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"Narrative images" as a learning approach: (transformative) adaptation scenarios for dealing with urban water risks in Hamburg, Germany

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In recent years, weather-related extreme events have shown the limits of technical approaches to urban water challenges and highlighted the urgent need to rethink the relationship between cities and water and to see water as a partner in shaping transformative, climate-safe and just urban futures. However, existing scientific studies depicting future trajectories of urban water management have struggled to make the intertwined social and ecological dynamics of (transformative) urban adaptation tangible and accessible. This study focuses on the potential of visual communication of scenarios to stimulate both learning among scientists (during the process of creating the scenarios) and social learning (as a next step using the developed "narrative images") to motivate diverse societal actors to engage with the complexity of sustainable urban water management. Art can overcome barriers of scientific and technical concepts and touch peoples' inner motivation for preserving and sustainably transforming our cities in a way that written texts cannot. As sustainability challenges transcend disciplines, this study draws methodically on an interdisciplinary scenario approach. Three adaptation scenarios were developed in a participatory process and professionally visualized as "narrative images" using the city of Hamburg as a case study. The scenarios take place in 2050 depicting a gradient ranging from coping to incremental adaptation to transformative adaptation for managing the water-adaptation nexus: "Water defensive city," "Water resilient city," and "Water aware city." The scenario study shows innovatively how to bring the humanities, natural and engineering sciences into a deliberative dialog, while at the same time promoting collective learning. It can serve as a model for successful future interdisciplinary research and scenario developing exercises.

KEYWORDS

scenarios, transformative adaptation, interdisciplinary research, art-based research, visual communication, collective and social learning, sustainability, urban water management

1 Introduction

Water and society are intrinsically linked. In urban areas, this is reflected in the values and often implicit agreements between communities, governments and businesses on how to manage water. However, this "hydro-social contract" (Brown et al., 2009, p. 848) is increasingly reaching its limits when it comes to tackling future water

challenges (Wong and Brown, 2014). In today's civilization, there is "an obsession with concrete" (Kravčík et al., 2021, p. 4924). While urban water infrastructures have led to improvements in urban living standard through effective provision of water supply, sanitation and urban drainage (Franco-Torres et al., 2021), water is "disciplined, hidden" (Bell, 2015, p. 1) to serve the needs and desires of modern citizen-consumers (Schramm, 2006; Gandy, 2014). In addition, watercourses are regulated into channels, dikes and levees have been built to protect urban settlements from floods, and artificial storage and reservoirs are used to cope with the natural variability of the water resources. However, in recent years, weather-related extreme events have shown the limits of this "prediction-and-control approach" (Pahl-Wostl, 2007, p. 51) and water-related challenges have been increasing (Rosely and Voulvoulis, 2023). This is rooted in the beliefs that sectoral understanding can reliably predict urban water problems and technocrats can control environmental variation (Pahl-Wostl et al., 2011; Wong and Brown, 2014).

In response to the complex and multi-faceted challenges related to climate change, increasing societal complexity and degrading quality of life in cities, a new urban water paradigm has emerged over the past two decades (Franco-Torres et al., 2021; Kravčík et al., 2021). This paradigm shift calls for a more organic worldview compared to the old mechanistic and technocratic understanding of living with water and requires above all institutional and socio-political adaptations (Bichai and Cabrera Flamini, 2018). The idea is to rethink the relationship between cities and water and to understand "water as a partner in shaping patterns of settlement and culture" (Bell, 2015, p. 4). This also means that the solutions to address the urban water challenges must go beyond the water sector and focus on interventions to improve the entire urban system (Rosely and Voulvoulis, 2023). Although this is putting pressure on many cities globally to fundamentally change their approaches to water management, such a transition to more sustainable urban water management (SUWM) or to Water Sensitive Cities (Wong and Brown, 2009) is still far from being accepted and accomplished in cities worldwide (Meier et al., in preparation)[1]. Many of the pressing problems related to water quality and quantity were seen as technical problems to which we have to adapt (Pahl-Wostl et al., 2011). In contrast, a "sustainable approach to urban nature" (Bell, 2015, p. 1) goes beyond predicting possible climate (change) impacts and implementing (technical) measures to mitigate them. Rather it is also about social learning and awareness raising in multi-actor settings (Pahl-Wostl et al., 2007) to develop deeper insights into the complex socio-ecological (Rosely and Voulvoulis, 2023; Hanf et al., under review[2]) and socio-technical interdependencies that underpin urban water systems. Such "learning environments" have been identified as crucial for transformation processes and adaptive governance of socio-ecological systems toward sustainability (Folke et al., 2005; Pahl-Wostl et al., 2007, 2010; Barth and Michelsen, 2013; Freeth and Caniglia, 2020; Singer-Brodowski, 2023). Conventional disciplinary approaches can no longer be the focus to achieve transformative change needed to realize sustainability (Neuhoff et al., 2023). Integrated and creative methods are required to reflect on existing practices while stimulating a fundamentally new social relationship with water in urban areas.

Nowhere else is integrated research described as being as crucial as in sustainability science (Stock and Burton, 2011). Sustainability challenges, such as sustainable climate change adaptation, transcend disciplines and, therefore, require effective interdisciplinary work (Horn et al., 2022). However, most interdisciplinary approaches do not adequately bring together the diversity of different disciplines. Effective interdisciplinary work requires first and foremost a change in the research objective "from a quest for unitary vision [...] toward plural and co-existing perspectives" (Schipper et al., 2021, p. 6). A "rethinking of interdisciplinarity" is needed (Schipper et al., 2021) that requires conversation across disciplines and greater engagement with the inherent tensions that can range from finding conceptual common ground and a shared language to difficulties involving different beliefs, worldviews, normative and power dimensions (Freeth and Caniglia, 2020). These multi-dimensional differences, if appropriate addressed, can be a source of creativity and deep learning. Here, we attempt to respond to this call from Schipper et al. (2021) for "rethinking interdisciplinarity." We present and apply a framework for interdisciplinary scenario development to explore "diverse pluralistic futures" for the purpose of stimulating the realization of transformative, climate-safe and just futures (Muiderman et al., 2020). By actively involving scientists from various natural, engineering and social science disciplines, we combine a broad range of relevant and actionable knowledge with different values, beliefs and worldviews in order to enhance the ability to collaboratively explore possible, alternative futures. With this in mind, we aim to opening up the process of envisioning the future and explicitly not "reducing the future to climate" (Hulme, 2011).

