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SPECIAL FEATURE: ORIGINAL ARTICLE

Operationalizing the Nature Futures Framework to catalyze the development of nature-future scenarios

The perspective of youth: envisioning transformative pathways and desirable futures for people and nature

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Abstract

This paper examines the pathways to desirable nature futures as envisioned by 22 young people from all United Nations regions and diverse cultural backgrounds who participated in the second edition of the IPBES Youth workshop (2022). The workshop employed the Three Horizons framework and the Nature Futures Framework (NFF) to describe the plurality of youth visions for desirable nature futures and transformative pathways to achieve these visions. Based on the outcomes of the workshop, we conducted a qualitative content analysis categorizing the ideas and quantitatively assessed commonalities and differences among workshop groups, which were based on the NFF perspectives (nature for nature, nature for society, nature as culture, and a group in between perspectives). There were important differences in the visions and pathways articulated by the groups, but also commonalities, such as the importance of governance, community-based approaches, and education for achieving desirable nature futures. We also discuss the importance of flexibility in the NFF to accommodate diverse perspectives and involvement of youth in shaping global sustainability agendas. While many ideas raised by young people during this workshop align with existing conservation narratives, the study reveals the need to foster new and innovative ideas to drive transformative change that is sensitive to diverse contexts, histories, and experiences.

Keywords Nature Futures Framework · Values · Biodiversity · Ecosystem Services · IPBES · Scenarios

Introduction

Human activities have led to significant changes in climate and declines in biodiversity and nature's contributions to people (IPBES 2019), with disproportionate effects being experienced by Indigenous Peoples and Local Communities. These changes are occurring in part due to the exclusion of various values of nature and worldviews from multiple stakeholders, including concepts, such as Mother Earth or kaitiakitanga (New Zealand Māori guardianship and resource management), in economic and political decision-making processes (Anderson et al. 2022). Rapid and long-term systemic changes are needed to address this social–ecological crisis. Various worldviews and knowledge must be taken into account, encompassing a wide range of cultural, geographic, and social groups, especially of Indigenous Peoples and Local Communities (IPBES 2019; Meadows 1999; Steffen et al. 2015). Due to the complexity of social–ecological systems, it is crucial to identify multiple pathways to reach these transformative changes (Meadows 1999; Ahlqvist and Rhisiart 2015). One of the tools to create desirable pathways for nature and people across different scales is the Nature Futures Framework (NFF), a flexible tool to support the development of scenarios and models of desirable futures for people, nature and Mother Earth, which was developed by the task force on scenarios and models of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) to address this gap and help inform

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ongoing IPBES assessments. The NFF defines three perspectives of nature that are interlinked and emphasize the different values associated with nature: "Nature For Nature" (emphasizing intrinsic values), "Nature For Society" (instrumental values), and "Nature As Culture" (relational values) (Pereira et al. 2020). The NFF has gained attention because it captures complex and diverse relations that humans hold toward nature whilst focusing on the need to envision and develop pathways toward more desirable futures for people and nature. Desirable nature futures can be envisioned through participatory exercises to promote inspiring narratives and collective actions among those involved in the process (Rana et al. 2020; Kuiper et al. 2022; Pereira et al. 2023).

However, there is currently a substantial gap in existing literature related to the plurality of desirable futures and how to reach them (Bennett et al. 2016). The NFF requires case study applications to investigate its applicability to identify visions of desirable nature futures and pathways for transformation toward them (Pereira et al. 2020). Recent applications of the NFF have focused on identifying visions of desirable futures (e.g., Mayer et al. 2023; Kuiper et al. 2022; Rana et al. 2020). More research is needed to investigate pathways of transformation toward those desirable futures. Participatory scenario development requires a sound representation of different stakeholder groups, specifically of marginalized groups.

The perspectives of young people are strongly underrepresented, both in the production of knowledge and in the decision-making processes toward global sustainability goals (Lim et al. 2017; Nilsson et al. 2021). Hence, this under-representation needs to be addressed (Turnhout et al. 2012; Díaz-Reviriego et al. 2019). Young people (35 years or below) form the largest demographic group (about half of the world population), differ in culture, socioeconomic status, life circumstances, etc. (Ritchie and Roser 2019; UNDP 2022). Young people are pivotal in shaping the future of environmental policy, advocacy, and innovation, as their perspectives and actions significantly influence societal attitudes and behaviors toward nature (Corner et al. 2015; Jones and Podpadec 2023). Considering ongoing crises, young people are also more fearful or uncertain about the future (Benoit et al. 2022; Léger-Goodes et al. 2022), and more likely to experience feelings of anxiety, grief, and powerlessness (Whitlock 2023). This indicates an urgent need for studies including young peoples' voices in scenario development, especially by including multiple regional perspectives to be globally relevant. In this paper, we aim to address this gap by using the NFF in a participatory workshop with youth representatives from across the globe and diverse cultural contexts. Our goal is to describe the plurality of visions for desirable nature futures of this group of young people and, importantly, to identify the transformative pathways needed to achieve these visions. We investigate if these visions and pathways differ among groups based on the NFF value perspectives and the key attributes of these pathways.

Methods

IPBES Youth Workshop

The study is based on an exercise conducted over three days at the IPBES Youth Workshop held in October 2022 (IPBES 2022), hosted by the International Academy of Nature Conservation of the Isle of Vilm (Germany). The workshop was designed and facilitated by IPBES experts and fellows, the latter being early-career professionals selected to join the IPBES Fellowship Programme, involved in the IPBES task force on scenarios and models. The workshop youth participants were not involved in its design and most of them were not familiar with the NFF prior. They included 22 early-career professionals, working on topics related to biodiversity, indigenous and local knowledge, and ecosystem services. Participants were first nominated by IPBES-related governmental and non-governmental organizations and then selected by the Technical Support Unit on Capacity Building of IPBES to represent multiple knowledge systems, gender balance, and geographical diversity in the workshop (Fig. 1). Despite this effort to represent youth diversity, most participants were between 25 and 29 years (64%) and held expertise in natural sciences and engineering (48%). Most participants worked in education or research, or for youth, environmental, or Indigenous non-governmental organizations (NGOs; 44% each). Participants were from Europe and Central Asia (36%), Asia and Pacific (27%), Americas (23%) and Africa (14%). There was limited representation of Indigenous Peoples (two persons). This work, therefore, does not claim to be a full representation of the diversity of young people; however, the voices of these young individuals offer insight into a segment of their early-career peers.

