.[15] emphasize the importance of incorporating stakeholder perceptions, knowledge, and preferences into governance processes. Additionally, Kabisch[16] advocates for comparative studies to better understand how governance systems enable or hinder UGS implementation and the recognition of ecosystem services.

Several studies have explored governance models for UGS and NbS across different regions. For example, Quinton et al.[17] examine how governance structures influence tree management in urban cemeteries in Canada and Sweden, highlighting trade-offs between decentralized and centralized approaches in terms of flexibility and consistency. Sainz-Santamaria and Maritenz-Cruz[18] analyze adaptive governance of UGS in Latin America during COVID-19 pandemic, finding that polycentric structures were more adaptable than centralized municipal systems. Similarly, Mabon and Shih[13], in a comparative study of subtropical Asian cities, find that institutional procedures posed greater challenges to UGS implementation than technical capacity, emphasizing the need for cross-sectoral collaboration. These studies underscore how diverse responsibilities across sectors and governance levels shape the planning and management of UGS, reinforcing the importance of integrated approaches.

Comparative studies on NbS governance highlight the importance of adaptive and polycentric governance, stakeholder co-creation, institutional flexibility, and cross-sectoral collaboration as key enablers for effective and transformative urban implementation. Martin et al.[19] identify key governance enablers for NbS across case studies in China, Germany, and Italy, showing how NbS can catalyze innovative governance arrangements through cross-scale and cross-culture collaboration. Scolobig

et al.[20] emphasize the importance of developing transformative institutional frameworks, noting that while visionary planning exists, long-term structural support is often lacking. Kauark-Fontes et al.[21] underscore the need for adaptive governance in both European and Latin American contexts, advocating for multiscale approaches, educational tools, and community engagement to unlock the potential of NbS. Similarly, Frantzeskaki[22], drawing on case studies across European cities, outlines key lessons for planning NbS, including the importance of collaborative governance, transdisciplinary co-creation, and long-term visioning.

These findings underscore that governance enablers and barriers are highly context-specific and shaped by cultural, institutional, and political dynamics. Rincón et al.[23] identify institutional capacity and flexible directives as key enablers for sustainable urban planning. Boulton et al.[24] emphasize the role of governance tools and political leadership in UGS provisioning, while Soanes et al.[25] note challenges in mainstreaming priority actions. Li et al.[26] argue that comparative studies can reveal shared enablers and barriers, informing better practices cultural contexts.

Drawing on Ostrom[27]'s socio-ecological systems (SES) framework, this study conceptualizes UGS as SES, comprising subsystems such as the resource system (UGS), resource units (e.g., trees, bushes), users (e.g., humans, animals, insects), and governance systems (e.g., government and organizations) that manage the UGS. The SES framework serves as the primary analytical lens for this research, structuring the implementation of governance interactions and institutional dynamics. Specifically, it helps explain how differences in centralized and decentralized governance systems influence interactions among resource systems, users, and governance arrangements,

such as Korea's emphasis on rapid implementation and Germany's focus on participatory planning, and how these interactions influence barriers and enablers in UGS management. While these are distinct components, the outcomes of an SES arise from the interactions among them, which in turn impact each component and can influence other SES. The SES framework emphasizes that these systems are shaped by interactions between institutional arrangements, diverse actors, and ecological processes[28].

This conceptualization aligns with previous research on urban forests as SES, where human and natural systems are deeply interlinked, and a full understanding of such systems requires attention to the broader socioeconomic and political context in which they are embedded[29]. The perceived value of ecosystem services can vary depending on characteristics of the human community and its surroundings, and meaningful ecological improvement requires the incorporation of people's perspectives into governance and management[29]. Although urban forests represent a specific type of UGS, the insights from this study are applicable to broader UGS governance. In practice, the boundaries between urban forests and other types of UGS are often blurred, both in public perception and institutional practices, due to overlapping definitions, management responsibilities, and historical precedence of urban forestry initiatives[30-32].

Further empirical evidence from cross-cultural research on UGS in a Korean and a German city highlights how visit patterns, preferences, and perceptions of nature are shaped by sociodemographic and cultural factors[33]. These findings underscore the importance of integrating contextual understanding and the involvement of diverse

stakeholders in UGS governance, reinforcing the SES framework's relevance in urban settings[33].

While UGS in this study are not self-governed commons, concepts from common governance, such as collective action theory, remain relevant. Collective action theory explains how cooperation among diverse actors depends on trust, shared norms, and coordination mechanisms. These principles resonate with the challenges highlighted in UGS governance, such as bridging institutional silos, aligning sectoral priorities, and creating intermediary platforms for collaboration[34,35].

In addition to SES framework, urban sustainability and resilience literature offers further conceptual grounding for understanding UGS governance. Urban sustainability frameworks emphasize that it is important to integrate social, economic, and institutional dimensions which have often been overlooked in comparison to physical and environmental dimensions[36]. In addition, to achieve socio-ecological resilience, it is crucial to recognize the interactions between social and ecological systems, along with initiating transformation in human-nature interactions to sustain the UGS despite the external stressors and barriers[37].

In this context, transformation science and transdisciplinary sustainability research offer valuable insights into how UGS governance can contribute to broader societal transitions. Previous studies[38,39] emphasize the importance of co-producing actionable knowledge with diverse stakeholders to address complex sustainability challenges and foster systemic change. Their work highlights the need for integrative, reflexive, and solution-oriented approaches that bridge academic and practitioner knowledge, particularly in

urban contexts undergoing transformation toward more sustainable and climate-adaptive futures. These frameworks collectively inform the study's overarching aim to understand how governance arrangements and sectoral dynamics in UGS contribute to urban transformation toward more sustainable, inclusive, and climate-adaptive living.

Despite the growing interest in UGS governance, few studies have systemically compared how governance structures function across countries with similar economic development but differing cultural and political systems. This study addresses this gap by comparing Korea and Germany, two advanced economies with distinct administrative frameworks and cultural values. Culture plays a key role in shaping public perception, stakeholder participation, and institutional practices, making it a critical differentiator in governance approaches. Recognizing these differences is essential for adapting successful practices to new contexts and for preventing mismatches in governance that could undermine efforts to make cities more resilient and sustainable.

This study aims to contribute to the understanding of how UGS governance can support urban transformation toward more sustainable, inclusive, and climate-adaptive cities. By examining governance arrangements and sectoral perspectives in Korea and Germany, the research explores how institutional structures, stakeholder roles, and policy contexts shape the planning and management of UGS. The central research question guiding this study is how governance arrangements and sectoral perspectives shape the planning and management of UGS in Korea and Germany. To address this question, the study pursues the three specific aims**:** (1) to identify main policies related to UGS at different levels of government and map the key stakeholders involved, (2) to analyze the factors that support or hinder effective UGS governance, (3) to compare sectoral similarities and

differences in expert perspectives on governance barriers and enablers in UGS implementation. These aims are essential for understanding how institutions, actors, and decision-making processes shape UGS governance in ways that influence urban transformation. They also help to identify transferable practices and context-specific challenges that can support more resilient, inclusive, and climate-adaptive approaches to urban sustainability.

2. Results

2.1 Governance landscape of UGS

UGS implementation in Korea and Germany involves a diverse range of stakeholders. The stakeholder geography was mapped iteratively during interviews, based on the identification of actors by interviewees. Key stakeholder lists are provided in Supplementary Information 3 (for Korea) and Supplementary Information 4 (for Germany). Simplified visual summaries of these stakeholder landscapes are shown in Figure 1 and Figure 2, respectively.

Interviewees from both countries identified government institutions, environmental and advocacy groups, academia, and urban planners as key actors. However, notable differences emerged:

- Government and public Institutions were frequently mentioned. According to interview participants, UGS policy in Korea is led by the Korea Forest Services (KFS), with implementation supported by regional offices and city-level departments. In Germany, UGS governance is perceived as more decentralized; instead, responsibilities are distributed across various city-level departments—such as the Forstamt (Forest

Agency), Gartenbauamt (Horticulture Department), and Amt für Umwelt- und Arbeitsschutz (Environmental and Occupational Safety Department)—in larger independent cities (kreisfreie Städte), and across county or state-level institutions in smaller municipalities.

- Urban Planners and Architects played different roles in each country. Korean interviewees highlighted specific landscape architecture firms as influential in UGS. In contrast, German participants emphasized professional associations such as Association for Urban, Regional, and State Planning (SRL), and attributed less influence to private companies.
- International and advocacy groups were also noted. Korean interviewees referred to organizations such as the UNDP Seoul Policy Centre, ICLEI Korea, and local NGOs as influential in UGS governance. In Germany, interviewees frequently mentioned the Forest Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification (PEFC), Nature and Biodiversity Conservation Union (NABU), and the German Federation for the Environment and Nature Conservation (BUND) as key stakeholders.

Interviewees discussed a range of policies influencing UGS, which are categorized by governance scale. Full lists can be found in Supplementary Information 5 (for Korea) and Supplementary Information 6 (for Germany). While not all policies mentioned by interviewees explicitly target UGS, many fall under broader frameworks of urban nature, forestry, or environmental governance. These policies were included in the analysis due to their perceived influence on UGS planning, management, or policy coherence.

At the international level, Korean interviewees most frequently cited the Sustainable Development Goals (SDGs) (N=8), particularly SDG 11 (Sustainable Cities and Communities) and SDG 15 (Life on Land), as key frameworks influencing UGS governance. Interviewee R2 described the SDGs as the most comprehensive framework for addressing UGS-related challenges, noting their relevance to land degradation, rehabilitation, and urban land conflicts. R2 also referenced collaborative international research linking SDG 15 to other goals, including those related to urban development. Localization of the SDGs was also emphasized. For example, R3 explained that the city of Suwon developed its own set of ten strategic goals aligned with the SDGs, including a local biodiversity strategy. These goals were co-developed with civil society actors and are monitored annually using indicators created in collaboration with citizens and NGOs.

Other international frameworks mentioned by interviewees included the Global Biodiversity Framework (GBF), the Convention on Biological Diversity (CBD), ICLEI pathways, Environmental, Social, and Governance (ESG) principles, and the UNFCCC. Korea's adherence to the GBF includes a national strategy, the National Biodiversity Strategy and Action Plan (N=3), aiming to restore 30% of degraded areas. Interviewees emphasized that while these frameworks are formally adopted at the national level, their implementation depends heavily on local government engagement. For example, an NGO representative (N3) explained that global networks such as ICLEI have long promoted local governments in biodiversity governance, with Korea's hosting of the CBD Conference of the Parties (COP) in 2014 serving as a key catalyst. The same interviewee noted that this event prompted efforts to introduce the concept of Local Biodiversity Strategy and Action Plan (LBSAP) (N=2), which had previously not existed in Korea.

Following this, interviewees from local government and policy advisory sectors reported that several metropolitan governments began developing their own biodiversity strategies, supported by national guidelines. Interviewee C2 highlighted the ethical and long-term importance of aligning domestic policies with global biodiversity goals, noting tensions between restoration targets and national decisions such as the release of protected green belts areas for development and nuclear energy expansion. NGO participants also noted ongoing efforts to align Korea's national biodiversity strategy with the GBF, including new guidance to help local governments incorporate GBF targets in their planning processes.