Using scenarios as mental models to focus on a shared goal and methodology can improve communication between researchers and their audience. Qualitative scenarios are particularly useful in supporting decision-makers to disentangle uncertainties about the future and in providing the wider public an insight into scientific work (Jack et al., 2020; Spijkers et al., 2021). Qualitative exploratory scenario approaches have proven to be well suited to deal with the inherent uncertainty and complexity associated with human-climate linkages of socio-ecological systems (Spijkers et al., 2021). Furthermore, qualitative scenarios can be used to explore the unforeseeable from the present and thereby also impacting upon the here and now (Vervoort and Gupta, 2018). "Images of the future" may widen the perspective of various actors (e.g. citizens, private companies, public authorities, municipalities) by opening up future options for society and helping them to visualize the concept of sustainability (Dreborg, 1996). In particular, the potential of visual communication to accelerate social learning and motivate sustainable behavioral change and policy responses is widely discussed in the literature (e.g. Sheppard, 2005, 2021;

1 Meier, L., Ahovi, P., Oßenbrügge, J., and Petzold, J. (in preparation). Urban water infrastructures: a global review on water perception, water risks and transformative frameworks.

2 Hanf, F. S., Ament, F., Boettcher, M., Burgemeister, F., Gaslikova, L., Hoffmann, H., et al. (under review). Towards a socio-ecological system understanding of urban flood risk and barriers to climate change adaptation using causal loop diagrams. *Int. J. Urban Sustain. Dev.*

Scurati et al., 2021). Galafassi (2018) introduced the notion of "transformative imagination" that expands and widens the range of possibilities by supporting fundamentally new ways of seeing, feeling, encountering and envisioning the world toward sustainability through art-based research approaches (Galafassi et al., 2018b). Apart from the importance of visualizing the scenario storylines, art plays a pivotal role in the process of creating the scenarios, as it is an effective way to connect the participants with their creative side and thus plays an important role in facilitating a "transformative space" (Pereira et al., 2018). Overall, creative art practices have a unique potential to engage with deep leverage points (i.e. values, goals and world views of actors; see Abson et al., 2017) for sustainability transformations (Vervoort et al., 2024). While there is an increasing engagement of the arts in climate change transformations, the role of the arts in addressing climate change solutions has so far been underestimated in the IPCC reports (Galafassi et al., 2018a).

Research can play an important role in stimulating imagination and enabling society to explore what is possible, plausible and desirable (Wyborn et al., 2020). Visioning is considered a key method in sustainability research and transformational sustainability science with the purpose of stimulating change by creating positive visions for the future of our society (i.e. desirable futures; Constanza, 2000; Wiek and Iwaniec, 2014). Scenario development has a long tradition in urban planning, but usually with the objective of developing a single preferred scenario or vision (i.e. normative scenario planning; Avin and Goodspeed, 2020; Avin et al., 2022). In contrast, quantitative scenario approaches for exploring urban futures focus primarily on technological feasibility and solutions, and economic impacts, while ignoring socially sustainable content (Neuhoff et al., 2023). Although the analysis of such probable futures is appropriate in certain cases, such as climate modeling, it represents a "restriction of the imagination" (Terry et al., 2024). There is a need to accept the fundamental plurality of both the present and the future world, otherwise we run the risk of path dependency and boxed-in thinking, which hardly allows to envision the necessary transformative changes (Terry et al., 2024) and rather reproduces unsustainability (Stirling et al., 2023). Moving away from coherent narratives to more pluralistic scenarios suggests an alternative way of developing future visions for cities (e.g. Pollastri et al., 2017).

In this study, we seek to explore the tension between possible and desirable futures using a qualitative scenario-building approach. By contrasting three different possible climate change adaptation scenarios that represent a gradient of increasing depth of transformative adaptation, we explore the possible range of urban adaptation futures while attempting at the same time to develop tangible images that can be potentially mobilizing (which is an important function of desirable futures). Our aim is to create pluralistic urban futures by explicitly integrating different academic perspectives. Inspired by McAuliffe and Rogers (2020), we draw our pluralism from an interdisciplinary engagement with the social, economic, political and environmental dimensions of cities, aimed at presenting a value pluralism that privileges the individual disciplines over the technical discourse on urban water infrastructures. In order to be "opening up" rather than closing down the range of possible futures (Stirling, 2008), we created three urban scenarios irrespective whether they are desirable. In particular, we focus on the visual communication aspect of scenarios and the potential of the arts in fostering imagination as a "transformative capacity" (Galafassi, 2018). By anticipating unexpected developments including undesirable outcomes, the scenarios aim at stimulating learning processes for (transformative) climate change adaptation and sustainability, while promoting a sense of conscious responsibility for our future. We see the creative "narrative images" as a particularly promising tool for promoting social learning, both in research (especially during the process of creating the scenarios) and in society as a whole (in a next step by using the developed "narrative images" in stakeholder dialogs). Artistic practices can be a form of research to study social-ecological relations (Galafassi, 2018). Here, we make a case for this being one way to bridge knowledge between disciplines for exploring social-ecological futures. In doing so, we recognize the "vital complexities" of real-world dynamics (Stirling et al., 2023). In particular, the images are intended to make the benefits of transformative adaptation tangible in order to "become meaningful" (Wiek and Iwaniec, 2014, p. 502). Our "narrative images" allow to engage with future developments of the city of Hamburg dealing with the socio-ecological problem of adaptation to urban water-related risks under climate change and thereby focus on the role of water in urban societies. In this way, this approach can also guide new ways of policy development aimed at co-creating more transformative futures through social processes. The purpose is to open up the *realm of the plausible* in order to determine what kind of urban water futures should be strived for, what should be avoided, and according to whom? The scenarios shall trigger questions such as: "What might possible futures look like?," "Which alternative worlds of adaptation could we opt for?," and "Which urban futures are plausible?".

2 Method

Neuhoff et al. (2023) have identified three existing forms of exploring, imagining and negotiating urban futures toward sustainability in the literature: (i) interdisciplinary expert-driven scenario-building, (ii) quadruple-helix futuring informing policy agendas, and (iii) public futuring for social learning. Our approach falls into the category of Type 1. While we recognize that there is a need for more Type 2 or Type 3 forms of participatory scenario building and planning for urban sustainability that directly involve the public in the process, we argue that our interdisciplinary scenario-building also has its place as a tool to promote learning. There is no one right approach to imagining and exploring the future development of human societies (Muiderman et al., 2020). Rather, it is necessary to constantly reflect on whether the chosen approach does justice to the problem at hand, in our case urban adaptation to climate-related water challenges. An interdisciplinary approach is particularly relevant in this context, as water-related challenges affect various disciplines and these should ideally also be represented in a future-making exercise. This section describes how this interdisciplinary collaboration evolved (Section 2.1), outlines the conceptual basis and the methodological steps of the interdisciplinary scenario development process (Section 2.2), and explores the role of "narrative images" as a specific learning approach (Section 2.3).