Nature Futures Framework (NFF)

At the beginning of the workshop, participants were introduced to the goal of the workshop, imagining visions and pathways in groups, as well as the NFF and its core concepts. They were asked to think of a positive experience related to nature and then to step into the space of the NFF triangle (which had been drawn on the floor) where they thought this relationship fit best (Fig. 2, Rana et al. 2020). While the NFF distinguishes three perspectives, the participants formed four groups based on how they identified with different values: "Nature For Nature" (NN), "Nature For Society" (NS), "Nature As Culture" (NC), and the intersection of NC and NS (NC–NS) (Figs. 1, 2).

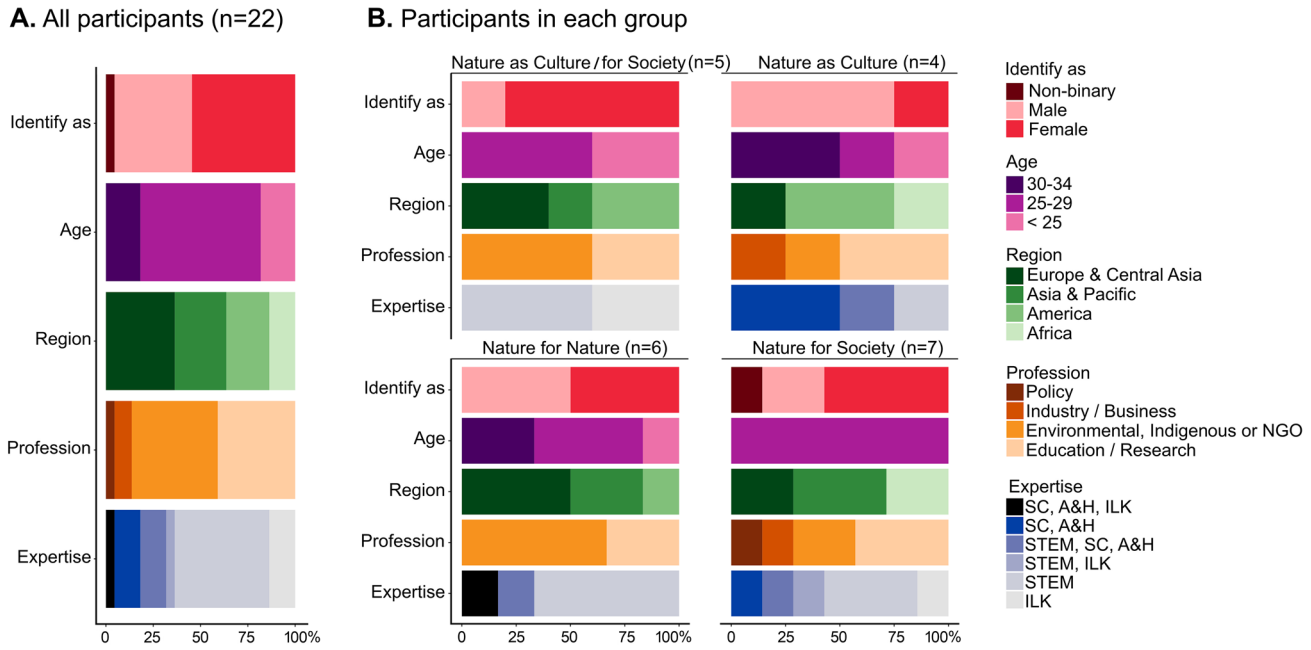

Fig. 1 Characterization of **A** all the participants, **B** participants in each group. *SC* social sciences, *A&H* arts and humanities, *ILK* indigenous and local knowledge, *STEM* natural sciences and engineering

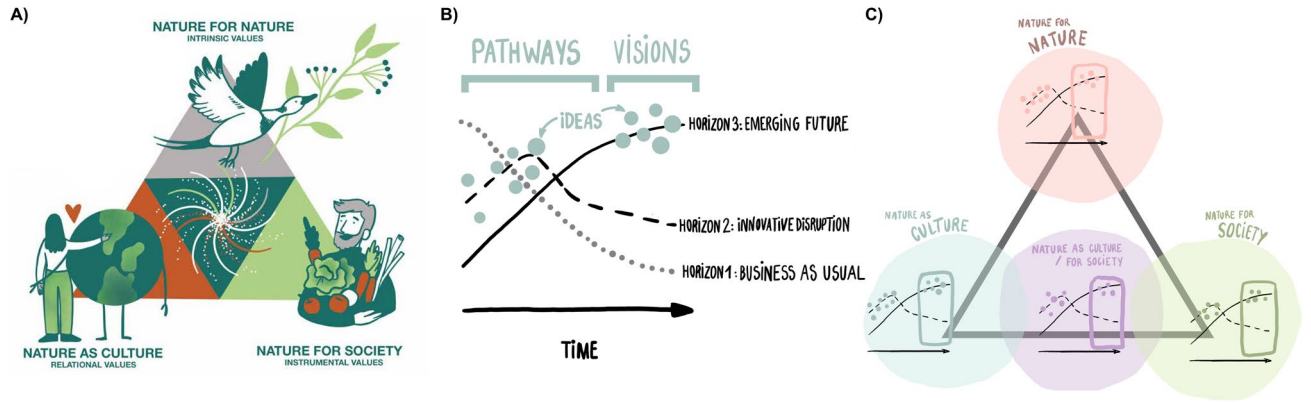

Fig. 2 **A** Nature Futures Framework triangle and the three value perspectives (Nature For Society, Nature As Culture, and Nature For Nature; drawings by Anke Dregnat and Manuel Recker). **B** Three Horizons approach used to develop ideas, pathways, and visions for each group. **C** Positions of the four groups, and their associated visions and pathways, relative to the NFF triangle

Group work to describe pathways to desirable nature futures

Each group then moved on to discussing their pathways and visions (see next paragraph for definition), facilitated by an IPBES fellow or expert (without any specific instruction regarding the geographical scale to which the pathway and vision should apply). Within each group, they discussed ideas that represented their visions of desirable futures and transformative pathways. These ideas included actions, tools, and descriptions of envisioned future states (see results and Table S1, for example, Fig. 2B). Participants developed these ideas using the Three Horizons framework, focusing on themes related to nature (Sharpe et al. 2016). Horizon 1 represents the current state of affairs, including existing systems, practices, and dominant trends. Horizon 2 represents emerging developments, innovations, and changes that have the potential to disrupt or transform the status quo. Horizon 3 represents longer term possibilities, including radical shifts, new paradigms, and transformative visions of the future (Fig. 2). Our analyses focused

on describing visions of the future (where Horizon 3 has fully emerged), and pathways of transformation (where Horizon 2 is dominant) leading to the vision.