Table 1. Frequency of urban green space policy mentions by governance scale in Korea

Scale	Name	Frequency
International	Sustainable Development Goals (SDG)	8
	Global Biodiversity Framework (GBF)	6
	Convention on Biological Diversity (CBD)	2
	The five ICLEI pathways	2
	Environmental, social, and governance (ESG)	2
	United Nations Framework Convention on Climate Change (UNFCCC)	1
National	Act on Urban Parks and Green Areas	4
	'National forest road' designation system	4
	The 5th National Biodiversity Strategy and Action Plan	3
	Creation and Management of Urban Forest Act	2
	Forest Public Value Conservation Payment System	2
	Special Act on Promotion of and Support for Urban Regeneration	2
	Pesticide Control Act	1
	Water Supply and Waterworks Installation Act	1
	Building Act	1
Local	Local-SDGs	3
	Local Agenda 21	2
	Local Biodiversity Strategy and Action Plan (LBSAP)	2
	Seoul Metropolitan Government Ordinance on Urban Afforestation	1

At the national level, the Act on urban parks and green areas (N=4), and the National Forest Road designation system (N=4) were most frequently cited by Korean interviewees. The Acts on Urban Parks and Green Areas were described as providing a comprehensive legal framework for park planning and development. One interviewee emphasized that under the Act, all park projects must follow a legally mandated sequence of planning stages, including the creation of a basic plan, approval of a detailed implementation plan, and subsequent reviews such as contribution and landscape assessment (G4). Another interviewee elaborated that these procedures are strictly regulated, requiring approval from the Ministry of Land, Infrastructure and Transport (R4). The Act also categorizes different types of parks, with neighborhood and children's parks being the most commonly developed. However, children's parks were described as often being small and similar in design, with some interviewees noting that they tend to lack variety and creativity. R4 also discussed Korea's National Urban Park category, introduced to support large-scale, symbolically significant parks. Despite its perceived potential, no site has yet been officially designated. The interviewee attributed this to challenges such as the requirement for municipalities to acquire large areas of land, often over 300 hectares, without direct financial support from the central government. This threshold, modeled after Japan's national park system, was described as unrealistic and exclusionary, and prompting ongoing discussions about revising the criteria. The interviewee noted that cities like Busan and Incheon have expressed interest in pursuing designation, but unclear standards and funding mechanisms remain major obstacles. They also highlighted perceived inequalities, such as Busan questioning why its substantial investment in local parks receives less national support compared to Seoul's

Yongsan Park. Other national frameworks mentioned included the Creation and Management of Urban Forest Act and several others (see Table 1 for a full list with frequency of mention).

At the local level in Korea, interviewees mentioned localized versions of international frameworks, including Local-SDGs (N=3), Local Agenda 21 (N=2). These initiatives reflect growing recognition of the role of municipalities in implementing global goals. As previously noted, cities like Suwon have developed their own strategic goals aligned with the SDGs, including biodiversity strategies co-developed with civil society. In addition to these examples, interviewees emphasized that national success depends on empowering local governments through supportive policies and budget prioritization (N3).

Germany's governance structure includes five distinct levels—international, EU, federal, state, country (Landkreis), and local—each of which is associated with specific UGS policies mentioned by interviewees. However, as shown in Table 2, no county-level were explicitly mentioned by interviewees, likely reflecting the urban focus of the study and the fact that counties typically do not formulate independent UGS polies. Notably, more EU level policies were referenced than international policies. At the international level, the International Labour Organization (ILO) conventions and Forest Stewardship Council (FSC) principles were each mentioned once as FSC certification standards require compliance with workers' rights as protected by the ILO Core Conventions.

Table 2. Frequency of urban green space policy mentions by governance scale in Germany

Scale	Name	Frequency
International	International Labour Organization (ILO) Core Conventions	1

	Forest Stewardship Council (FSC) Principles	1
EU level	Regulation on Deforestation Free Products (EUDR)	8
	EU Green Infrastructure Strategy	2
	Natura 2000	2
	Habitats Directive	1
	New EU Forest Strategy for 2030	1
	EU Restoration Law	1
Federal level	Federal Forest Act	4
	Volksentscheid (Referendum)	3
	Federal Nature Conservation Act (Bundesnaturschutzgesetz)	1
	German Building Code	1
	Guideline on Urban Road Design	1
	Act on the Protection of Cultural Monuments	1
State level	State Nature Conservation Act (Naturschutzgesetz)	4
	Volksentscheid (Referendum)	3
	Forestry Act	1
Local level	Bürgerentscheid (Local referendum)	2
	Urban Biodiversity Concept	1
	Strategic City Development Concept	1

At the EU level, the Regulation on Deforestation-free Products (EUDR) was the most frequently mentioned (N=8), emphasizing its importance in ensuring that products do not contribute to global deforestation or forest degradation. Although UGS are not typically exploited for commercial products, interviewees from international forestry and sustainability organizations, as well as regional planning bodies, described how the EUDR indirectly shapes UGS governance by reinforcing broader forest protection norms, raising awareness about land-use impacts, and promoting coherence between urban and rural green space policies. Other frameworks included the EU Green Infrastructure Strategy, and Natura 2000, as well as the Habitats Directive, New EU Forest Strategy for 2030, and the EU Restoration Law. Natura 2000 was mentioned in relation to its

regulatory implications for local forest and species protection. One interviewee noted that Natura 2000 protections are layered on top of national laws and require local authorities to inform and monitor public behavior such as ensuring that visitors stay on designated paths and do not disturb protected habitats or species (G9).

At the federal level, interviewees most frequently referred to the Federal Forest Act, and Volksentscheid (referendum) as relevant frameworks for UGS governance (N=4 and N=3 respectively). Several other policies were mentioned only once (see Table 2). For example, the Federal Nature Conservation Act was referenced in relation to public communication, such as restriction on tree cutting during bird breeding seasons (G9).

The Federal Forest Act was described by interviewees as important for defining the multifunctionality of forests—timber production, recreation, and nature protection. One interviewee noted that this framework allowed the City Council to prioritize biodiversity and recreation use over timber production in forest management decision (G7). Others highlighted that the level of implementation varied across states where it was clearly mandated in forest law, while in others it was only vaguely referenced (R10).

Interviewees also pointed to difference in ownership structures, noting that in Berlin, where most forest land is publicly owned, the state was perceived to have greater capacity to implement forest-related policies. In contrast, in Brandenburg, private ownership was seen as limiting such control (P2). Additionally, one participant described how federal and state-level parliamentarians collaborate in shaping forest legislation, which an interviewee described as an example of the multi-level nature of governance in forest policy (P2).

At the state level, the State Nature Conservation Act (Naturschutzgesetz) was most often highlighted (N=4), with interviewees noting that state laws are often more specific than federal ones. As interviewee C4 explained, “The state ministries play a crucial role in building and nature preservation … the states are more important because it's more concrete and the federal level is more general.”

Volksentscheid (referendums), and the Forestry Act were also mentioned at the state level. Interviewee R7 explained that while decisions are typically made by the elected officials, Volksentscheid offers citizens a direct voting mechanism on major public issues. At the local level, interviewees described several participatory processes, including formal consultations and citizen assemblies. One interviewee noted that municipalities may invite residents to participate in planning discussions over several months, while others described more structured mechanisms such as Bürgerentscheid (local referendums). In cities like Stuttgart or Karlsruhe, if 20% of eligible voters request a decision, the local government is legally required to hold a referendum (R7). These mechanisms were described as important tools for public involvement in land use and development decisions, including those that may affect green space availability.

For example, R7 recalled past referendums in Stuttgart and Karlsruhe on whether to build a new main station or an underground transit system. While not directly about green space, such projects were seen as shaping urban land use priorities and potentially competing with green infrastructure. Interviewee G6 added that while their level of government does not conduct referendums directly, zoning decisions, such as allocating land for development, can be subject to public votes following outreach and funding

requests. Other local frameworks mentioned included the Urban Biodiversity Concept and the Strategic City Development Concept.

2.2 Governance barriers and enablers

This analysis identified and categorized governance barriers and enablers of UGS planning and management based on interview data. Figure 3 and 4 illustrates the barriers in Korea, and Germany, respectively. In both countries, stakeholder engagement emerged as the most frequently mentioned barrier (Korea: 20.9%, Germany: 38.3%). This category was coded when interviewees described difficulties in reaching or involving specific stakeholder groups, as well as conflicts of interest— such as between pet owners and non-pet owners, landscape architects and foresters, or differing visions of park aesthetics. Insights from interviewees suggest a broader challenge in involving diverse groups in UGS governance, particularly when their interests diverge.

These challenges are often intertwined with resource constraints, which were the second most cited barrier in Korea (12.1%) and the third in Germany (10%). As one German public sector interviewee explained:

“Engaging the public is complex due to logistical constraints. They desire more green spaces and playgrounds, but our budget is limited, making it difficult to fulfill all their wishes” (G5).

In Germany, land ownership and availability was the second most cited barrier (20%), while it was less prominent in Korea (4.4%). Interviewee R7 noted that in Southern Germany, farmland is often divided among all siblings, resulting in fragmented land ownerships, which complicates UGS planning—particularly in peri-urban areas where

agricultural land is increasingly considered as multifunctional green uses, including urban agriculture and community gardens[40,41].

In Korea, other frequently mentioned barriers included the lack of supportive policies and legal framework (9.9%) and lack of awareness and understanding (9.9%), followed by lack of will and commitments (8.8%) and lack of expertise and knowledge (7.7%). Interviewees pointed out that frequent departmental rotations among public officials hinder the development of long-term expertise. One private sector interviewee emphasized:

“In terms of policy, there is a need for an intermediary manager who can carry out ecological management in park management. So, I propose ecological monitoring” (C2).

In Germany, additional barriers included lack of awareness and understanding (6.7%), lack of expertise and knowledge (6.7%), and path dependency (3.3%). Interestingly, evidence on performance and co-benefits was only mentioned in Korea, suggesting a difference in how outcomes are evaluated and communicated across contexts.

Turning to enablers (Figures 5 and 6), interviewees often described enablers not as fully established strengths, but as mechanisms or aspirations to overcome persistent governance barriers. Rather than being consistently implemented, many enablers were seen as emerging practices or potential solutions still in development.

Supportive policies and legal frameworks were the most frequently cited enablers in Germany (26.9%) and the third most cited in Korea (12.3%). These were closely linked to public participation (7.7% in Germany, 12.8% in Korea) and stakeholder engagement (14.1% in Germany, 10.8% in Korea). However, governmental officials noted that while

stakeholder engagement is expected, they are often no formal guidelines or training on how to do it effectively. Without legal requirements or institutional support, engagement efforts are often deprioritized. Interviewee's comments suggest that stakeholder engagement may not be a fully experienced enabler, but rather a conditional one—its effectiveness depends on addressing structural and procedural gaps.

Another key enabler was communication and awareness-raising, which ranked first in Korea (15.4%) and second in Germany (21.8%). Interviewees emphasized that effective communication helps people understand the value of their communications to UGS initiatives. As one non-profit sector interviewee explained: "Effective communication is crucial. It enables people to understand the value of their contributions [through UGS]. However, if these efforts remain disconnected—just planting trees or implementing programs without purpose—they lose meaning." (N2).

Polycentric and cross-sectoral arrangements were also frequently cited enablers (Korea: 9.2%, Germany: 11.5%). Interviewees viewed these arrangements as essential for enabling integrated regional approaches, bridging administrative boundaries, and aligning diverse policy actors toward shared goals. In both contexts, they were viewed as a way to link planning and policy with on-the-ground delivery, and to coordinate across departments, levels of government, and sectors. For example, German interviewees emphasized the importance of partnerships between cities, NGOs, and administrative bodies to address ecological issues that transcend boundaries (N4, G9, P2). In Korea, interviewees highlighted the need for better coordination between central and local governments, and the value of incorporating diverse perspectives into national policies

(G1, G3). Interviewees viewed these arrangements as potentially useful for scaling up local innovations and circulating resources and knowledge.

This emphasis on coordination and integration also aligns with the importance of flexibility and adaptiveness (Korea: 9.2%, Germany: 6.4%). In Korea, interviewees emphasized recognizing informal green spaces, allowing local experiments, and scaling up successful initiatives with central government support (G3, N2). In Germany, interviewees highlighted adapting concept based on public opinion (C4) and preparing for unpredictability by maintaining flexible strategies (G6).

Long-term commitment was more frequently emphasized in Korea (7.7%) than in Germany (2.6%). Korean interviewees noted that the commitments of institutional leaders were seen as crucial, especially given their short-term appointments (G4). One interviewee noted that alignment between public demand and a mayor's priorities were perceived to enhance implementation efforts (R1). Conversely, funding and financial tools were more frequently mentioned in Germany (6.4%) than in Korea (3.1%). German interviewees emphasized that stakeholder engagement was feasible largely due to available budgets for applied research and participatory workshops (G8, N4).