2.1 An interdisciplinary collaboration

This scenario-building study was conducted within the scope of the C1 project "Sustainable adaptation Scenarios for Urban Areas – Water from Four Sides" funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) as part of the Cluster of Excellence CLICCS ("Climate, Climatic Change and Society") at the University of Hamburg (UHH) together with partner institutions. CLICCS is focused on assessing "possible" and "plausible" climate futures (i.e. the potential future states of the co-evolution of the physical climate system and society) at all scales from global to local (Engels et al., 2024). In light of this, the C1 project aims at understanding the plausibility of sustainable climate change adaptation in city of Hamburg. This scenario-building study with its "narrative images" is intended to provide a tangible entry point for scientists and society (in a next step in context of stakeholder dialogues) to engage with possible future states of the city of Hamburg that deal with the socio-ecological problem of adapting to urban water-related risks in the face of climate change. The scenario-building process was designed and led by a team of C1 project scientists who engaged the interdisciplinary C1 project team of researchers in various workshop formats throughout the process (see Section 2.2 for more details). From the outset, the C1 project was designed as an interdisciplinary collaboration between the natural, engineering and social sciences, bringing together experts from various institutions (from the UHH) and partner institutions ranging from basic research to expertise in applied fields. However, in contrast to the traditional approach taken in academia, which usually starts from disciplinary knowledge gaps, we focus on a transdisciplinary research topic, i.e., research that engages with a societal problem (Klein, 2014; Brennan et al., 2021). In this sense, our project sees itself at the interface between an interdisciplinary and a transdisciplinary approach. It is perhaps important to mention that the project builds on the collaboration of the predecessor project "Urban Systems" of the previous Cluster of Excellence CLISAP ("Integrated Climate System Analysis and Prediction") and has benefited from its networks and collaborations. This long-term collaboration has brought together a broad range of specialist background knowledge on different dimensions of the urban realm, focusing on urban water-related risks, climate change adaptation and social justice, with the city of Hamburg as a common focus of interest. In fact, the interdisciplinary team involved in this scenario-building study comprised participants with expertise in meteorology; physics; climate statistics and extremes; river and coastal engineering; biology; soil sciences; physical geography; integrative geography; human geography; urban and regional planning; planning, building and environmental law; transport planning; environmental governance; and environmental economics. Not all disciplines were equally represented, with most scientists coming from the natural sciences. However, the three members of the C1 team leading the scenario-building represented a diverse mix of natural and social science expertise from the fields of meteorology, human geography and environmental governance. In total, around 35 participants were involved in the scenario-building process, although the number fluctuated over time as new scientists joined the project. This ensured that new impulses were constantly introduced and existing ideas validated. Overall, this scenario study represents a process that led to a consensus after several iterations over 3 years.

2.2 Interdisciplinary scenario-building process

Findings from the empirical study of the city of Hamburg, Germany

In the following, we present and discuss the six key steps and findings from the interdisciplinary, participatory scenario-building process, which was empirically applied using the city of Hamburg, Germany as an example (Figure 1). The entire scenario-building process took around 3 years, starting with the first workshop in September 2021 and ending with the completion of the professional illustrations in May 2024. A detailed description of this multi-step approach is given in Supplementary material S1. The participatory approach involved workshops and group discussions in attempt to explore the different disciplinary perspectives. Although shown linearly, some steps of the process were generally performed iteratively, with some loops between them. Steps 1 and 2 were executed in the same kick-off expert workshop. Step 4 was actually carried out as a series of workshops.

Step 1. Brainstorming and identifying meta-characteristics

This first step created the foundation of the successive scenario elaboration. Together with the interdisciplinary team of experts, we specified key elements, which we called the meta-characteristics of the scenarios, such as the thematic coverage, the geographical scope, the underlying societal assumptions on which the scenarios are based and the time horizon.

In line with the scope of the C1 project, we agreed on the thematic coverage of our scenarios, namely future urban adaptation against the backdrop of climate change-induced water challenges in the form of precipitation-induced flash floods, riverine flooding, storm surges and changing groundwater levels, i.e. "water from 4 sides" in the Hamburg urban area. However, we also agreed that, in addition to the topic of "too much water," we also wanted to address the topic of "too little water" in order to explore their synergy potential for sustainable adaptation in urban areas.

We found that the main challenge was to develop possible, alternative scenarios while sticking to the normative concept of sustainable adaptation. By presenting three different possible scenarios for adapting to climate change, we decided to move away from the approach of developing just one ideal vision of the future. We believe that the visual juxtaposition of different adaptation scenarios can be even more motivating for people to advocate for transformative, sustainable solutions than if only one desirable future is shown. We chose to take the approach to climate change adaptation that the city will pursue in the future as the overarching framework for the three scenarios. From this, the overall logic of the scenarios were derived. This means that a set of three scenarios was used to represent a gradient of increasing transformative adaptation for managing the water-adaptation nexus (Figure 2). In

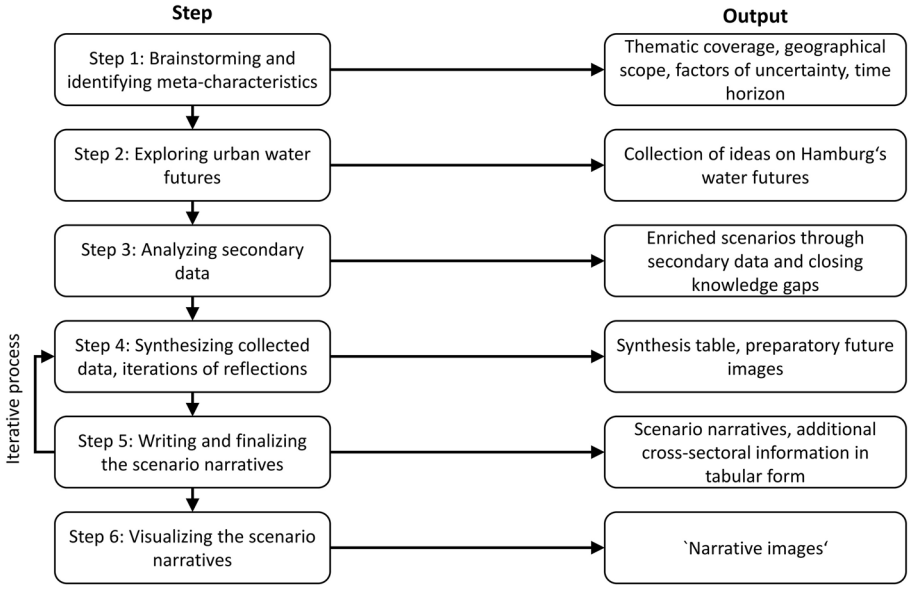


FIGURE 1
Details of the interdisciplinary scenario-building process for the case study of the city of Hamburg, Germany.