To facilitate this exercise, groups were provided with narratives from Durán et al. (2023), each describing a possible way the future might unfold, based on value perspectives from the NFF. These narratives were not meant to be prescriptive but provided the groups with a starting point for creative thinking. Groups could rely on the narrative or select only relevant ideas. To help participants think through these ideas, a short visualization of future scenarios exercise was conducted.

The groups started by imagining visions of the future (where Horizon 3 is predominant, Fig. 2) using an adaptation of the Manoa Mash–up method (Pereira et al. 2018). The first step was for participants to think of 'seeds' of desirable futures that exist in the present. Seeds are initiatives (social, technological, economic, or social–ecological ways of thinking or doing) that exist, at least in prototype form, and that represent a diversity of worldviews, values, and regions, but are not yet dominant in the world (Bennett et al. 2016). Then these seeds were used to develop desirable future visions (top right-hand corner of the Three Horizons framework). The next portion of the exercise focused on defining possible pathways (where Horizon 2 is predominant), including declines in undesirable features of the current system that are fundamentally unsustainable, and the growth of seeds needed to achieve positive futures. A key mechanism to help everyone think through these complicated ideas included a short visualization exercise where the participants were asked to close their eyes and think what the worlds they were thinking of could look like, smell like, what everyone would be doing, what their day would look like. Finally, the groups developed and shared creative performances to present their visions and pathways with all attending the workshop; they were free to select the type and content of the performance. The workshop ended with a common reflection on the exercise and days spent together.

Overall, groups did their best in each task, but time limits may have affected the quality and depth of their discussions. Group dynamics and the discussion varied for each group (e.g., Pereira et al. 2020), depending on the participants' identities and breakout group facilitator. All the participants were devoted to the methodology of the workshop, and were not thinking about further steps such as analyzing the results or writing an article, as these possibilities were not yet on the agenda and hence did not influence participant behaviors).

For more explanation and illustrations on the workshop, see the workshop report and graphic recording novel (IPBES Youth Workshop 2022).

Data analysis

The visions and pathways resulting from the group exercise were analyzed using a mixed-methods approach. All ideas associated with the visions and pathways were summarized into discrete thematic categories (Table 1, see next section). We descriptively compared the results and statistically assessed the differences across groups. These analyses were conducted online after the workshop by the authors (representing a subgroup of the workshop participants and fellows, with participants from all groups).

Performances were qualitatively summarized and their most striking ideas were compared to the quantitative analyses described below for each group.

Coding of visions and pathways

In this study, we conducted comparisons across groups to identify differences and similarities. We used an abductive coding approach, which strikes a middle ground between inductive, exploratory research and deductive theory-driven coding (Coffey and Atkinson 1996; Thompson 2022). We adapted the categories developed by Kuiper et al. (2022; Table 1) to ensure consistency between NFF case studies, but also to accommodate youth-specific foci, by adding a category about "Science, knowledge and education". All ideas and their categorization are provided in Table S1.

The categorization was a multi-step process to maximize consistency in coding. First, the ideas were anonymized, meaning that the coders did not know which workshop group came up with the idea and the authors were designated to separate teams (A–C). Second, members of Team A (four authors) individually categorized ideas into theme-based categories and then decided as a team on the first version of the categorization. Third, Team B (five authors) commented and identified inconsistencies. Fourth, in a joint meeting, Teams A and B decided on a second version of the categorization. Fifth, Team C (three authors) checked for consistency. Adjustments were made in a meeting with representatives of Team A and Team B. Finally, all authors were invited to check the coding and a final version of the categorization was decided upon. For the most predominant categories (Governance, Social, and Resource extraction), we also coded separately whether the ideas were more related to society (e.g., "Free, Prior and Informed Consent", "bottom-up systems for decision-making process") or the environment (e.g., "ecosystem-based governance", "green taxes"; see Table S1). Each idea was classified in one category, though some could be sorted into more than one (e.g., "farmers not getting paid enough" could be categorized as

Table 1 Definitions of the categories used to code the pathways and visions ideas, adapted from Kuiper et al. (2022)

Category	Category title used in the text	Definition
Agriculture, production from land and sea, and resource extraction	Resource extraction	Encompasses ideas related to sustainable and innovative practices in agriculture, land- and sea-based resource production, and extraction. It includes concepts, such as agroforestry, alternative food sources, developing resilient crops, fisheries, food sovereignty, and minimizing pollution and resource extraction
Biodiversity and nature management	Biodiversity	Involves strategies for maintaining high biodiversity, ecological connectivity, and natural dynamics. Focused on the conservation, restoration, and sustainable management of biodiversity and ecosystems
Culture and heritage	Culture	This category emphasizes recognizing and preserving natural and cultural heritage within the landscape. It involves respecting, fostering a strong sense of place and recognizing the spiritual connection between society and nature
Economy, trade and transport	Economy	This category explores sustainable economic activities, trade practices, and transportation systems within the designated area. It includes concepts such as circular economy
Governance, policy, and regulation	Governance	Centered around sustainable development governance, policy-making, and regulatory frameworks. This involves inclusive and participatory decision-making processes, ecosystem-based governance, prioritization of environmental conservation in laws and policies, and international coordination for environmental and social initiatives
Livability, health, environment, and well-being	Livability	This category addresses the interconnectedness of human well-being, environmental health, and quality of life. It includes measures, such as pollution reduction, disaster preparedness and risk mitigation, sustainable land management, and the promotion of peace, quiet, and recreational opportunities in intact nature
Science, knowledge and education	Knowledge	Involves environmental education, intergenerational learning, indigenous knowledge, traditional knowledge, evidence-based assessments, and the integration of ecological education at all levels
Social structure, community participation, behaviour, norms, and awareness	Social	Focused on social dynamics, community engagement, and behavioural changes necessary for sustainability. It includes concepts, such as citizen participation, empathy, equity, and responsible consumption
Spatial planning, landscape, urban, and infrastructure design	Spatial planning	This topic relates to the sustainable planning, design, and administration of spatial and urban areas. It encompasses ideas, such as green infrastructure, small-scale communities, integrated model cities, and self-sufficient urban and rural regions
Technology and nature-based solutions	Technology	This category emphasizes the importance of technology and innovative solutions in tackling environmental and social issues. It covers a range of topics, such as nature-based solutions, sustainable building materials, diverse energy sources, digital connections, and the shift toward renewable energy sources