2.3 Sectoral convergence and divergences in expert perspectives on UGS governance

This section presents a sector-based analysis of governance challenges and enablers in UGS implementation within Korea and Germany. Using MAXQDA's Code Matrix Browser, we visualized how different expert groups—in research and academia (R), government (G), NGOs and international organizations (N), consulting, private, and social enterprise

(C) and political actors (P)—emphasized various governance barriers and enablers. For this analysis, “government” refers to individuals in administrative or public service roles (e.g., city departments or national agencies), while “political” actors include those affiliated with political parties or elected offices. In this section, interviewees within the same stakeholder group were grouped into document sets, allowing the analysis to be conducted at the stakeholder group level rather than at the level of individual interviewees.

Sectoral differences in perceptions of governance barriers and enablers are key to understanding how diverse actors engage with UGS initiatives. Recognizing these distinctions helps tailor strategies that reflect each sector’s unique roles and priorities. In both countries, government (G) and research sectors (R) were central in identifying barriers (Figures 7 and 8), particularly those related to stakeholder engagement, institutional limitations, and lack of supportive policy frameworks. This may be related to their direct involvement in policy implementation and administrative coordination.

A particularly strong pattern was the widespread identification of public or stakeholder engagement as a barrier by both government and NGO interviewees. In Korea, this barrier was mentioned four times each by government and NGO participants; in Germany it was cited 10 times by government and 9 times by NGO interviewees. These findings indicate a shared concern across institutional and civil society actors, as expressed by interviewees, about the challenges of involving diverse publics in UGS planning, especially when interests conflict or participation mechanisms are limited.

In Korea, government interviewees also consistently pointed out to resource constraints (8 mentions), bureaucracy (5) and evaluation challenges (3), suggesting a shared concern around implementation capacity. The research sector also emphasized lack of awareness (8) and stakeholder engagement (9), indicating a strong interest in public communication and inclusivity. Notably, lack of will and commitment was mentioned across all sectors, suggesting broader recognition of the need for stronger leadership and long-term dedication.

In Germany, government interviewees showed strong agreement on stakeholder engagement (10 mentions) and land ownership issues (2), while the research sector emphasized land fragmentation (8) and expertise gaps (2). Political actors and NGOs were more varied in their responses, with NGOs focusing heavily on stakeholder engagement (9) and political actors highlighting resource limitations and policy gaps. Compared to Korea, the German data showed less consistency across sectors, suggesting more fragmented perceptions of governance challenges.

While private and consulting sectors were relatively minor contributors overall, in Korea they were more active in identifying barriers such as lack of expertise (2), insufficient policy support (2), and lack of will (3). This may reflect their intermediary role between public institutions and implementation on the ground.

In Korea, enablers were more evenly distributed across sectors, through NGOs (22 coded references) and researchers (18) were particularly active in identifying them (Figures 9 and 10). NGOs emphasized communication and raising awareness (6 mentions), stakeholder engagement and equity (4), and public participation or interest (4), reflecting

their close connection to civil society and grassroots initiatives. Government interviewees, on the other hand, focused more on polycentric and cross-sectoral arrangements (4), flexibility and adaptiveness (3), and supportive policies and legal frameworks (3), highlighting their role in institutional coordination and policy implementation. Interestingly, communication and awareness-raising were the most frequently cited enabler overall (10 mentions), but it was not mentioned at all by government actors—suggesting a disconnect between institutional priorities and civil society strategies.

In Germany, government (27) and research (20) sectors again played a central role in identifying enablers, but with clearer sectoral clustering. Government interviewees overwhelmingly emphasized communication and raising awareness (13 mentions) and supportive policies and legal frameworks (6), indicating a strong focus on institutional capacity-building and public outreach. Researchers highlighted stakeholder engagement and equity (5) and public participation (3), aligning with their interest in inclusive governance. NGOs, while less prominent than in Korea, contributed notably to polycentric arrangements (4) and funding mechanisms (4), reflecting their role in bridging sectors and accessing external resources.

Across both countries, stakeholder engagement and equity and polycentric arrangements were recognized by multiple sectors, suggesting broad support for collaborative governance models. However, expertise, knowledge, and maintenance were rarely mentioned in Germany, where they were not cited at all. Interviewees suggested that this absence may reflect German governance system's perceived strength in building expertise and maintaining continuity, in contrast to the challenges associated with

departmental rotation in Korea. Notably, political will and long-term commitments was more frequently emphasized by researchers in Korea (4 mentions), while in Germany it was mentioned only twice, suggesting differing expectations about the role of political leadership in enabling UGS governance.

Overall, while there is some alignment across sectors—particularly around the importance of collaboration and communication—distinct differences in emphasis can be observed. These variations highlight the need for tailored engagement strategies that reflect each sector's unique perspectives and capacities. These findings highlight the perceived value of sector-specific engagement approaches in UGS governance. Building on these insights, the next section explores how these sectoral dynamics intersects with broader governance structures and policy frameworks.

3. Discussion

To understand how UGS governance operates in Korea and Germany, it is essential to examine the roles of different sectors and the integration of relevant policies. This study provides new insights into UGS governance by comparing institutional approaches in Korea and Germany. Buijs et al.[42] explain that UGS governance approaches differ significantly across countries, shaping how urban nature is conceptualized and managed. By examining these two contrasting contexts, we identify key governance mechanisms that, according to interviewees, shape the planning and management of UGS.

Beyond institutional structures, it is crucial to understand sectoral differences in how governance barriers and enablers are perceived. Each sector brings distinct priorities, constraints, and capacities to the governance process. These sectoral patterns, as

reflected in interviewee perspectives, indicate that government actors often prioritize administrative feasibility and regulatory compliance, as seen in their emphasis on supportive policies, institutional arrangements, and resource constraints. NGOs, by contrast, focus more on community engagement and social equity, frequently highlighting public participation, stakeholder inclusion, and communication. Researchers tend to emphasize evidence-based planning and long-term outcomes, reflected in their attention to awareness-raising, inclusive governance, and political commitment. Interviewees described how these differing perspectives are influenced by the institutional context—centralized in Korea and decentralized in Germany—which, in their view, shapes how sectors interact, collaborate, and contribute to UGS governance.

These differences have practical implications for designing more effective government arrangements. Mechanisms such as intermediary institutions, joint planning committees, and structured participatory platforms can help bridge sectoral priorities by combining administrative feasibility with inclusive engagement. For example, embedding stakeholder workshops within formal planning processes or creating cross-sectoral coordination units can align regulatory requirements with community-driven goals. Such approach leverage sector-specific strengths while reducing blind spots, ultimately enhancing the legitimacy and adaptability of UGS governance.

Ugolini et al.[43] found that while government officials may have less up-to-date knowledge than other actors, they actively engage with stakeholders to improve their understanding and express a strong desire for collaboration. By identifying these sectoral differences, policymakers and planners can tailor governance approaches that leverage sector-

specific strengths and address blind spots, ultimately enhancing the effectiveness and legitimacy of UGS initiatives.

NGOs play a key role in advancing community goals, but their efforts are often constrained by external factors, including limited funding, shifting political priorities, and reduced governmental capacity or commitment to collaboration[44]. Aronson et al.[45] suggest that collaboration between scientists and resource managers can enhance the capacity to preserve and manage biodiversity in UGS. Ansell and Gash[46] highlight when collaborative groups focus on achieving small, incremental successes, it can create a positive feedback loop that strengthens trusts, deepens commitments, and enhances mutual understanding over time.

These sectoral dynamics do not exist in isolation—they are deeply influenced by the broader governance structures in which they operate. Korea's governance is highly centralized, with cities following uniform national regulations while developing localized action plans. Experts from research sector attributed to this centralization, in part, to the appointment of principal officers at the local level by the national government, which is perceived to prioritize speed and efficiency in decision-making. Local officials are general civil servants with limited subject-matter expertise and are subject to frequent job rotation across departments every few years. While this system is intended to prevent maladjustment and reduce corruption, interviewees noted that it may also contribute to a lack of continuity and deep expertise[46].

This aligns with interviewee accounts, which highlighted that departmental shifts may hinder the accumulation of expertise and suggested the use of intermediary managers to

bridge knowledge gaps. Kim[47] also emphasizes that excessive job rotation undermines efficiency, accountability, and policy consistency. While early-career rotation may help officials explore different roles, longer tenures for mid- and senior-level officials are needed to build institutional expertise. Korea is working on this; for example, the average tenure for civil servants at the director level or higher in central ministries increased from 1 year and 2 months in 2014 to 1 year and 6 months in 2018[48]. However, this remains relatively short and continues to pose challenges for strengthening local government capacity.

Despite this centralization, research suggests that even highly centralized systems—such as Korea's—can accommodate local innovation through pilot projects and policy implementation, particularly when mid-level bureaucrats or local agencies are empowered to adapt national goals to local contexts[49]. However, most interviewed researchers and a government official observed that Korea's centralized approach may facilitate rapid implementation, but can also lead to short-term, technocratic planning that prioritizes delivery over long-term integration. This tendency is not solely due to centralization itself, but rather reflects broader institutional and cultural dynamics, including rapid urbanization and performance-driven administrative cycles. As noted in the literature, Korean UGS planning is characterized by tight timelines and limited flexibility, which can constrain comprehensive planning and make it difficult to demonstrate long-term benefits[50,51]. Compared to Germany's more decentralized and participatory planning processes, most interviewed researchers and few government officials perceived that Korea's approach tends to emphasize execution over deliberation, which may limit opportunities for adaptive and inclusive green space development.

In contrast, Germany operates under a decentralized system, where federal regulations provide overarching guidelines, but states and cities have the authority to develop specific regulations that often take precedence[52]. This system allows for tailored local regulations and referenda at the federal, state, and local levels, enabling citizen participation in UGS governance[53]. However, it faces challenges in understanding actions taken on a broader scale and often engages in prolonged discussions without producing tangible outcomes.

Effective communication and stakeholder engagement emerged as essential enablers in both contexts, though the logistical complexities vary due to contrasting governance structures. Involving diverse stakeholders and the public make it challenging for government officials, policymakers, and practitioners, to navigate administrative layers and coordinate across sectors. This finding is consistent with Follmann and Viehoff[54], who identified community engagement as a key governance barrier. These challenges are further compounded by the limited and complex nature of available resources—a critical issue in both Korea and Germany. Securing resources remains a shared challenge, regardless of whether the system is centralized or decentralized. This finding is consistent with Toxopeus and Polzin[55], who highlight financial constraints as a major obstacle to upscaling urban NbS.

Beyond national governance structures, this section explores how UGS policies align with international frameworks and broader sustainability agendas. Despite structural differences, several points of convergence emerge—particularly the challenges both countries face securing resources, engaging stakeholders, and demonstrating long-term

impacts. However, divergences in institutional design, sectoral roles, and international alignment shape how these challenges are addressed.

Although German regulations are tailored to local situations, interviewees from state ministry, municipal department, as well as political party, highlighted challenges in interpreting policies beyond their jurisdictions. Researchers and federal advisors further pointed to complexity of navigating diverse governance structures across cities and states. Mell et al.[56] describe Germany's multi-level federal structure, where each state has its constitution, parliament, and government. This structure is often highlighted for its capacity for comprehensive planning, although competing interests arise between different governmental levels and sectors with varying objectives and priorities. Extensive coordination and joint strategies are required to balance regional autonomy with the integration of diverse interests.

Both countries are working to integrate UGS policies with broader sustainability goals, such as the SDGs and biodiversity strategies. This trend aligns with Hansen et al.[57], who highlight the growing integration of green infrastructure concepts in urban planning, and with the concept of multi-level governance in UGS management, as discussed by Pauleit et al.[58] In Germany, alignment tends to occur more with EU-level frameworks, while in Korea, local and national strategies are often shaped by global agendas such as the SDGs and Agenda 21. This trend has been described as a form of "glocalization" in environmental governance[59].