doing so, we structured our scenario framework upon the three archetypal approaches to climate adaptation: coping, incremental adaptation and transformative adaptation (Kates et al., 2012; Fedele et al., 2019). This chosen tripartite structure differs from the scenario planning approach of the scenario-axes technique and is explicitly not based on a 2 × 2 matrix with only two critical uncertainties (cp. Dean, 2019; Avin et al., 2022). By incorporating a variety of societal assumptions (see Table 1), we take into account multiple dimensions of uncertainty about how the future might unfold and thus achieve greater richness and complexity in the scenarios.

Regarding the time horizon, we have decided to relate the scenarios to the year 2050. This time horizon is intended to provide sufficient scope for a significant deviation from the present state of affairs while at the same time allowing for a comprehensible subject of discussion, as it is not too far in the future. In addition, the city of Hamburg aims to become carbon neutral by 2045 (HmbBü-Drs 22/12774, 2023), which would require a fundamental shift from the current arrangements, opening up possibilities to consider the potential interfaces (synergies and trade-offs) between mitigation and adaptation in the city for the next three decades.

Even if climate mitigation is not the focus of this scenario study, it has to be taken into account as a central element of sustainability when considering sustainable adaptation. This study does not aim to explore mitigation pathways, but rather the important interfaces with adaptation. Adaptation should be understood alongside mitigation as a vehicle for transformative change. Our approach allows for an exploration of the complex interdependencies (i.e., synergies and trade-offs) between adaptation and broader sustainability objectives.

Step 2. Exploring urban water futures

Once the scope of the scenario-building process had been defined, a kick-off workshop was conducted to outline the contours of the three future images of the city of Hamburg for 2050 based on the knowledge of the interdisciplinary team of researchers. Due to restrictions during the COVID-19 pandemic, this workshop had to be conducted online. During the workshop, the participants discussed how the city of Hamburg would look like assuming the city has adapted to the urban water-related hazards by adopting one of the three different adaptation strategies. The workshop was held in the form of a World Café style with each of the five water-related hazards representing a station where a standardized template had to be completed during the workshop session (see Supplementary material S2). The approach deliberately encouraged participants to consider the three different strategies to adaptation (i.e. coping, incremental adaptation and transformative adaptation) simultaneously in order to coherently work out the differences between the scenarios by relating them to each other. Each of the water hazard stations was moderated by a person who was responsible for capturing the discussions in the form of post-it notes in the template (Supplementary material S3). All moderators followed the same set of open-ended guiding questions (Supplementary material S4) to lead the discussion at each station. The templates were hosted on the MURAL visual workspace (https://www.mural.co/) and Zoom (https://explore.zoom) break-out groups were used as online forums. Efforts were made to ensure that participants were spread evenly across the stations. Participants were asked to change stations after 30 min to allow each participant to work on three different hazard stations during the workshop session.

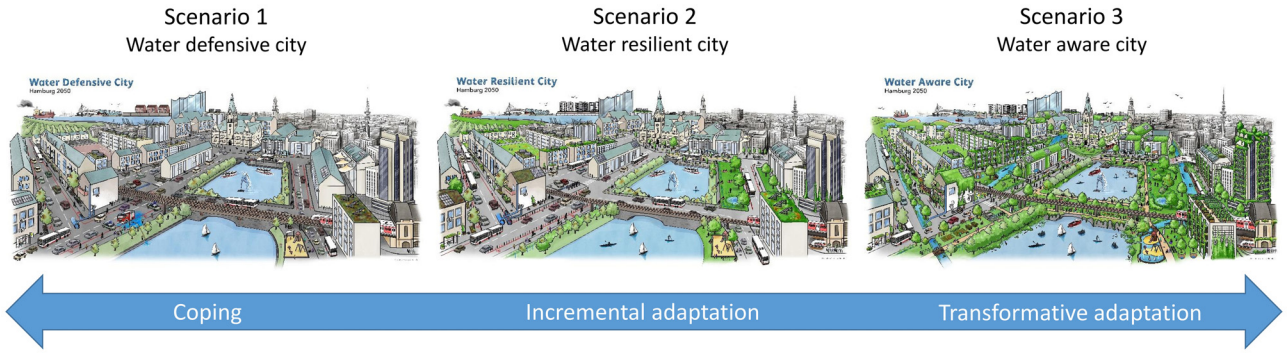


FIGURE 2
Three scenarios of possible adaptation futures for the city of Hamburg in 2050 with a gradient ranging from coping to incremental adaptation to transformative adaptation.

All participants found it very difficult to assign specific adaptation measures to the three different adaptation approaches. The different categories of adaptation responses are not always clearly distinguishable. This corresponds to the discussions in the literature about how difficult it is to move from the conceptual level around transformative adaptation to an empirical and practical understanding (e.g. Garschagen et al., 2018). There was agreement among all participants that these joint discussions supported learning on this topic. In particular, the step of visualizing the scenarios (as described below in Step 4 and in Section 2.3) stimulated discussion about exploring the transition from the abstract and conceptual level to the empirical and practical level.

Step 3. Analyzing secondary data

In addition to the expert workshop an analysis of secondary data on (i) existing future making exercises of Hamburg by diverse regional actors and (ii) on guiding principles of sustainable urban water management frameworks was carried out. The results of the expert-workshop were based on a purely academic perspective due to the composition of the workshop participants. Therefore, this approach aimed at enriching the scenarios through the integration of articulated aspirations of actors engaged in urban water governance in the city of Hamburg. Desktop research was used to collect findings from various existing initiatives, which have developed goals, visions or scenarios focusing on urban development. In addition, this step aimed at addressing the knowledge gaps identified in Step 2, for example in the assignment of specific adaptation measures to the three analytical categories (i.e., coping, incremental adaptation and transformative adaptation).