both Economy and Governance), the final decision on which category to apply was agreed upon by all authors involved in one of the three teams (at least one member representing each group).

Quantitative analyses

Based on the categories from the qualitative content analysis, we conducted descriptive analyses to identify differences and similarities between the four groups, based on the relative proportions of each category. Resemblances and differences in categories between groups were analysed using a contingency table (Table S2). Analyses were conducted using R (RStudio 2023.03.0 + 386), using the packages fmsb, ggplot2, tidyr, dplyr, and stats (R Core Team 2022; Wickham et al. 2024; 2023).

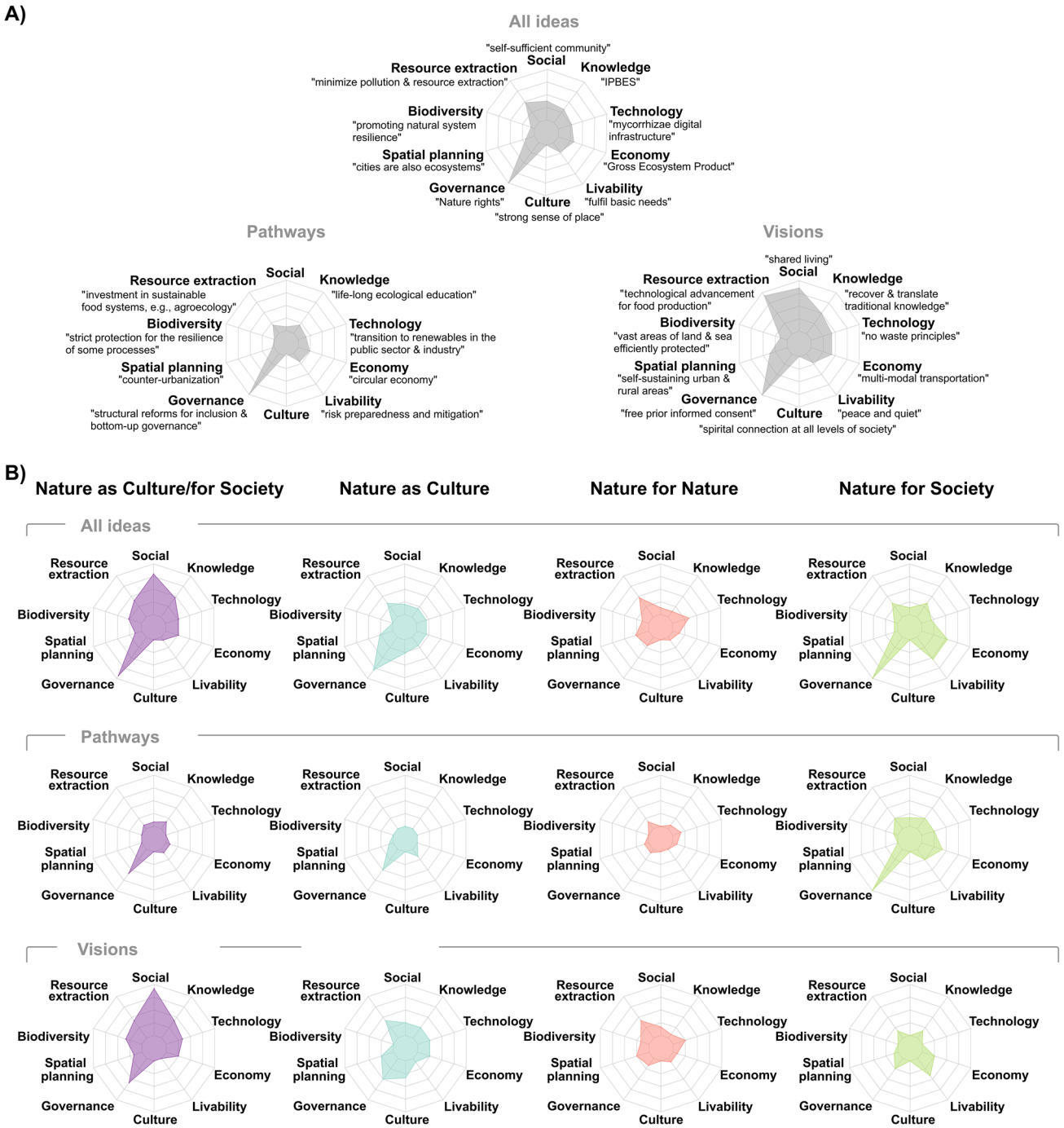

Fig. 3 **A** Distribution of the ideas in all groups (as illustrated by the lack of examples, some categories show a limited set of associated ideas, see all ideas in Table S1). **B** Distribution of the ideas per categories and groups considering all ideas combined, the ideas of transformation pathways, and the ideas for visions of the future

Results

The workshop exercise on youth perspectives of desirable nature futures generated 170 ideas across the four groups (Fig. 3). The most predominant category was *Governance* (25.9% of all ideas), followed by *Resource extraction* (13.5%), and *Social* (11.2%). The other categories represented 10% or less of all ideas. The ideas categorized as *Governance* and *Social* were more oriented toward society (63% and 58%, respectively) than toward the environment (37% and 42%). In the category *Resource extraction,* 52% of the ideas were oriented toward society and 48% toward the environment.