In Korea, interviewees from international organizations and academic sector frequently referenced the SDGs—particularly SDG 11 and SDG 15—not only as guiding frameworks

but also as tools for legitimizing local initiatives. For example, the city of Suwon developed its own set of strategic goals aligned with the SDGs, co-created with civil society and monitored through participatory indicators. These practices indicate that the SDGs function not only as top-down mandates but also as locally adapted tools to both shape and justify UGS strategies. This dual role is supported by the literature; while some scholars argue that SDGs are often used to legitimize pre-existing policies[60,61], others highlight their potential to promote rights-based agendas and address local invisibilities[62].

Thus, rather than viewing the SDGs as either drivers or justifications, it may be more accurate to understand them as discursive frameworks that enable local actors to align their strategies to global narratives[63], while also leveraging them to gain legitimacy, funding, or political support. Although the SDGs have been critiqued for their broad scope and implementation challenges[64,65,66,67], their strategic use in Korea demonstrates their value as flexible tools for navigating complex governance landscapes in local contexts when it is being adapted adequately.

In contrast, interviewees in Germany placed greater emphasis on legally binding EU directives and strategies, such as the EU Deforestation Regulation and Natura 2000, which require national implementation but set common goals across member states. While EU directives are legally binding, their implementation depends on national transposition, which can lead to inconsistencies across member states in how environmental and planning policies are applied[68].

Korea’s international commitments and domestic policy efforts—such as GBF and the National Biodiversity Strategy and Action Plan—demonstrate proactive engagement with

global sustainability agenda, though implementation challenges remain, particularly in balancing development pressures with the need for ecosystem protection. As Beatley[69] illustrates through European case studies including Freiburg and Copenhagen, maintaining green infrastructures such as green belts is essential for preserving ecological integrity and urban livability, even as cities face increasing pressure to expand. According to Kim et al.[70], the Korean government has decided to ease green belt regulations to stimulate nationwide industrial development. Such policy shifts may pose risks to forest conservation, potentially undermining Korea's natural heritage and ecosystem services[71]. These trends highlight the urgency of establishing governance mechanisms that protect green infrastructure while managing the pressures of urban expansion.

In the German context, fragmented farmland ownership—particularly in peri-urban areas—was cited as a barrier to UGS planning. While farmland is not traditionally categorized as UGS, it is increasingly integrated into green infrastructure strategies through urban agriculture and community gardening. These multifunctional spaces contribute to ecological, recreational, and social goals, and have been used to reclaim underutilized urban areas and foster community engagement[72-74]. This aligns with the principle of multifunctionality in green infrastructure planning and highlights the importance of considering diverse land uses in UGS governance.

The lack of systemic post-implementation evaluation in Germany and Korea's challenge in demonstrating long-term benefits underscore the need for standardized, long-term impact assessment. This highlights the importance of interpreting enablers not only as

existing capacities, but also as areas where targeted support and institutional change are needed. As Kabisch et al.[6] emphasize, developing indicators is essential for assessing and demonstrating the effectiveness of NbS, improving the measurability of their outcomes, and enabling systemic evaluation of comparability across projects. Future research could explore governance frameworks for UGS and NbS that support both societal resilience and ecosystem health, applicable to centralized and decentralized systems like those in Korea and Germany. It should also address local governance barriers and explore how UGS and NbS can support multiple policy objectives, fostering holistic urban policies that capitalize on multifunctional benefits. Hansen and Pauleit[75] highlight multifunctionality as a crucial principle of green infrastructure planning, as ecological, social, and economic functions of UGS should be considered in parallel—yet guidelines for operationalizing multifunctionality in planning are still lacking.

Recognizing both the shared challenges and context-specific dynamics in UGS governance is essential for developing adaptive, inclusive, and resilient urban strategies. Continued research should explore how governance models can be tailored to local realities while promoting cross-sectoral and international knowledge exchange.

While the findings offer valuable insights, several methodological limitations must be acknowledged. Dexter's transactional theory[76] of interviewing emphasizes that interviews are not neutral data collection events but social interactions shaped by the dynamic interdependence between interviewer and interviewee. The interviewer is not only a recorder of a data but also a stimulus, influencing what is said, realized, and perceived. Given this framework, several methodological limitations must be acknowledged.

First, the interviewer defined their theoretical, ontological, and epistemological stance prior to conducting the interviews to minimize personal bias and subjectivity. However, differences in positionality (expert vs. PhD candidate) and cultural background (Korean interviewer vs. German interviewee) may have influenced both the interview dynamics and the interpretation of responses.

Second, the small sample size—16 interviewees per country (32 in total)—presents a limitation. While this meets the minimum threshold for qualitative research[77,78,79], it may not fully capture the complexity of each national context. As detailed in the Data Collection section, stakeholders were selected through purposive, theoretical, and snowball sampling strategies, with efforts made to include a balanced mix of experts across sectors and governance levels. Nonetheless, variation in interviewee expressiveness meant that some participants proposed significantly more barriers and enablers than others, which may introduce bias in the frequency-based analysis.

Third, the study did not include interviewees from the political sector in Korea, due to difficulties in securing participants. This absence may have limited the study's ability to adequately capture the political dimensions of UGS governance in the Korean context.

Fourth, language barriers posed potential limitations. To minimize bias, interviewees were given the option to speak in their preferred language. In Korea, three interviews were conducted in English, and 12 in Korean. In Germany, 13 interviews were conducted in English, with occasional use of German terms for organizational names and other specific references. One Korean interviewee chose to speak in English with a German colleague present. Two interviews required interpretation support, with interpretation. While these

accommodations aimed to reduce bias, nuances may have been lost or altered in translation.

Fifth, as with any qualitative content analysis, the process of categorizing barrier and enablers involves a degree of subjectivity. While the coding process followed grounded theory principles, determining the most appropriate code was sometimes challenging, particularly when certain themes were overlapped—such as distinguishing between path dependency and bureaucracy, or between sectoral silos and lack of supportive frameworks. As Collier et al.[80] and Martin et al.[81] note, data classification is inherently interpretive, and the boundaries between categories are often fluid. To mitigate this, coding decisions were reviewed collaboratively among co-authors, as described in the Data Analysis section. These discussions served to clarify ambiguous cases, resolve overlaps between codes, and ensure that the agreed definitions in Table 3 were applied consistently across transcript. However, the absence of formal inter-rater reliability metrics (e.g., Cohen's kappa) means that some degree of interpretive variability remains inherent in the categorizations. This limitation is acknowledged as part of the qualitative nature of the study.

The SES framework provides the primary lens for interpreting these governance patterns, revealing how interactions among resource systems, users, and governance structures shape barriers and enablers in Korea and Germany. The study conceptualized UGS as SES (see Figure 11), comprising interlinked subsystems such as the resource system (UGS), resource units (e.g., trees), users (e.g., humans), and governance systems (e.g., organizations). The findings from Korea and Germany illustrate how interactions between

governance systems and users are shaped by institutional arrangements, administrative structures, and cultural norm, resulting in distinct governance outcomes. Differences in stakeholder engagement and policy integration reflect how governance system influence user behavior and perceptions, reinforcing the SES framework's emphasis on dynamic interdependencies.

Interaction between governance systems and users are evident in Korea's centralized governance, which enables rapid implementation but limits long-term engagement due to frequent departmental rotations. In contrast, Germany's decentralized governance fosters participatory planning but often slows decision-making processes. Interactions between governance systems and resource systems are illustrated by Korea's national park destination system (resource system), which is hindered by strict land acquisition requirements, whereas Germany's EU-aligned forest policies promote multifunctional use of urban forests. Similarly, interactions between users and resource units are reflected in stakeholder engagement challenges, such as conflicts between pet owners and non-pet owners, which affect how parks and trees are perceived and used.

The SES framework's emphasis on feedback mechanisms and resilience aligns with several findings. Stakeholder engagement (user behavior) feeds back into government decisions, as seen in Germany's use of referenda. Resource constraints, such as land fragmentation and ownership issues, limit adaptive capacity. Meanwhile, polycentric arrangements and cross-sectoral collaboration enhance resilience by bridging institutional silos and enabling more integrated governance.

By applying the SES framework to cross-national urban contexts, this study contributes to a deeper understanding of how institutional arrangements and cultural norms mediate socio-ecological resilience in UGS governance. It highlights the value of SES as a lens for analyzing governance complexity, adaptive capacity, and the interplay between ecological and social dimensions in urban sustainability transitions.

In addition to the SES framework, the study's findings resonate with environmental justice perspectives, particularly in relation to stakeholder engagement, land use, and policy legitimacy. Although not applied as an analytical lens in this study, these frameworks offer supplementary insights into equity dimensions including distributional justice (fair access to and benefit from UGS), recognitional justice (acknowledge diverse cultural values and socio-demographic perspectives), procedural justice (ensuring fair and inclusive decision-making processes)[82]. Applied Justice Taxonomy and Assessment Framework (AJUST)[83] further introduces corrective justice (e.g., prioritizing UGS in underserved areas, involving previously excluded groups in planning processes) and transitional justice (e.g., navigating trade-offs and sequencing in the pursuit of equitable outcomes). Together, these perspectives can help illuminate not only ecological and institutional dynamics, but also the social implications of governance, particularly in relation to long-term resilience and sustainability[82,84].

Dimensions such as distributional, recognition, procedural, corrective, and transitional justice emerged across both contexts. These concepts offer valuable directions for future research, especially in understanding how governance processes can better address equity over time. For example, centralized governance structures may prioritize implementation speed at the expense of inclusive deliberation, raising questions about

how justice is delivered across populations and temporal scales. Practices such as Suwon's co-developed biodiversity strategy and Germany's use of referenda suggest emerging efforts to involve broader publics and address pass exclusions. These mechanisms may serve as entry points for more reparative approaches.

Building on these empirical and conceptual insights, the following reflections synthesize key findings and explore their practical and policy implications for UGS governance. This research examines Korea's centralized and Germany's decentralized governance models for UGS planning and management. Participants perceived that Korea's centralized approach facilitates swift implementation and localized action plans[85], though they also noted challenges with long-term strategic integration and demonstrating broader benefits. According to municipal officials, regional planners, and researchers, Germany's decentralized system, grounded in state and local autonomy and aligned with EU policy frameworks, was seen as fostering more participatory and context-sensitive solutions[86]. However, political actors and urban planners emphasized that extensive public participation and negotiation processes often prolong decision-making and slow implementation.

The findings suggest that cross-national policy learning is possible. Interviewees from Korea's national forestry research institute emphasized Germany's long-term, systemic approach to management and integrated urban planning as valuable for building resilience and municipality. Researchers also highlighted Germany's strong public engagement and mandatory participation processes as lessons for improving dialogue in Korea. Conversely, German municipal planners and academic experts acknowledged that Korea's centralized governance enables rapid implementation, contrasting with

Germany's prolonged negotiation cycles. These insights underscore opportunities for countries seeking to balance efficiency with inclusivity in UGS and NbS governance.

A stakeholder-based analysis reveals that different actor groups—government actors, NGOs, and researchers—bring distinct priorities and constraints to UGS governance. These differences are shaped by institutional roles and sectoral mandates. For example, in Korea, government officials described how the central government, agencies like the Korea Forest Service, provides strategic oversight, allocate budgets, and offers technical expertise, while research institutions contribute scientific evidence to guide policy. In contrast, government officials noted that frequent departmental rotations, often every two years at the local level, hinder long-term capacity building and lead to reliance on external contractors for implementation. NGO representatives emphasized their strength in public engagement and community-based initiatives, acting as bridges between citizens and local government, though they acknowledged limited influence on formal policy-making. Landscaping and engineering firms highlighted their technical capacity for efficient implementation but admitted that economic priorities can conflict with long-term ecological goals. Across these sectors, both participants from the government and research sectors pointed to fragmented responsibilities among ministries and local departments as a major barrier, underscoring the need for better coordination mechanisms to align priorities and resources.