Step 4. Synthesizing collected data, iterations of reflections

The project members who led this study synthesized the results of the workshop and the findings from the secondary data in tabular form. A synthesis table was used to summarize statements collected during the workshop according to main topics (e.g., impacts of extreme events, land use, water infrastructure, social dimension, governance). Categories were developed inductively through clustering and scenarios were presented in a table for comparison. This synthesis table was returned to the interdisciplinary team to get feedback and an evaluation of the results. In addition, preparatory future images were developed on the basis of the data from the synthesis table. The preparatory future images were initial sketches of the three scenarios, drawn up by a member of the research group and served as a starting point for discussion in further workshops. This first visual perspective on the topic has clearly stimulated many discussions among scientists concerning the degree of transformation of individual adaptation measures and have helped to link the conceptual debate on the different approaches to climate change adaptation with the empirical and practical level. These sketches were intended to stimulate the imagination of the participating scientists and help them to form an initial picture of the three different adaptation scenarios in order to further sharpen the focus of the future images.

In fact, stages of reflection and refinement of the scenarios took place throughout the scenario development process. To ensure that the three scenarios represent “plausible descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces" (IPCC, 2022), a set of quality criteria for scenarios (Kok and van Vliet, 2011) was followed. The scenarios were evaluated in a series of four additional workshops in terms of relevance, credibility, legitimacy, creativity and structure. For example, the scientists were asked to critically reflect on the relevance of the critical uncertainties (i.e. societal assumptions that were assumed to play a dominant role in shaping the adaptation future of Hamburg; Table 1), to check the credibility of the scenarios based on their scientific expertise or whether they are generally coherent in structure.

Step 5. Writing and finalizing the scenario narratives

In a next step, the scenario narratives were written by the project members who led the scenario-building process based on the synthesized data. At the beginning of the writing process, a joint decision was made on how the scenario narratives should be structured. All three narratives are preceded by a common starting point, which briefly describes the projected climate changes in

TABLE 1 Comparison of the underlying societal assumptions between the three adaptation scenarios.

Societal assumptions	Scenario 1 Water defensive city	Scenario 2 Water resilient city	Scenario 3 Water aware city
Adaptation strategy	Coping	Incremental adaptation	Transformative adaptation
Depth of transformative adaptation	Low	Medium	High
Accounting for systemic complexity in risk managing of "water from 4 sides"	Not systemically addressed	Not systemically addressed	Systemically addressed
Level of society's perception in relation to water	Low	Medium	High
Level of environmental and climate change awareness	Low	Medium	High
Scope of public and private participation in climate adaptation measures	Only public	Public and private	Public and private
Degree of social fragmentation	Business as usual	Green gentrification	Sustainable urban commons

They reflect the breath of the uncertain socio-economic context in the scenarios with regard to the long-term future of the city.

Hamburg in 2050. Then, in each narrative, we used the identified societal assumptions (Table 1) to build the core storyline.

Step 6. Visualizing the scenario narratives as "narrative images"

To address a broad target group with the scenarios, we have developed various user-specific outputs: one narrative for each scenario (see Section 3), additional cross-sectoral information in form of a table (Supplementary material S5) and, above all, the visualization of the narratives as "narrative images" (see Figure 3), as explained in more detail in the next Section 2.3.

2.3 The "narrative images"

We see that scenarios gain their power above all from the translation of their narratives into images. Images provide data in a different way than qualitative or quantitative indicators. They leave a lasting impression and influence perceptions. By connecting to people's "inner dimensions," art can contribute to achieve sustainability goals as it touches on our intrinsic motivations for preserving and transforming our environment (UNU-EHS, 2024). In addition, art-based research can be seen as a form of research on social-ecological relations (Galafassi, 2018) and it thereby can help people engaging with the complexity of urban system processes.

This step is considered to be particularly important for this scenario study as it explicitly aims (i) to promote learning among scientists (both within the project team and beyond) by exploring transformative adaptation and risk reduction versus non-transformational types (coping, and incremental adaptation) within the complex urban system, and (ii) in a next step, to encourage local societal actors (e.g., citizens, public authorities, private companies) to actively engage with (transformative) climate change adaptation and sustainability and envision the future of Hamburg. In order to test new ways of visual communication via "narrative images" the developed scenarios were visualized by a professional illustrator. These images are meant to stimulate social learning and motivate people to see adaptation not as a constraint or burden, but as an opportunity for a more sustainable future. In particular, these "narrative images" are seen as mental tools that help a wider community to perceive complex socio-ecological problems in a way that is easy to grasp and thus initiate public as well as policy discussions.

A local illustrator was explicitly selected who is familiar with the specifics of the city. It was decided to select an angle of the city that most people living in Hamburg are familiar with. Moreover, various small sides, scenes and hidden objects should be illustrated so that the various aspects of the three narratives become visible. Also, the research group selected appealing and colorful structures and scenes as the scenarios should open up to a broader audience and thus, a catching scene with all these hidden fragments should trigger the interest of both, the scientific community, stakeholders and the broader public. The "narrative images" are characterized by a color gradient of blue and green. While gray is the dominant color in the coping scenario, fresh green and blue dominate in the transformative scenario. In order not to hinder the exchange of knowledge through language, we have also developed the "narrative images" in the local language (i.e. German; see Supplementary material S6).

In addition, six bubbles were designed and inserted into the illustrations to emphasize key topics. Finally, short descriptions of the bubbles to facilitate their understanding complete the illustrations. Title and texts are available in both English (Figure 3) and German (Supplementary material S6), so that the appropriate text can be presented and used for further studies and knowledge transfer depending on the audience. In the short texts below the images, attention was paid to the words chosen for communication. Scientific terminology can create barriers. This is clearly attempted to be avoided here.

3 Results

Three qualitative scenarios were developed following the methodological steps mentioned above and visualized in "narrative images" (Figure 3). The scenarios, entitled "Water defensive city," "Water resilient city," and "Water aware city," take place in Hamburg in the year 2050. Global greenhouse gas emissions have