Out of the 170 ideas, 108 ideas were about visions and 62 ideas were about pathways. *Governance* (17%), *Resource extraction* (16%), and *Social* (15%) were the main categories of ideas in describing visions (see Fig. 3, for example). In these categories, food, environmental concern, the focus on locality (e.g., relying on local resources), and thinking in systems were particularly highlighted by young participants overall in their vision (Fig. S1). Ideas about pathways focused on *Governance* (41%, all other categories made up 11% or less of these ideas). Ideas describing pathways focused on environmental and transformative education, local actions (incentives, innovations, governance, fitting the local context), food, sustainability (in land management, materials).

Results per groups

Nature for nature

The group “Nature for Nature” (NN), representing intrinsic values of nature, named itself “Gaia" (personification of the Earth in Greek mythology). The group envisioned a future where biodiversity took center stage in human life. The narrative provided emphasized a strong separation between humans and nature. The group, however, made the separation much thinner (e.g., by not excluding human settings from “nature” as the narrative suggested). Biodiversity held diverse meanings for the group, ranging from a vital resource to a source of inspiration and creativity. As they wrote: “Biodiversity is around all of us and connects all of us. We need to protect it at all costs.” See SI B for a more detailed self-reflection by the group. The NN group performed a visit to a futuristic museum showcasing robots explaining how the world changed, comparing a darker and irrational past (today’s present) and a brighter present connected to nature (Fig. 4), illustrating that if there is a will, then there is a way. The museum showcased the restoration of habitats, a switch to a plant-based diet, mainstreaming green energy production, taxes imposed on polluters, and ecocide laws. These changes were thought to have led to a higher awareness and connection to nature and inclusive governance, ensuring the representation of Indigenous voices.

Participants in the NN group thought of 28 ideas overall, which were distributed across all categories, except for *Culture* (Fig. 3). This group highlighted eight ideas for pathways of transformation, from six categories, with most ideas related to *Resource extraction* (e.g., “regenerative food systems”) and *Technology* (e.g., “bioreactor”, 22% each of the pathway ideas), but no pathway ideas related to *Social*, *Livability*, *Culture* and *Biodiversity*. The group NN noted 20 ideas describing their vision of the future, falling into nine categories, mostly related to *Resource extraction* (24%, e.g., “technological advancement for food production”), *Technology* (14%), and *Spatial planning* (14%), without any ideas associated with *Culture*.

Nature as culture

The group “Nature as Culture” (NC), representing relational values of nature, named themselves "Girassol", which means sunflower in Portuguese. The group envisioned a sustainable future in which nature and society are interconnected and evolve together. They emphasized a vision involving a stronger connection between people and nature, with a shift toward building cities that prioritize biodiversity and sustainability. Effective communication was a key element in the envisioned pathway to achieve societal changes (see SI B for a more detailed self-reflection by the groups). Hence, this team presented their vision and the pathways by performing a futuristic TV news show, delivering "news" from the upcoming decades, showcasing how real problems (e.g., a pandemic, enormous cities) were successfully addressed in the near future (pathways) and far future (vision) (Fig. 4; SI B). For instance, the TV show highlighted the importance of an institute of integrated knowledge for their pathway (“IPBES” was explicitly highlighted in the vision, Table S1). Pathways also included the educational system being transferred from a “teacher-centric” education to “nature-centric” education. As they reflected: “The future we envision has three major pillars: governance, education and technology. Ecosystem-based forms of governance will emerge, representing a major shift in the way human societies and the natural world relate, without the dominance of a nation state. We believe that a key factor to achieve changes in society is communication.” (SI B).

NC participants described 40 ideas overall across all categories (Fig. 3). Nine of them were ideas related to pathways of transformation, related to three categories, namely, *Governance* (60% of ideas related to pathways; e.g., “targeted subsidies for local production”,

Fig. 4 Illustration of the performances that showcased envisioned futures and pathways by each group. The Ujamaa (Nature for Society) group showcased a podcast called "conservation conversation". The Girassol group (Nature as Culture) presented the tv show "Girassol news". The Gaia group (Nature as Nature) presented a guided tour in an interactive museum. Finally, the Excentreprocity group (at the intersection of Nature for Society and as Culture) organized a citizen assembly with a voting process. Drawings by Anke Dregnat and Manuel Recker

"co-managed protected areas"), *Spatial planning*, and *Livability*. The group showed 31 ideas to describe their visions of the future, which included nine categories, with a focus on *Governance* (19%; e.g., "ecosystem-based governance", "open frontiers"), *Resource extraction* (16%) and *Culture* (13%). No ideas for their vision of the future were coded as *Biodiversity*.

Nature for society

The group "Nature for Society" (NS), representing instrumental values of nature, named themselves "Ujamaa" (fraternity in Swahili), presenting a conservation philosophy of unity that underscores the practical benefits of nature and ecosystem services for society. In the group's vision,

biodiversity thrives within undisturbed ecosystems, where humans coexist harmoniously with nature: “In Ujamaa, biodiversity and nature meant an undisturbed ecosystem where people coexist peacefully with nature. Where there are no boundaries to separate humans from nature and vice versa. In Ujamaa everyone takes care of biodiversity/nature and lives with it.” (SI B). The NS group performed a morning TV show "Biodiversity Conversation” with experts seriously and happily discussing the solutions to the problems of today (Fig. 4). The pathways that were identified to move toward this future were presented in the show as a roadmap toward Ujamaa. The pathways presented relied on technological advancements across various aspects of human life, from agriculture (e.g., smart agriculture) to risk preparedness with technologies to foresee and model the future, and ultimately achieve sustainable development. The group also emphasized an improved community participation and involvement, particularly in decision-making.