In Germany, municipal officials and political actors noted that decentralized governance allows for strong local knowledge and autonomy, but aligning with national or EU-level strategies can be complex. NGOs and civil society organizations stressed their role in participatory planning, while researchers emphasized evidence-based decision-making.

Yet, several participants including municipal planners and political actors pointed out that fragmentation and prolonged negotiation often limit the effectiveness of cross-sectoral collaboration.

Building on the sectoral differences, interviewees identified mechanisms, such as pilot projects, intermediary institutions, and capacity-building initiatives, as practical ways to reconcile government actors' focus on administrative feasibility, NGO's emphasis on community engagement, and researcher's priority for evidence-based planning. Municipal planning and forestry officers viewed pilot projects that blend centralized and decentralized elements as experimental spaces for testing collaborative governance models. These pilots were described as opportunities to clarify roles, improve communication across sectors, and identify scalable practices for UGS management.

Experts with policy advisory and research experience emphasized the value of establishing international or transboundary working groups between policy makers and urban planners. According to these interviewees, such platforms can facilitate cross-case learning, foster more adaptive governance, and help cities navigate trade-offs between centralized efficiency and decentralized inclusivity.

Across sectors, interviewees highlighted the role of intermediary institutions or coordination platforms in mediating between actors and ensuring that both technical and social dimensions of UGS governance are addressed. Municipal officials pointed to the need for dialogue-based mechanisms to resolve interdepartmental conflicts, while forestry representatives described stakeholder meetings involving NGOs, recreational groups, and industry actors as essential for balancing competing interests.

Representatives from international sustainability organizations also noted that certification bodies often act as intermediaries, convening diverse stakeholders to reach consensus on standards and practices.

Finally, participants stressed the importance of capacity building initiatives—including training programs for public officials, stakeholder workshops, and institutional reforms to support long-term expertise—for strengthening governance systems. Interviewees from international forestry and sustainability organizations called for educational courses to improve civil society engagement, while municipal planners highlighted gaps in evaluation practices that require institutional support. Forestry departments underscored sector-specific training, such as apprenticeships for forest workers, as critical for sustaining technical capacity.

In addition to empirical insights, this study contributes conceptually by applying the SES framework to analyze governance interactions, stakeholder dynamics in UGS planning. By reflecting on justice considerations as supplementary reflections, this study highlights equity-related challenges that resonate with environmental justice perspectives and underscores the importance of understanding how governance arrangements shape both the functionality and fairness of urban NbS.

While the core analysis focuses on institutional enablers and barriers, the discussion acknowledges the relevance of value pluralism and justice considerations for informing future research and practice. Drawing on the Nature Futures Framework (NFF)[87], future policy design should aim to balance instrumental goals (e.g. climate resilience, public health), relational and cultural values associated with urban nature. Embedding such

plural perspectives into planning frameworks was viewed by participants as a way to support more inclusive and adaptive governance. These findings highlight the need for further research into how governance actors express and negotiate diverse values in decision making processes. Such inquiry could deepen understanding of the role of cultural worldviews and value pluralism in shaping policy legitimacy and public acceptance in UGS governance.

Finally, future research should explore how these governance models and sectoral dynamics play out in other contexts—particularly in rapid urbanizing regions or in cities facing climate-related pressures. Comparative studies, such as those between different governance systems and cultural contexts, may contribute to the development of a globally informed yet locally grounded framework for inclusive and resilient urban nature governance.

4. Methods

4.1 Data collection

This paper draws on qualitative data from 30 semi-structured interviews to gather insights on UGS implementation in both countries. Interviews were carried out with stakeholders in UGS management and planning in Korea (N=16) and Germany (N=16). These included city administrators, government officials, policymakers, scientists, landscape architects, and members of non-governmental and inter-governmental organizations. While one-on-one interviews were requested, in each country, one interview included an additional participant, resulting in a total of 32 individuals interviewed across 30 sessions. Interviews in Korea were conducted between mid-February and mid-April 2024 in five cities (Seoul,

Yongin, Daejeon, Suwon, and Seongnam), and in Germany between mid-April and the end of June 2024 in six cities (Berlin, Karlsruhe, Stuttgart, Munich, Bonn, and Düsseldorf).

Interviewees were selected based on expertise in UGS planning and management, policy development, and NbS. Selection criteria included organizational affiliation, geographical location, knowledge and expertise, experience, and professional background. Initial participants were identified through institutional networks, expert directories, and prior collaboration. At the end of each interview, participants were asked to recommend other individuals who they believed would offer valuable insights into UGS governance. This referral process helped identify additional stakeholders and broaden representation of sectors and governance levels. While full representativeness was not feasible, efforts were made to include a balanced mix of experts from government, academia, civil society, and the private sector in different cities.

The study employed purposive, theoretical, and snowball sampling[88,89]. Purposive sampling involved selecting individuals based on specific criteria to ensure relevance and critical insights into the research topic. Theoretical sampling guided the selection of interviewees from different expert sectors (e.g. policy, academia, civil society), based on emerging needs during the data collection. Snowball sampling was used to identify additional participants though referrals, continuing until data saturation was reached[89,90,91].

In Korea, twelve interviews were conducted in Korean and three in English. In Germany, thirteen interviews were in English, and two involved colleagues who assisted with translation. Interviews lasted between 30-90 minutes. Interview questions were partially

based on a previous questionnaire on public perceptions, usages, and demands on cultural ecosystem services from UGS in Korea and Germany.

The interview questions were open-ended, with follow-up questions to facilitate problem-oriented exploration. An interview protocol (Supplementary Information 1) provided a structured yet flexible framework for exploring key themes. These included: (1) the role of experts' and public engagement in UGS governance; (2) barriers, enablers, and policy contexts in UGS governance; (3) governance challenges, responsibilities, and future directions; and (4) a set of closing questions to reflect on overarching insights.

An Information and Declaration of Consent Form (Supplementary Information 2) was developed in accordance with the Data Protection Instructions at Karlsruhe Institute of Technology (KIT) and reviewed by the Data Protection Officer at ITAS, KIT. To ensure participant confidentiality and informed consent, data protection measures were documented in KIT's electronic processing directory (eVV).

To ensure anonymity while enabling sectoral comparison, interviewees were assigned codes based on their institutional affiliation: R (Research/Academia), G (Government), N (NGO/International Organization), C (Consulting/Private/Social Enterprise), and P (Political), followed by a number (e.g., R1, G2). Each code (e.g., R1, G2) corresponds to a different individual interviewee within that stakeholder group and is used consistently throughout the article.

4.2 Data analysis

Interviews were recorded and transcribed. The analysis was conducted using MAXQDA, a Qualitative Data Analysis (QDA) software, to systematically code and categorize the

data based on recurrent themes and patterns[91,92]. The analytical approach was guided by grounded theory principles, particularly its iterative and inductive nature. Reflexivity was maintained throughout the process, acknowledging the potential influence of the researcher's positionality on interpretation[90]. While the coding was primarily conducted by the lead author, coding decisions, especially in cases of ambiguity or overlapping themes, were discussed and reviewed with co-authors during regular meetings. Throughout this process, reference was made to the definitions provided in the code system (see Table 3) to guide consistent interpretation and application of codes. This collaborative discussion helped refine the code system and improve consistency across the dataset, even though formal inter-coder reliability metrics were not applied.

The coding process focused on three main analytical categories. First, mentions of policies within the transcripts were coded using MAXQDA and categorized by governance level for each city, facilitating a structured understanding of the policy landscape influencing UGS implementation. This analysis emphasized key policies at different governance levels, distinguishing between general references to policy frameworks and specific regulations or initiatives.

Second, a code system was developed to identify and organize data related to governance challenges and facilitating factors. Initial codes were informed by the framework used in Martin et al.[81], with additional inductive coding applied to capture emerging themes. Non-recurring or redundant codes were removed through an iterative process, resulting in a refined code system that categorized governance barriers and enablers (Table 3).

Table 3. Code system for interview analysis

Category	Code	Definition
Key policies	Policy in general	References to policy frameworks, governance structures, or regulatory approaches without specifying a particular law or framework
	Particular policy being mentioned	Direct mention of a specific policy, regulation, or initiative relevant to UGS or NbS planning and implementation
Governance Barriers	Climate change and natural disasters	Challenges from increasing frequency or severity of climate events that impact UGS planning or highlight the urgency for NbS
	Evidence on performance and co-benefits	Lack of robust data demonstrating NbS effectiveness and associated co-benefits
	Insufficient or poor quality of evaluation	Absence of systemic monitoring or inadequate evaluation methods that hinder learning and accountability
	Lack and complexity of resources	Shortage or fragmentation of financial, human, or technical resources needed for NbS implementation
	Lack of awareness or understanding	Limited stakeholder knowledge or misconceptions about NbS benefits and functions
	Lack of supportive policy or legal frameworks	Absence of enabling policies or regulations that incentivize or facilitate NbS adoption
	Land ownership and availability	Scarcity of suitable land or conflict over implementing NbS on privately owned land
	Path dependency	Structural lock-in to historically dominant planning or infrastructure models, limiting innovation
	Stakeholder engagement	Challenges in involving diverse stakeholder groups or reconciling conflicting interests in UGS planning and management
	Sectoral or administrative silos	Fragmentation between departments or sectors that impedes coordination

	Bureaucracy	Procedural rigidity and hierarchical decision-making that slow implementation and reduce flexibility
	Lack of expertise and knowledge	Insufficient technical or institutional know-how for NbS planning and delivery
	Lack of will and commitment	Weak political or organizational commitment, including absence of long-term vision for NbS
Governance Enablers	Disasters	Disruptive events that expose limitations of grey infrastructure and catalyze NbS adoption
	Flexibility and adaptiveness	Governance mechanisms that allow NbS to adjust to changing conditions
	Funding and financial tools and support	Availability of financing tools, schemes and funding sources for NbS
	Expertise and knowledge	Presence of technical know-how and institutional learning to support NbS implementation
	Maintenance	Ongoing care and management of green spaces to ensure long-term sustainability and resilience
	New initiatives	Introduction of innovative programs, policies, or pilot projects that demonstrate and scale NbS approaches
	Political will and long-term commitment	Enduring support and prioritization of NbS by political leadership
	Polycentric and cross-sectoral arrangements	Collaborative governance across levels and sectors to integrate NbS
	Public participation or interest	Active involvement or support from citizens and community groups

Stakeholder engagement and equity	Inclusive process that ensure diverse voices and fair representation in decision-making
Communication and raising awareness	Efforts to inform and engage stakeholders about NbS benefits and opportunities
Supportive policies and legal frameworks	Existing policies or regulations that enabler and incentivize NbS implementation

Third, sectoral convergence and divergence in expert perspectives were explored using MAXQDA's Code Matrix Browser by visualizing existing codes related to barriers and enablers. This tool enabled a comparative analysis of how different expert groups (e.g., academia, government, NGOs, private sector, political actors) emphasized various governance barriers and enablers within each country. The visualization normalized for the amount each interviewee spoke, allowing for a balanced comparison of thematic emphasis across sectors.

In addition to the qualitative coding, a non-systematic stakeholder mapping exercise was conducted separately. During the interviews, participants were presented with a preliminary list of stakeholders involved in UGS management (tailored to each country) and asked to modify it by adding or removing stakeholders based on their relevance. The iterative process across interviews resulted in finalized stakeholder lists for each country, reflecting the locally perceived governance landscape

Data Availability

The interview protocol, participant information and consent forms, key stakeholder lists related to urban green space (UGS) planning and management in Korea and Germany,

and the urban green space policy documents referenced during interviews are provided in Supplementary Information 1 to 6 accompanying this article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contributions

J.S. led the study conceptualization, developed the interview protocol and consent materials, ensured compliance with data protection regulations, conducted the interviews, performed the data analysis, and wrote and revised the manuscript. J.M., J.L.-M., and S.S. provided input during the study design and the development of the interview protocol. The data analysis was conducted during a research stay at IIASA under the supervision of J.M. and J.L.-M. J.M., J.L.-M., C.K., and S.S. reviewed the manuscript, provided feedback, and approved the final version. S.S and C.K. provided doctoral supervision to J.S. All authors have read and approved the manuscript.