Water Defensive City

Hamburg 2050

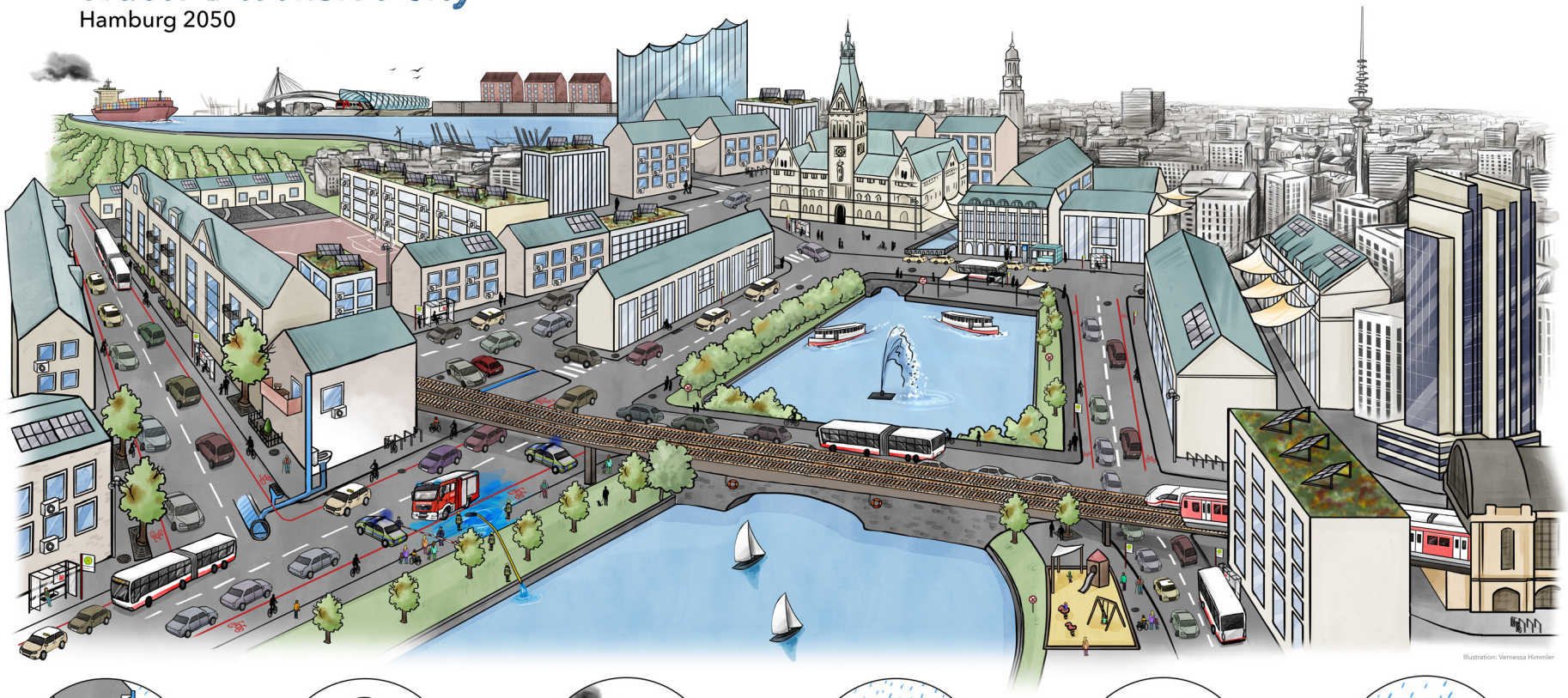
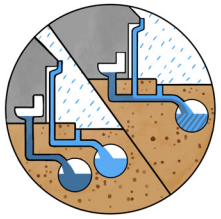


Illustration: Vernessa Himmler

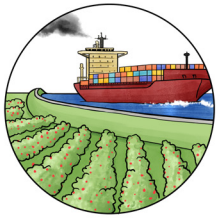


Urban Water Cycle

Stormwater runoff from built-up and paved areas is discharged directly into the sewer system, either via combined or separate wastewater and stormwater sewers. To prevent overflows from combined sewers due to heavy rainfall events, the network of separate sewers is being expanded.

Citizen Engagement

Urban flood risk and water management is in the hands of the city. There is no citizen participation in the decision-making process. The focus remains on involving citizens in order to inform them.

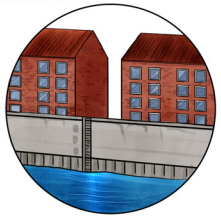


Coastal Protection and Shipping Regulations

Coastal protection relies on conventional measures such as dikes, which are raised only in response to extreme events (i.e., after dike failure). Full trust in public coastal protection has led to agriculture extending right up to the dikes.

Stormwater Retention and Infiltration

Stormwater runoff from sealed parking lots is drained directly into the combined or separate wastewater and stormwater sewer system.



Construction in Flood-Prone Areas

Construction continues to take place directly in flood-prone areas, with hard structures such as dikes and seawalls along the Elbe traditionally being used to protect against flooding.

Green Roofs

Combined solar green roofs on all new buildings and suitable flat or slightly pitched roofs that are being renovated. Only extensive green roofs with low-growing vegetation and low maintenance requirements are implemented.

FIGURE 3

The three "narrative images" of the qualitative adaptation scenarios for Hamburg in 2050. Scenario 1: "Water defensive city". Following pages: Scenario 2: "Water resilient city" and Scenario 3: "Water aware city".

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Water Resilient City

Hamburg 2050

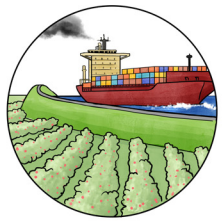
Illustration: Vernessa Himmler

Urban Water Cycle

A city-wide network of separate sewers for wastewater and stormwater is intended to prevent combined sewer overflows. The capacity of the stormwater sewers is being increased for new construction projects. Decentralized stormwater management measures are increasingly being implemented ('sponge city' concept). Some pilot projects use the 'circular economy' approach with consistent separation and recycling of water flows at the point of origin for circular wastewater management.

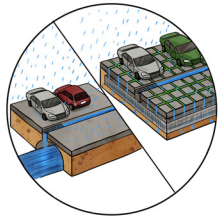
Citizen Engagement

New innovative approaches involving citizens have been further developed and increasingly implemented. However, the focus remains on legitimizing decisions through citizen participation in the form of deliberative processes. Citizens are called upon to contribute ideas and suggestions and provide feedback in discussion rounds. Responsibility for planning and decision-making remains in the hands of the city.



Coastal Protection and Shipping Regulations

Public dikes along the tidal Elbe River are raised with long-term planning (climate proofing). The presence of dikes gives sense of security, and agriculture extends all the way to the dikes.



Stormwater Retention and Infiltration

Stormwater runoff from sealed parking lots is drained directly into the stormwater sewer system. The use of parking lots for local stormwater retention, treatment and infiltration through underground storage and infiltration systems only takes place in a few isolated pilot projects.

Construction in Flood-Prone Areas

All new waterfront developments are built on elevated plots in front of the dike line according to the so-called 'Warft' model. Raised sidewalks allow people to be evacuated in the event of flooding, and flood gates protect ground-level entrances to the individual buildings.

Green Roofs

Combined solar green roofs on all new buildings and suitable flat or slightly pitched roofs that are being renovated. In addition to extensive green roofs with low-growing vegetation, intensive green roofs with shrubs and trees are increasingly being implemented. During extended dry periods, however, plants of green roof systems that are exclusively fed with rainwater tend to die-off due to insufficient rainwater storage and irrigation.