Participants from the “Nature for Society” group reported 48 ideas overall, from all categories but *Culture* (Fig. 3). This group had 32 ideas related to pathways, related to eight categories, predominantly *Governance* (36%; e.g., “Increase allocation to environment & ecosystem/biodiversity initiatives”, “Involving local administration in strict enforcement of laws and policies”) and *Economy* (15%), while none were associated with *Culture* or with *Spatial planning*. The group reported 16 ideas relating to their vision of the future, from six categories, mostly from *Livability* (29%; “Low nature risks and disasters”, “Enhanced planetary health”), *Economy* (18%) and *Governance* (18%), and none relating to *Social*, *Technology*, or *Biodiversity* categories.

NC–NS

The participants of the Nature-Culture/Nature-Society (NC–NS) named themselves "Excentreprocity" (“excentric” and “reciprocity”). The group created a vision of organized living in human-ecological communities, with governance at the ecosystem level and citizen participation through regular assemblies, with the value of “reciprocity” at the core of the society. Their inspiration revolved around governance rather than technological advancements (see SI B for a more detailed self-reflection by the group). The group performed an example of a joyful citizen assembly for human-ecological communities of the Baltic Sea to decide over the future of sand extraction, including a strong cultural bonding, with a presentation of traditional knowledge and a dance (Fig. 4). As they recall, “We wanted to highlight the main revolution of our world: the democratic decision-making is run by citizens, representing their community’s interest (instead of countries/political parties) and based on shared and co-created knowledge (not only “science”) background.” (SI B). Citizens were invited to vote on a potential pathway for sand extraction in the region, first identifying relevant stakeholders, finding alternatives to sand and halving the demand, before it would eventually be fully banned. This group highlighted the importance to design pathways based on decision-making for long-term goals, that can notably rely on technology, with a strong emphasis on intergenerational collaboration and education to various types of knowledge.

The NC–NS participants reported 54 ideas overall, from all categories, except for *Culture* (Fig. 3). Thirteen ideas were about pathways of transformation, with 50% related to *Governance* (e.g., “redistribution of funds through taxing”, “Indigenous fellows in UN headquarters or negotiations”), 15% about *Knowledge*, and none associated with *Biodiversity*, *Spatial planning* or *Technology*. The group highlighted 41 ideas related to their vision of the future, from eight categories, focusing on *Social* (26%; e.g., “self-sufficient community”, “empathy”, “reciprocity”) and *Governance* (17%), but there were no ideas on *Livability*.

Overlaps and differences in categories among groups

We first found that the groups NC–NS, NN, and NC displayed a greater emphasis on ideas focused on visions, whereas the NS had a higher concentration of ideas centered around transformation pathways (Fig. 3). Some major differences emerged when comparing the ideas highlighted by each group (see the distribution of ideas across categories for each group in Table S2). NS had significantly more ideas related to livability than the other groups, NC had more ideas related to culture, while the NC–NS showed more ideas related to social norms but no ideas related to livability. These three groups had mostly ideas related to *Governance*. NN emphasized less *Governance* ideas but highlighted more ideas than any of the other groups related to *Resource extraction*, *Spatial planning* and *Technology*.

Discussion

The goal of this study was to explore young peoples’ visions and pathways of transformations of desirable nature futures using the NFF. Here, we discuss the findings related to the relevance of different value perspectives, innovative ideas for transformation (in describing visions and pathways), and the centrality of governance and education in achieving desirable futures, and then reflect on the performances and workshop as a whole.

Before discussing results in detail, it is important to note that our group can only represent a snippet of youth perspectives, by design. The young participants were selected for their interest in and experience with conservation or sustainability topics. The group, therefore, showed overall

positive environmental attitudes and was already aware of many seeds highlighted in this exercise. Organizing small groups based on NFF perspectives allowed participants to discuss a wide range of perspectives and topics. Though, this has led the resulting visions and pathways to focus on global targets (e.g., food production) with less focus on local circumstances or youth priorities (e.g., career, adulthood transition; see in contrast the more specific Futures Literacy Laboratories held all over the world, Miller 2018).

Interconnected ideas from multiple value perspectives

The commonalities and differences among groups highlight concrete ideas for visions and pathways associated with the different value perspectives found in the NFF. First, based on literature (e.g., Chan et al. 2016; Himes and Muraca 2018; Arias-Arévalo et al. 2018) and the narratives that the groups received for inspiration (see Durán et al. 2023), we would expect major differences between NN and NS, because of the dichotomy between instrumental and intrinsic values. Indeed, the NN group initially aspired to the idea of creating separate spaces for nature that are not touched by people, because of nature's intrinsic value (as expected from NN value perspective). This is in contrast to NS that focused on using nature to enhance multiple ecosystem services. Although the groups diverged from the extreme narratives when imagining visions and pathways, the dichotomy between the value perspectives was still present. We found that the most predominant category of all ideas developed by NS were related to *Livability*, while NN had more ideas related to *Resource extraction* than any other group. Pathways that were developed by NS relating to *Livability* are strongly based on contributions of nature to people (e.g., erosion reduction or risk mitigation), while pathways related to resource extraction by NN are directly related to impacts on biodiversity itself (e.g., minimizing resource extraction or regenerative food systems).

Differences among groups can be partly explained by the participants' personal experiences and motivations. For example, the NN group came from a predominantly STEM background and most participants were from the Global North, while the participants from the NS and the NS–NC groups had representation from all UN regions and their backgrounds included indigenous knowledge, natural and social sciences.

Even if based on the different values of the NFF, groups showed a lot in common too. For example, although focusing on biodiversity in its ideas related to *Resource extraction*, the NN group highlighted ideas related to the transition of the food system. This emphasis on the food system shows that young people also considered nature to provide services to people, predominant in NS. NS mentioned additional ideas fitting in the notion of ecosystem services (instrumental values of nature), while including aspects going beyond instrumentalization of nature, such as the principle of one health, happiness and nature as a space for recreation. These concepts also strongly overlap with relational values linking nature and culture, highlighting the unsubstitutable relationships that connect people with nature. Relational values are the basis of the NC value perspective and have been previously found to be able to build a link between intrinsic and instrumental values (e.g., Schmitt et al. 2022); unsurprisingly, NC proposed more ideas related to *Culture* than any other group. In addition, for this group, ideas from other categories (e.g., *Resource extraction*, *Social structure, Knowledge*) were also related to cultural aspects. These ideas include a strong sense of place, spiritual connection at all levels of society, and traditional knowledge and practices (Kim et al. 2023). The NC–NS group highlighted ideas that envisioned a society based on communities (falling in the categories *Governance* and *Social structures*), merging intrinsic (nature legal personhood), relational (reciprocity and empathy) and instrumental (seasonal food) values.