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Figure Legends

Figure 1. Simplified stakeholder map of urban green space implementation in Korea. This figure presents a visual summary of key stakeholders involved in urban green space (UGS) planning and management in Korea, as identified through semi-structured interviews. Stakeholders include government agencies, NGOs, urban planners, and international organizations. The full list of stakeholders is provided in Supplementary Information 3.

Figure 2. Simplified stakeholder map of urban green space implementation in Germany. This figure presents a visual summary of key stakeholders involved in urban green space (UGS) planning and management in Germany, as identified through semi-structured interviews. Stakeholders include government agencies, NGOs, urban planners, and professional associations. The full list of stakeholders is provided in Supplementary Information 4.

Figure 3. Barriers to urban green spaces planning and management in Korea. This figure presents the distribution of governance barriers identified through semi-structured interviews with experts in Korea. The analysis was conducted using MAXQDA, a qualitative data analysis (QDA) software, to systematically code and categorize responses based on recurring themes. A structured code system was developed to

identify governance challenges and facilitating factors. The definitions and structure of the code system are provided in Table 3. Stakeholder engagement was the most frequently cited barrier (20.9%), followed by resource constraints, lack of supportive policies, and limited awareness and expertise.

Figure 4. Barriers to urban green spaces planning and management in Germany. This figure presents the distribution of governance barriers identified through semi-structured interviews with experts in Germany. The analysis was conducted using MAXQDA, a qualitative data analysis (QDA) software, to systematically code and categorize responses based on recurring themes. A structured code system was developed to identify governance challenges and facilitating factors, with definitions provided in Table 3. Stakeholder engagement was the most frequently cited barrier (38.3%), followed by land ownership and availability issues (20.0%) and resource gaps and complexity (10.0%).

Figure 5. Enablers of urban green spaces planning and management in Korea. This figure presents the distribution of governance enablers identified through semi-structured interviews with experts in Korea. The analysis was conducted using MAXQDA, a qualitative data analysis (QDA) software, to systematically code and categorize responses based on recurring themes. A structured code system was developed to identify governance challenges and facilitating factors, with definitions provided in Table 3. Communication and awareness-raising was the most frequently cited enabler (15.4%), followed by public participation and interest (13.8%), supportive policies and laws (12.3%), and stakeholder equity (10.8%).

Figure 6. Enablers of urban green spaces planning and management in Germany. This figure presents the distribution of governance enablers identified through semi-structured interviews with experts in Germany. The analysis was conducted using MAXQDA, a qualitative data analysis (QDA) software, to systematically code and categorize responses based on recurring themes. A structured code system was developed to identify governance challenges and facilitating factors, with definitions provided in Table 3. The most frequently cited enabler was the presence of supportive policies and legal frameworks (26.9%), followed by communication and awareness-raising (21.8%) and stakeholder equity (14.1%).

Figure 7. Sectoral distribution of urban green space governance barriers in Korea. This heatmap was generated using MAXQDA's Code Matrix Browser to visualize the frequency of coded references related to governance barriers (B) in urban green space planning and management. Color intensity reflects the number of references, with deeper shades indicating higher frequency. Interviewees are classified by sector: R (Research/Academia), G (Government), N (NGO/International Organization), C

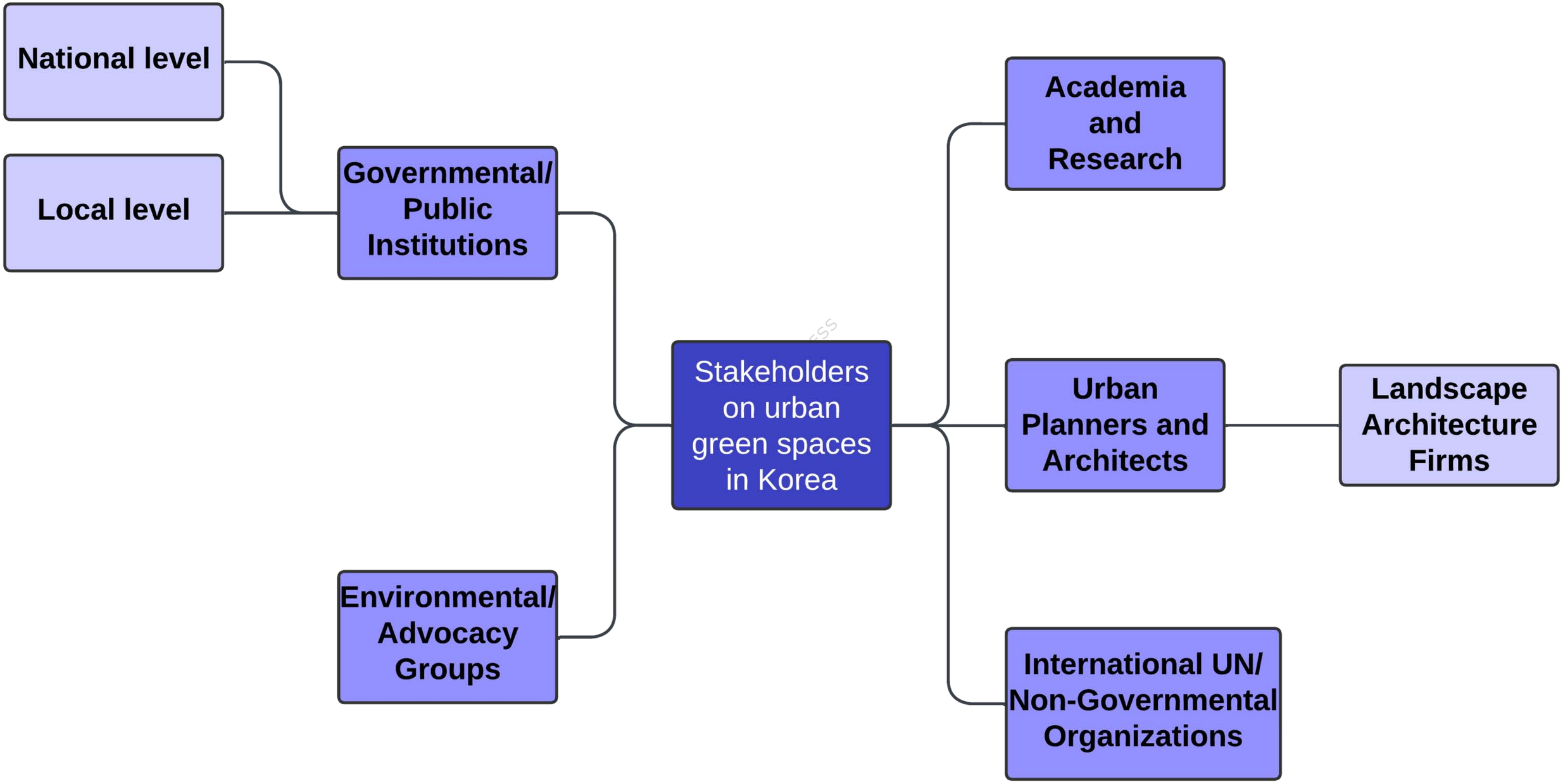
(Consulting/Private), and P (Political). *Note: No interviewees from the Political sector (P) were included in the Korean dataset.*

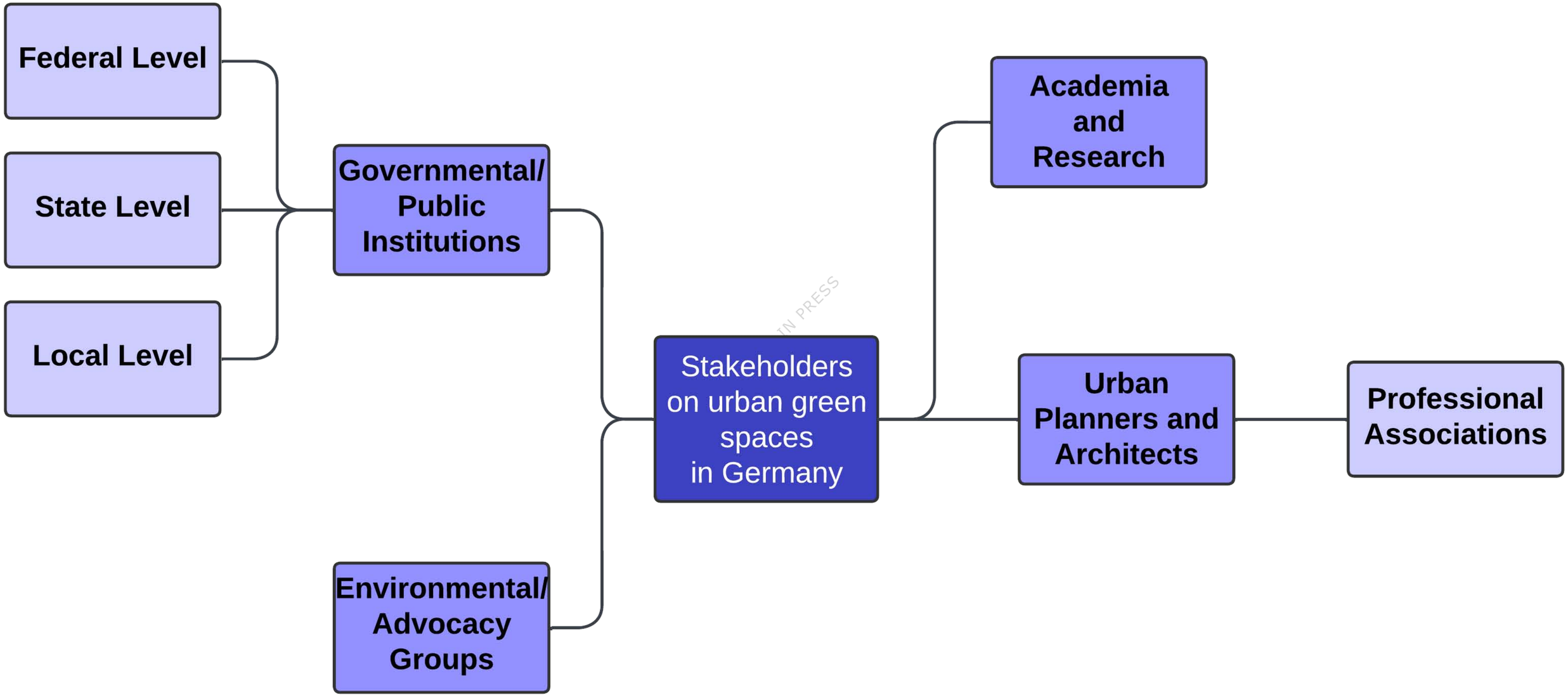
Figure 8. Sectoral distribution of urban green space governance barriers in Germany. This heatmap was generated using MAXQDA's Code Matrix Browser to visualize the frequency of coded references related to governance barriers (B) in urban green space planning and management. Color intensity reflects the number of references, with deeper shades indicating higher frequency. Interviewees are classified by sector: R (Research/Academia), G (Government), N (NGO/International Organization), C (Consulting/Private), and P (Political).