FIGURE 3 (Continued)
Scenario 2: "Water resilient city".

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Water Aware City

Hamburg 2050

Illustration: Vernessa Himmler

Urban Water Cycle

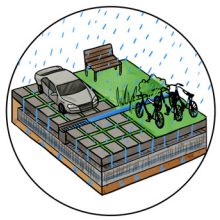
A paradigm shift from centralized to decentralized infrastructures has taken place in urban water management in order to bring the urban water cycle closer to its natural state. The innovative 'circular economy' approach, which is based on the separation of rainwater, stormwater, blackwater and graywater at the point of origin and its efficient treatment and recycling, is now a city-wide standard.

Citizen Engagement

Co-creation is the new standard that brings together a variety of public and private actors, including citizens, in joint committees for creative problem-solving processes. The focus is on a collective decision-making process to shape the future of the city together.

Coastal Protection and Shipping Regulations

'Room for the river' measures are implemented in partnership with neighboring federal states, e.g. dike relocation, floodplain restoration and wetland creation. Agriculture is moving inland to make room for protected floodplains. The size of ships entering the port of Hamburg is limited in order to reduce maintenance work on the Elbe.



Stormwater Retention and Infiltration

Parking lots are used throughout the city for local stormwater retention. Stormwater is collected and treated, e.g. in underground storage and filtration systems, and then used to irrigate green spaces or for infiltration. Extensive unsealing measures in connection with the transport infrastructure were carried out in favor of space for local recreation and bio-retention areas.

Construction in Flood-Prone Areas

Flood-adapted buildings are the standard in flood-prone areas. A variety of building approaches have been implemented to be prepared for flooding: e.g. buildings on elevated plots, floating buildings, buildings that allow floodwaters to enter and leave again, or water-resistant objects.

Green Roofs

Intensive green roofs in combination with solar panels are standard throughout the city. Roofs are thus being transformed into usable garden landscapes. Urban rooftop agriculture is also increasingly being practiced. All this is made possible by integrated local water management with rainwater harvesting, storage and reuse for greening.

FIGURE 3 (Continued)
Scenario 3: "Water aware city".

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led to global climate change, which for Hamburg is characterized by an increase in the frequency and intensity of heavy precipitation. In addition, with global mean sea level rise, extreme water levels are more likely for Hamburg.

3.1 Scenario 1: "Water defensive city"

To respond to the impacts of climate change, the city of Hamburg has developed a water defensive policy agenda. In this agenda, water is perceived as a threat to be feared. The city is seeking to defend itself through reactive measures with a short-term time horizon, in which the affected socio-ecological urban system maintains a similar state or business-as-usual functioning resembling clear characteristics of a so-called coping strategy. The political agenda focuses on disaster management through controlling and fighting water based on experience from past events, characterized by top-down approaches to adaptation. There is no citizen participation in the decision-making process and the focus remains on involving citizen in order to inform them.

Water has largely disappeared from public cityscape; concrete is the dominant element in the city. Small streams and rivers flow regulated and diked in canals or hidden in underground pipes. The call for more extreme changes and transformations at the beginning of the 21st century has been neglected, as the society did not see the need to change its water and living habits. The preference for a supposedly easier and less restricted lifestyle is the driving force behind this development and did not allow for major changes politically either. The unchanged lifestyle has led to an increase in individual water consumption. As a reactive measure during periods of water scarcity, a restrictive water policy is temporarily implemented to reduce individual water consumption in the short term.

The responsibility for storm surge and coastal flood protection and related risk management lies entirely in the hands of the city and the public trusts and relies on it completely. Traditional solutions with hard structures (e.g., dikes, seawalls) are used for coastal flood risk management. According to the coping strategy, dikes are raised only in response to extreme events (i.e., after dike failure); there is no long-term planning or climate proofing. The city follows the logic of rebuilding after floods as before. In addition, the city relies on early warning systems such as new loudspeaker systems and warning apps, which are mandatory.

Flood risk is not systemically addressed; protection against hazards other than coastal flooding has been neglected. Flooding of areas located along the public dike line (e.g., Hamburg Fish Market) is a regular phenomenon during storm surges. The resulting damage has become habitual and is accepted. However, during heavy rainfall events and the associated flooding, the city and its citizens, in particular the most vulnerable groups of the population are severely affected by damage. The state of emergency is declared more frequently due to pluvial and associated sewer flooding as well as fluvial/hinterland flooding. In addition, social inequality and hotspots of social vulnerability are main issues contributing to fragmented flood risk.

The visibility of the dikes and the full trust of the citizens in the public coastal flood protection has led to a sense of security among the citizens. There is a strong belief that the dikes will hold and are secure. The individual quality of life has not yet changed drastically, but the overall quality of urban life has (e.g., less green and blue areas). However, the fact that insufficient climate adaptation in the city has led to a lower quality of community life in the cities has not yet reached the awareness of society.

3.2 Scenario 2: "Water resilient city"

To respond to the impacts of climate change, the city of Hamburg has begun to rethink the way it manages water hazards. The city explores the role and impact of bottom-up initiatives in adaptation. Although citizens are called upon to contribute ideas and suggestions, the focus remains on legitimizing decisions through citizen participation in the form of deliberative processes. To build resilience to climate change and prevent negative impacts, the city strives to make small-scale adjustments to the current socio-ecological system that can be seen as extensions of actions and behaviors already being implemented. These are common characteristics of what is known as an incremental adaptation strategy.

Water has taken on an increasingly prominent role in aspects of urban planning and is now partly visible in the city. Water has a rather positive perception. While water management is not anymore a purely technical matter, still the integration of cross-sectoral aspects is limited. Society has become more aware of the threats that climate change may cause and the uttermost positive effects that water can have in the city and as part of the city. This change in awareness was brought about, among other things, by early awareness raising, particularly in schools. Individual water consumption has decreased slightly as the importance of water sensitivity has grown within the society.

To manage coastal flood risk, a mix of traditional and innovative strategies is used. On the one hand, the existing flood protection measures were extended according to the prediction and control approach: the dikes along the tidal Elbe River (public dike line) were raised with long-term planning (climate proofing). Smaller rivers and streams within the urban area were diked as a precautionary measure for fluvial/hinterland flooding. On the other hand, new adaptive flood risk governance approaches involving multiple public and private actors have also been further implemented. For example, the so-called "Warftenkonzept" (by building on elevated plots in front of the main dike line), first introduced in Hamburg's HafenCity, is now applied to all new waterfront developments. This is used in combination with individual object protection and the institutionalization of flood protection communities ("Flutschutzgemeinschaften") among property owners and residents.