These results emphasize that the three value perspectives on nature are not mutually exclusive, as all groups came up with ideas that spanned multiple value perspectives. This supports the idea that these value perspectives are intricately connected and can reinforce each other (Martín-López 2021). Our results showed how the NFF can be used as a starting point to highlight different perspectives and to identify visions and pathways for transformation. As a flexible tool to create scenarios of a desirable future, it is beneficial for applications of the NFF to allow flexibility for participants to express and adapt their position on the triangle, recognizing the nuances in how people see and experience the world. Additionally, we would like to highlight that this analysis focused on the intrinsic, instrumental, and relational values related to nature, as framed by the NFF. However, the participants also expressed deep concerns not directly influenced by nature, such as inequality, stress and anxiety, or racism, all relating to a broader set of values. Such concerns are typical for youth (Barraclough et al. 2021) and existed across all four groups.

Youth ideas for the future: implementing the old and creating the new

Despite groups starting at different corners of the NFF triangle, all groups converged to develop similar pathways to transformation, based on long-term visions. Most pathways were based on changing aspects related to "*Governance, policy, and regulation*", by implementing citizen and inclusive participation in bottom-up decision-making (in governments, UN negotiations spaces, protected areas) and changes in policies and their implementation (compensation,

incentives, taxes, effective controls). This resonates with previous research highlighting the need for inclusive governance as a major youth concern for sustainable futures (Barraclough et al. 2021; Knappe and Renn 2022). Previous research has also highlighted inclusive governance and bottom-up decision-making as critical aspects of pathways toward sustainable futures (e.g., Chan et al. 2020), together with cultural or technological changes (Scoones et al. 2020; Pereira et al. 2020). Pathways including technological changes did not play a major role in this group of young people (despite being highlighted in the narratives of Durán et al. (2023) shared with participants prior to the discussion). Some examples of pathways including technological advances included transitioning to renewables, nature-based solutions, and using sustainable, carbon–neutral building materials, which are more realistic pathways than the ideas described in the narratives. In their pathways, young participants in all groups also highlighted the significance of education and recognition of diverse knowledges for achieving desirable futures, especially in the performances. We even introduced a unique category, "*Sciences, knowledge, and education"*, that had not been previously used in the categorization developed by Kuiper et al. (2022). This focus on knowledges and education could be linked to the sample of participants, relatively young and largely coming from a STEM background compared to the sample of other studies that have employed the NFF. Environmental education and awareness, implemented at large scales, to encourage pro-environmental behavior are essential for moving toward a sustainable future (Grilli and Curtis 2021), as is the inclusion of traditional and local knowledge (e.g., traditional uses of plants in medicine, or agricultural practices Cussy-Poma et al. 2017), as highlighted by the groups NC and NC–NS.

Many ideas describing visions and pathways were based on existing but not wide-spread or well-known initiatives that can be important to build a more positive future, frequently referred to as "Seeds of a good Anthropocene" (Bennett et al. 2016). These seeds included ideas such as recognizing ecocide, urban food production, existing integrated (indigenous) education systems, and participatory approaches in decision making by recognizing and including Indigenous Peoples and Local Communities. In their visions and pathways, the groups imagined these seeds had fully operationalized and deployed at large scale, such as a strong integration of indigenous fellows in UN headquarters and negotiations or investments in sustainable food systems. These ideas are indeed already advocated by multiple political institutions, such as the United Nations in climate negotiations, European Union policies, advocacy groups such as the Global Youth Biodiversity Network (related to the CBD), or knowledge production bodies, such as IUCN, IPCC, and IPBES (e.g., Cariño and Ferrari 2021; Sachs et al. 2019). Some workshop participants have experienced the potential of these ideas, as they have been involved in policy and decision-making processes that integrate multiple knowledge, for example, by participating in the creation of a protected area or international policy negotiations. Among all the categories, all groups highly emphasized ideas related to "*Governance, policy, and regulation*" (as discussed for pathways above), including local and community-based governance structures. Ideas such as "bottom-up systems for decision-making" (NS), and "co-managed protected areas", "ecosystem-based governance" (NC, NC–NS) reflect this theme. This need for a transformation of governance systems is also highlighted in a large body of literature, arguing for local communities to manage their resources based on co-produced knowledge and context-specific solutions (Evans et al. 2023; Lombard et al. 2023). This approach recognizes the local contexts (institutional arrangements, values, knowledge) and the capacity and legitimacy of local communities to contribute to sustainable resource management (Armitage 2005; Berkes 2007).

Besides ideas related to existing seeds, few more radical and rarely explored ideas emerged in pathways and visions. These ideas were most predominantly based on novel governance structures (even for NN that had few ideas about governance in the quantitative analysis). NC envisioned replacing all nation states with purely ecosystem-based governance approaches, while NS developed governance systems based on communities of people connected with nature. NC–NS imagined community-living based on cultural and ecological features, with frequent gatherings to make decisions at the scale of each ecological feature. Groups also highlighted how legal tools can also be used; NS, for example, proposed to "mainstream legal personhood of ecological entities", which involves granting legal rights to non-human entities, such as rivers and forests. It represents a radical shift in legal and governance frameworks and has only been implemented in a few places around the world, such as New Zealand, India, Colombia and Ecuador (Kauffman and Martin 2017). These laws not only contribute to protecting natural ecosystems but can also protect the cultural practices of local communities and solve disputes between governments and Indigenous Peoples and Local Communities (O'Donnell and Talbot-Jones 2018). These ideas for new governance and legal systems could be further considered and explored to assess their potential connections to existing initiatives supporting similar radical transformations of legal and governance systems, most often imagined or supported by civil society and academia. Interestingly, the marine realm has seen such embryos of governance units based on ecological units or features that could be experimented in other ecosystems (i.e., embryos as they are limited in scale or in power they hold), such as the species-focused or regional scale governing bodies for fisheries, Antarctica, or seas beyond national jurisdictions.