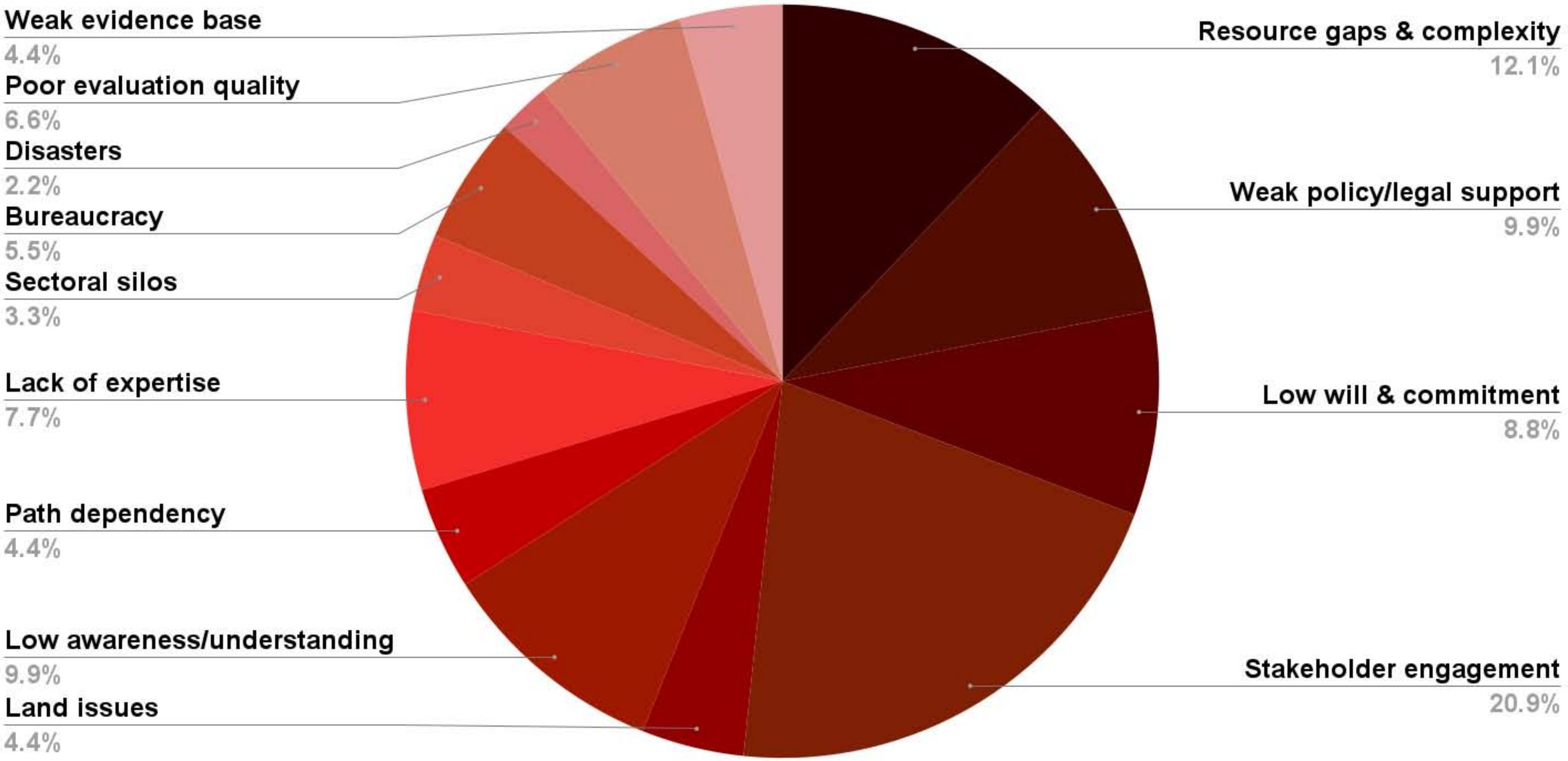
Figure 9. Sectoral distribution of urban green space governance enablers in Korea. This heatmap was generated using MAXQDA's Code Matrix Browser to visualize the frequency of coded references related to governance enablers (E) in urban green space planning and management. Color intensity reflects the number of references, with deeper shades indicating higher frequency. Interviewees are classified by sector: R (Research/Academia), G (Government), N (NGO/International Organization), C (Consulting/Private), and P (Political). *Note: No interviewees from the Political sector (P) were included in the Korean dataset.*

Figure 10. Sectoral distribution of urban green space governance enablers in Germany. This heatmap was generated using MAXQDA's Code Matrix Browser to visualize the frequency of coded references related to governance enablers (E) in urban green space planning and management. Color intensity reflects the number of references, with deeper shades indicating higher frequency. Interviewees are classified by sector: R (Research/Academia), G (Government), N (NGO/International Organization), C (Consulting/Private), and P (Political).

Figure 11. Conceptualization of urban green spaces (UGS) as socio-ecological systems (SES). The figure illustrates UGS as SES using a nested structure, adapted from previous work[29] and based on Ostrom's SES framework[27], where resource units, users, governance systems, and the broader resource system interact to shape ecological and social outcomes. Created by the author using Lucid.app.



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Poor evaluation quality
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Disasters
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Path dependency
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Low awareness/understanding
9.9%
Land issues
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Resource gaps & complexity
12.1%
Weak policy/legal support
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Low will & commitment
8.8%
Stakeholder engagement
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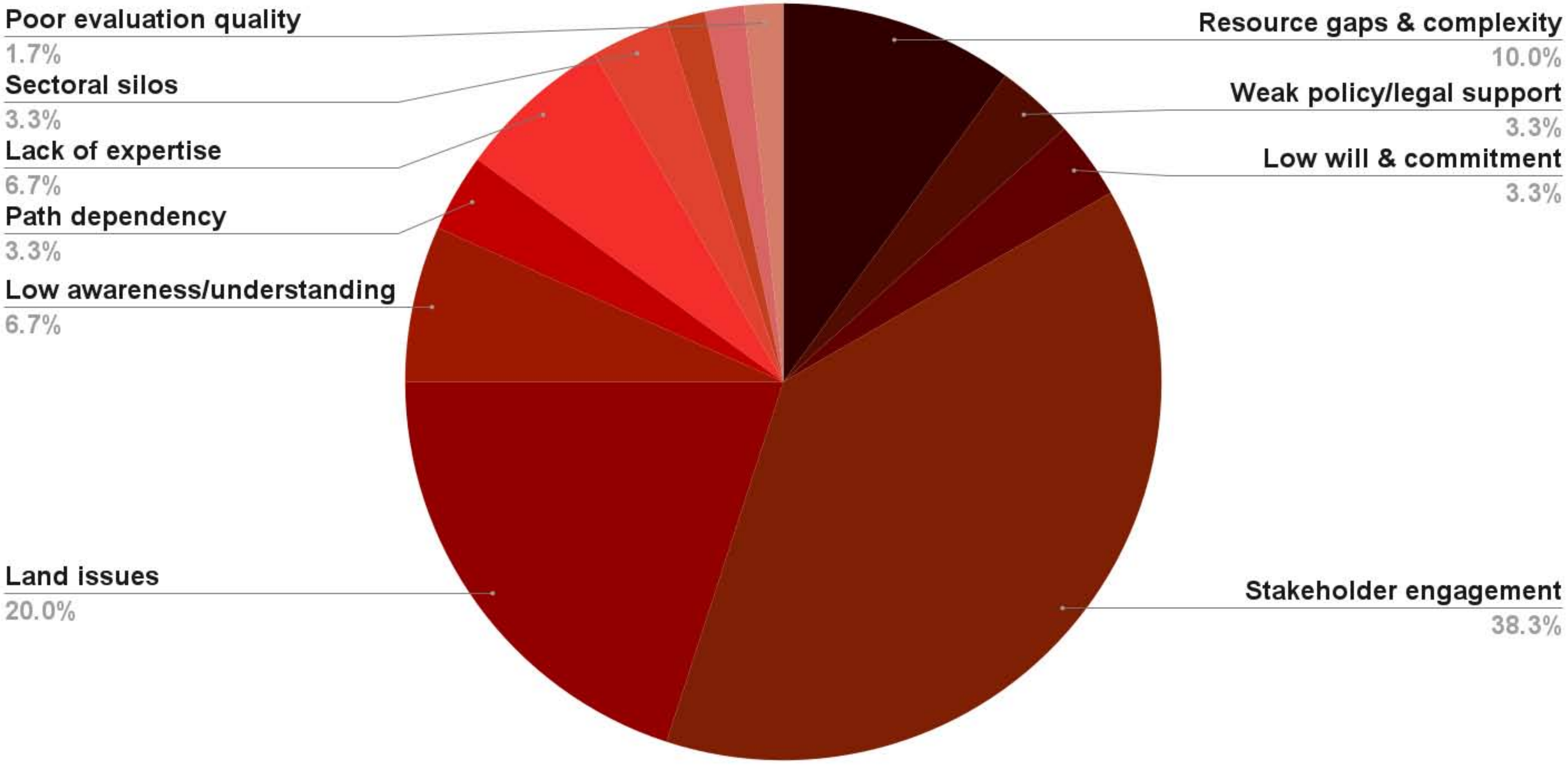
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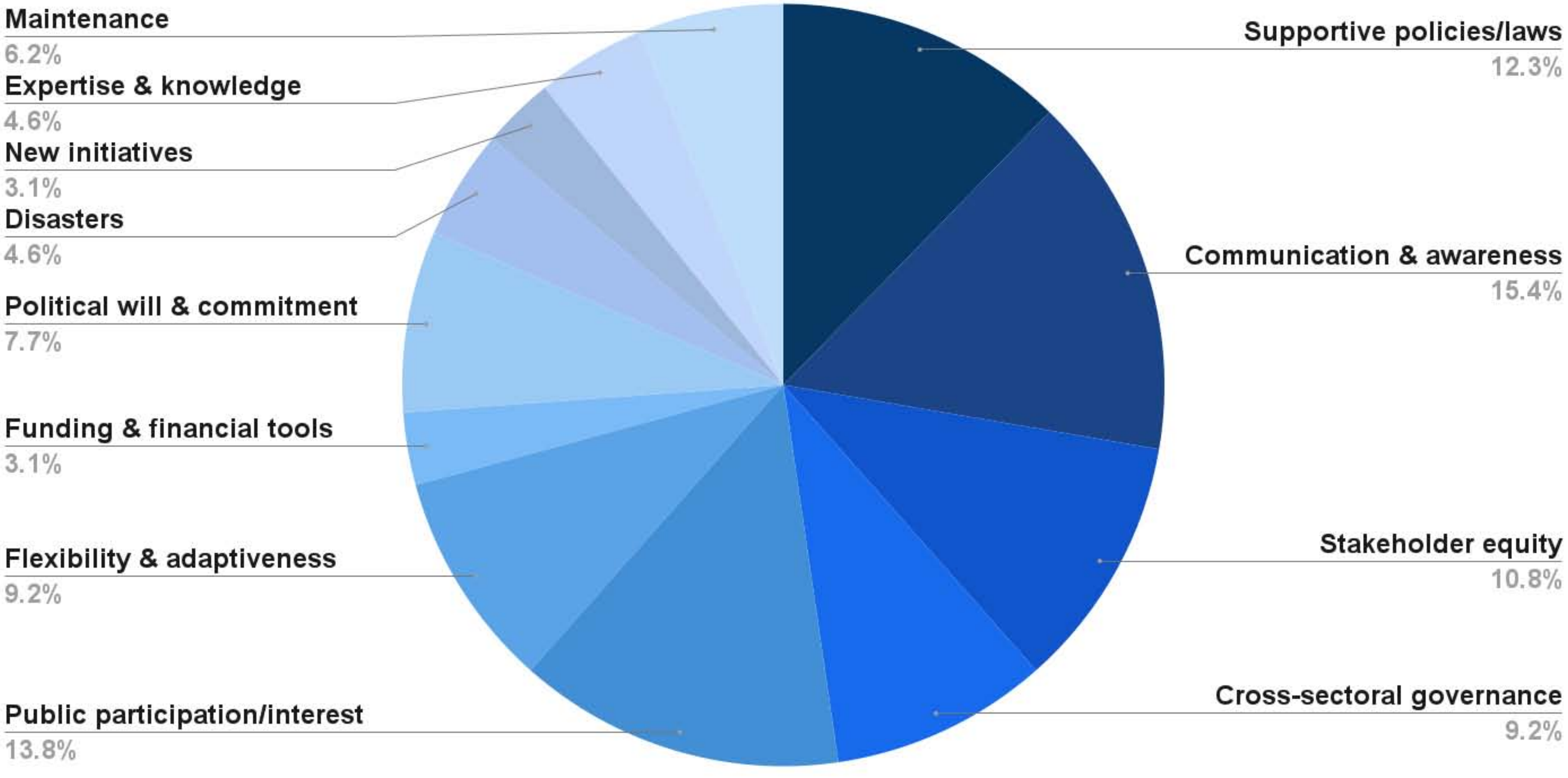
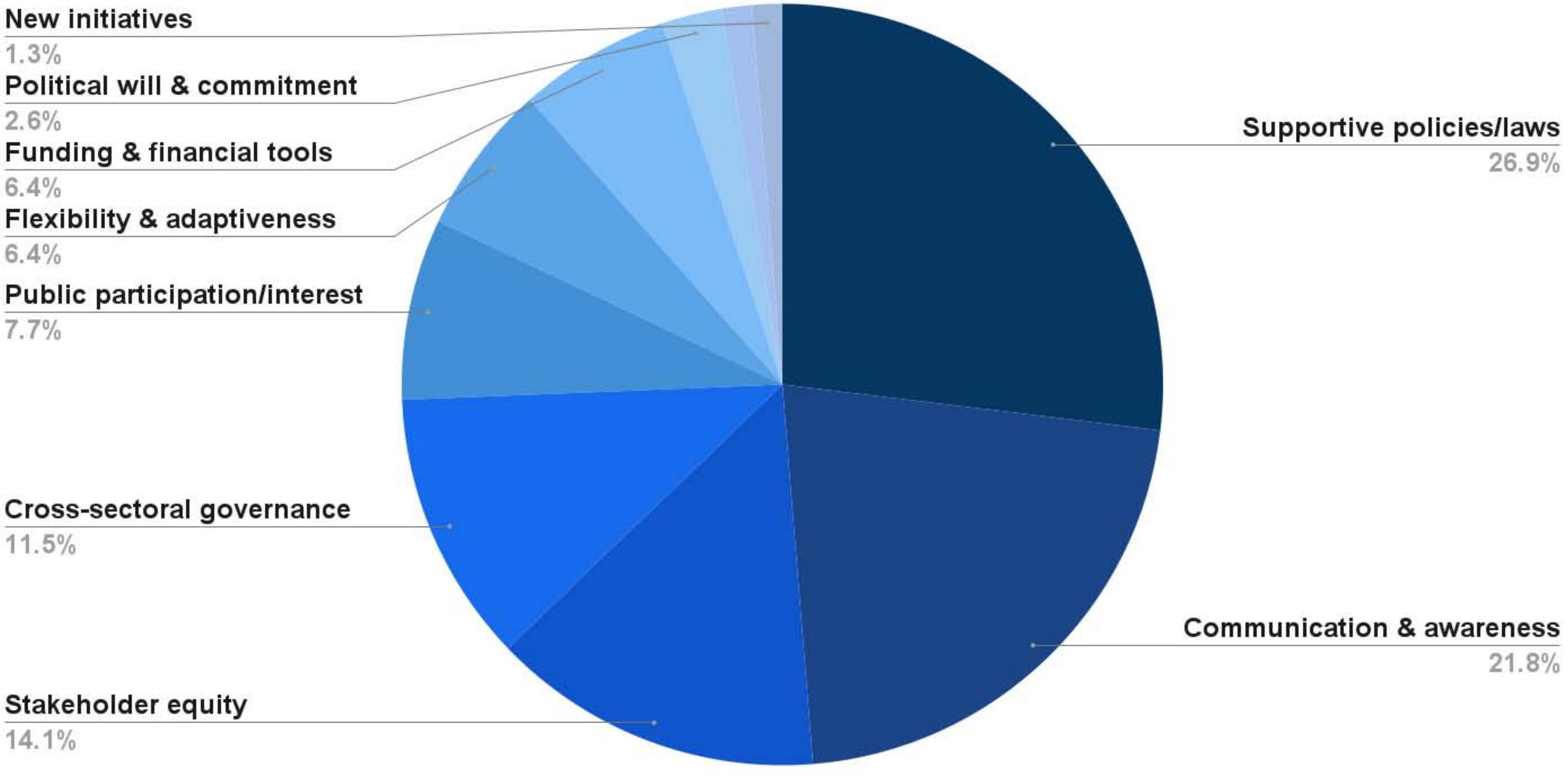
6.7%
Land issues
20.0%
Resource gaps & complexity
10.0%
Weak policy/legal support
3.3%
Low will & commitment
3.3%
Stakeholder engagement
38.3%

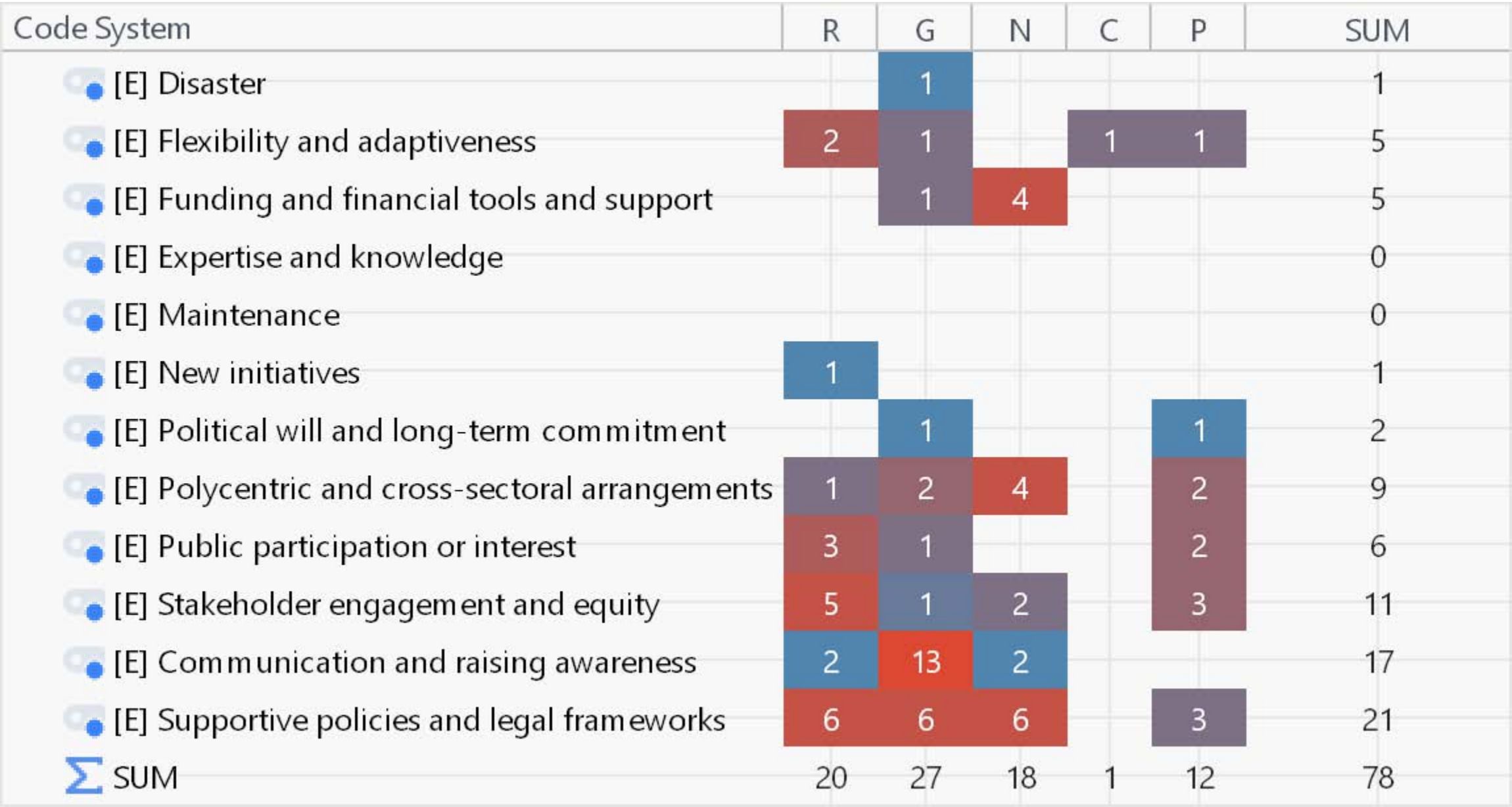

Maintenance
6.2%
Expertise & knowledge
4.6%
New initiatives
3.1%
Disasters
4.6%
Political will & commitment
7.7%
Funding & financial tools
3.1%
Flexibility & adaptiveness
9.2%
Public participation/interest
13.8%
Supportive policies/laws
12.3%
Communication & awareness
15.4%
Stakeholder equity
10.8%
Cross-sectoral governance
9.2%


New initiatives
1.3%
Political will & commitment
2.6%
Funding & financial tools
6.4%
Flexibility & adaptiveness
6.4%
Public participation/interest
7.7%
Supportive policies/laws
26.9%
Cross-sectoral governance
11.5%
Communication & awareness
21.8%
Stakeholder equity
14.1%

Code System	R	G	N	C	SUM
[B] Climate change and natural disasters	2				2
[B] Evidence on performance and co-benefits	1	2		1	4
[B] Insufficient or poor quality of evaluation	3	3			6
[B] Lack and complexity of resources	2	8		1	11
[B] Lack of awareness or understanding	8	1			9
[B] Lack of supportive policy or legal frameworks	3	1	3	2	9
[B] Land ownership and availability	1	3			4
[B] Path dependency	2	2			4
[B] Public or stakeholder engagement	9	4	4	2	19
[B] Sectoral or administrative silos	1	1		1	3
[B] Bureaucracy		5			5
[B] Lack of expertise and knowledge	4	1		2	7
[B] Lack of will and commitment	3	2		3	8
Σ SUM	39	33	7	12	91

Code System	R	G	N	C	P	SUM
[B] Climate change and natural disasters		1				1
[B] Evidence on performance and co-benefits						0
[B] Insufficient or poor quality of evaluation	1					1
[B] Lack and complexity of resources	1		1		4	6
[B] Lack of awareness or understanding	1	3				4
[B] Lack of supportive policy or legal frameworks		1			1	2
[B] Land ownership and availability	8	2		1	1	12
[B] Path dependency	1		1			2
[B] Stakeholder engagement	3	10	9		1	23
[B] Sectoral or administrative silos			2			2
[B] Bureaucracy					1	1
[B] Lack of expertise and knowledge	2		1		1	4
[B] Lack of will and commitment	1		1			2
Σ SUM	18	17	15	1	9	60

Code System	R	G	N	C	SUM
[E] Disaster		1	2		3
[E] Flexibility and adaptiveness	2	3	1		6
[E] Funding and financial tools and support		1	1		2
[E] Expertise and knowledge		1		2	3
[E] Maintenance			2	2	4
[E] New initiatives	1	1			2
[E] Political will and long-term commitment	4	1			5
[E] Polycentric and cross-sectoral arrangements	1	4	1		6
[E] Public participation or interest	4	1	4		9
[E] Stakeholder engagement and equity	1	1	4	1	7
[E] Communication and raising awareness	2		6	2	10
[E] Supportive policies and legal frameworks	3	3	1	1	8
Σ SUM	18	17	22	8	65


Code System
R
G
N
C
P
SUM
[E] Disaster
1
[E] Flexibility and adaptiveness
2
1
1
1
5
[E] Funding and financial tools and support
1
4
5
[E] Expertise and knowledge
0
[E] Maintenance
0
[E] New initiatives
1
1
[E] Political will and long-term commitment
1
1
2
[E] Polycentric and cross-sectoral arrangements
1
2
4
2
9
[E] Public participation or interest
3
1
2
6
[E] Stakeholder engagement and equity
5
1
2
3
11
[E] Communication and raising awareness
2
13
2
17
[E] Supportive policies and legal frameworks
6
6
6
3
21
SUM
20
27
18
1
12
78

Resource system: UGS as the broader socio-ecological system

Governance system: institutions managing UGS

Users: interact with & benefit from UGS

Resource Unit: individual elements within UGS