The integration of young people's ideas into sustainability agendas is crucial as they can bring fresh perspectives and innovative solutions to the table. Young people have demonstrated their significant impact on global sustainability efforts, for example, through youth-led movements such as school strikes for the climate (e.g., Friday For Future), the mobilization of YOUNGO in UN Climate negotiations, the Global Youth Biodiversity Network for the Global Biodiversity Framework and the EU restoration law, and key young activists for the US Green New Deal (the Sunrise movement) or against deep sea mining (from Look Down and Sustainable Ocean Alliance in particular) (Bustos et al. 2020; Rapporteur of the European Union Nature Restoration Law 2023; Rodela and Stuber 2023; Thew 2018). These movements and actions show that many young people are agents of change participating in driving radical transformations in society. Youth representation in sustainability agendas is increasingly recognized as essential. For example, the United Nations' International Youth Day highlights the contributions of young changemakers and aims at addressing the structural obstacles they face (UN 2019). Barraclough et al. (2021) for instance emphasize the importance of improving the consideration of young people as distinct actors in sustainability research. However, programmes that foster young peoples' engagement in policy are still very limited and still struggle with intersectional boundaries (Barraclough et al. 2021; Gustafsson et al. 2019).

Performances and reflections

The workshop underscored the importance of creative freedom in envisioning future scenarios by creating opportunities to collectively imagine desirable futures, while being together to laugh about it, helping participants shift to a more positive attitude about the future. Through active performances, young participants visualized and engaged with the futures they developed. Establishing an environment for artistic performances that differs from everyday environments has helped workshop participants in previous studies to explore ideas and to challenge norms (Williams et al. 2022; Griniuk 2021). This is sensible as spaces for artistic performances can provide psychological safety, which is crucial for fostering creativity, self-exploration, and expression, ultimately providing valuable additional insights to traditional qualitative methods (Grandi 2021; Lobman 2017). Our workshop provided a dedicated, encouraging, and friendly space to set the scene for participants to feel secure in engaging with artistic performances. Each group performed in four very different ways: a TV show presenting news with interviews from all over the world across different centuries, a morning show with experts discussing conservation by highlighting ideas to change the world, a guided tour in an interactive museum comparing life in 2072 to 2022, and a citizen assembly gathering stakeholders of ecological units to make an important vote. Participants played roles to showcase their vision and pathways, presenting creative, interactive, joyful performances, while demonstrating a great deal of thoughtfulness and seriousness. Participants also felt that this exercise helped them connect on a personal level, as they could more deeply understand and sympathize with other groups' ideas. In their performances, all groups highlighted the past (which was the 2022 present) in a negative manner, as a time of irrational living and problems. One group focused on current issues that were still in the process of being addressed. The way the performances depicted the 2022 present, illustrated the anxiety that participants felt about the future when they first joined the workshop. In contrast, the visions of the future depicted in the performances were desirable and hopeful.

Participants were asked "What do you think about the future?" (using a Mentimeter), at the beginning and end of the workshop. If participants described the future using positive words ("biodiverse", "opportunities"), they first described it as "scary", "doomed", or with the word "technology". At the end of the workshop, the future was associated with "hope", "ujamaa" (fraternity' in Swahili), "green", "bright" or "justice" (Fig. S1). This workshop was also an opportunity to interact, share experiences, learn from each other and build friendly and professional relationships. This kind of week-long event forms a safe place for young people to imagine the world they would like to see.

To understand the effects of future NFF and similar envisioning exercises, monitoring the effects of this kind of workshop on the participants' life or careers (values, environmental behaviours) could be helpful. Moreover, these exercises could have a much stronger impact if linked to real-world attempts aiming for change, rather than an isolated event. In the case of this workshop, the results could feed the technical scenario work of IPBES and of the NFF community of practitioners and researchers, and might, together with the increasing body of literature on this topic, feed into future policies influenced by IPBES assessments. The global setting of this workshop was unique and provided valuable insights into desirable futures as envisioned by young people. This workshop can also serve as a basis for similar local and regional youth workshops. In a recent workshop on developing visions for Europe and Central Asia using the NFF, youth participants managed to describe even more concrete visions of desirable futures for the region, e.g., through an imaginary guided tour through a future version of the city of Berlin in Germany (Kim et al. 2025). In addition to workshops covering a large spatial scale, developing pathways and visions in local and place-based cases, in which young people are deeply rooted, could empower youth to play a major role in shaping pathways toward desirable futures.

Conclusion

This study, based on a workshop with young participants from all over the world, explored the visions and transformative pathways toward desirable nature futures using the NFF. The findings illustrate the rich diversity of perspectives among youth, reflecting intrinsic, instrumental, and relational values of nature. Central to these visions was the recognition of the urgent need for systemic change to address the socio-ecological crisis. The transformative pathways that the participants developed were strongly based on existing seeds that youth perceived to be important to be implemented on larger scales, but also on radical and rarely explored ideas. Governance emerged as a critical lever for driving sustainable transformation, with youth arguing for more bottom-up decision-making, community involvement, and legal recognition of ecological entities. Participants also recognized the role that education and traditional knowledge plays in shaping attitudes and behaviors toward sustainability. This study underscores the value of frameworks like the NFF that foster innovation and flexibility to accommodate diverse perspectives, and regional contexts in creating visions and pathways for the future. The voices gathered during visioning exercises using the NFF can be presented in large science–policy interfaces, such as IPBES plenaries and assessments, and feed the next mainstream narratives that can drive international actions for human communities and nature. It is therefore important to continue the efforts initiated by IPBES and make sure young people can participate in shaping this common future. In continuing these efforts, enhancing the representativity of young people (e.g., age, region, experience, social groups) is imperative. Overall, our study shows that young people, coming from all over the world and from various backgrounds, can contribute to building a sustainable future.

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Data availability All data used for the quantitative analysis are provided in Table S1. The qualitative data, including video recordings, are not publicly available due to privacy concerns.

Declarations

Conflict of 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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