Flood risk is not systemically addressed; although the threat of heavy rainfall has been recognized, the city's precautions are not given the same priority as for storm surges. Regular flooding of the city's waterfront areas during storm surges does not cause any damage, as all waterfront buildings are protected by innovative technology. However, the risk posed by the hazard of heavy rainfall and associated pluvial flooding is not minimized citywide, but only in some selected areas through sustainable urban drainage pilot projects; there is no citywide level of safety. Therefore, flooding still causes severe damage in vulnerable areas. Also,

areas remain at risk mainly due to the fragmented distribution of social vulnerability (hotspots of high social vulnerability), which contributes to increased risk. Flood protection and management are thus not yet characterized by social justice and equality.

People are networking and awareness of water sensitive design structures is increasing among various actors in society. The appearance of the city is slowly changing toward more green and blue infrastructure, also in line with more "blue-green infrastructure" projects being realized. Thus, even people who were not aware of the harms caused by climate change realize that the overall quality of community life has changed positively.

3.3 Scenario 3: "Water aware city"

To respond to the impacts of climate change, the city of Hamburg has radically changed its approach to water hazards and adapts to climate change in a transformative way. The city of Hamburg is considered a water aware city. The political agenda focuses on addressing the root causes of vulnerability to climate change in the long term by changing the fundamental attributes of the socio-ecological urban system. This broader systemic change is linked to integrated, deep and citywide interventions that aim to establish new human-environmental relationships and address multiple aspects of risk (i.e., hazard, exposure, vulnerability and responses). These are features of what is known as a transformative adaptation strategy. Bringing together a variety of public and private actors, including business sector and citizens, through co-creation in joint committees for creative problem-solving processes is the new standard. The focus is on collective decision-making processes to make or implement public policy and thus shape the future of the city together.

Water is perceived as a positive element that is widely visible in the urban space. The people's perception of water has changed fundamentally; they are more willing to contribute to change on an individual level as well. On the one hand, this radical change is the result of early awareness raising in schools. On the other hand, policy makers have recognized the breadth and depth, as well as the social dimensions of transformation needed to achieve sustainable adaptation characterized by social justice. The conscious way of living with water and the environment has led to a decrease in individual water consumption. In particular, the separation, treatment and reuse of rainwater, stormwater, graywater, and blackwater at the point of origin, including energy generation through biogas combustion, have contributed to this through the city-wide implementation of "circular economy" strategies.

A comprehensive sustainable transformation of the city toward a water-sensitive and water aware structure has taken place. The integration of water issues into urban development follows the concept of "living with water," considering water as an integral part of the city, and involves new forms of interactions between city administrations and private actors. Hamburg's stormwater and associated pluvial flood management base on the "Sponge City" concept, a nature-based solution to flood reduction that aims to increase water absorption and reducing surface runoff while addressing water scarcity, water pollution, environment quality and urban livability. To manage coastal and fluvial flooding, buildings in the respective risk areas are designed to be prepared for flooding (e.g., buildings on elevated plots, floating buildings, buildings that allow floodwaters to enter and leave again, or water-resistant objects). In addition, "room for the river" measures are implemented in partnership with neighboring federal states, e.g., dike relocation, floodplain restoration and wetland creation.

As sustainable adaptation to climate change is linked to the Sustainable Development Goals (e.g., reducing inequalities, no poverty, good health and well-being, availability of clean water and sanitation for all), achieving synergies and co-benefits is a high priority in the city's transformative adaptation strategy. Flood risk is systemically addressed. Hamburg no longer has hotspots of high social vulnerability that would contribute to increased risk. Innovative flood management and the citywide implementation of the "Sponge City" concept by public and private actors ensures that floods no longer cause significant damage to citizens and infrastructure. Policy works hand in hand with a variety of stakeholders to ensure that all interests can be taken into account. Thus, flood risk management in Hamburg is characterized by social justice and equality citywide.

The active and responsible involvement of the population through co-creation, has led to a high level of satisfaction among the urban population. Overall, the citizens appreciate the city's water transformation: in particular, the introduction of numerous water and environmental conservation measures and the establishment of a citywide sustainable lifestyle.

4 Discussion

With the approach presented above, we aim to stimulate both learning among scientists through joint art-based scenario-building and social learning among diverse local actors (e.g., citizens, public authorities, private companies) through the outcome. While the success of the first objective can be measured during the process, i.e., within the interdisciplinary group of researchers, the second objective, the stimulation of social actors, will only become apparent after the presentation of the "narrative images" as a next step of this work.

This study explored possible future states of the city of Hamburg for future urban adaptation to water-related risks through an interdisciplinary approach using "narrative images." Three distinct qualitative scenarios considering different adaptation strategies and ongoing trends in (sustainable) urban water management frameworks were developed embedded in a collective learning process. Key lessons taken from this Hamburg case study as outlined below may aid in the success of future *interdisciplinary research and scenario developing exercises*. The approach presented here was developed using the city of Hamburg as a case study. However, the methodological framework developed can be transferred to other cities and other climate-related topics, and is not exclusively intended for urban water risks.

4.1 "Narrative images" as a learning approach

The innovative aspect of our interdisciplinary approach is that we have brought the humanities, natural and engineering sciences into a deliberative dialog on the topic of (transformative)

adaptation to climate change, with the aim of moving from the conceptual debate on transformative versus non-transformative adaptation strategies (i.e., coping and incremental adaptation) to the empirical and practical level with the help of the arts. We did this by explicitly drawing on the visual potential of "narrative images" in a future-making exercise, using art as a form of research to engage with the social-ecological relations of adaptation to urban water-related risks under climate change. The visual approach helped to foster discussions on the three different categories of adaptation measures, which are not always clearly distinguishable. As such, we see our art-based research as a contribution to bridging the existing gap between the conceptual debates and the empirical analysis of different approaches to climate change adaptation (Garschagen et al., 2018).

To support this learning approach, the scenario-building study was designed in such a way that there was sufficient space for communication to happen across disciplines and all levels of seniority (Leigh and Brown, 2021). The process was characterized by improved communication: all disciplines were taken seriously and had the opportunity to explain their point of view. We constantly strived to create a working and learning environment in which no one felt inhibited from expressing their opinions and using disciplinary terms and language. This open discussion and sharing of knowledge contributed to thinking through the scenarios and not limiting our visions. Time is an important factor for the effective development of a group identity in an interdisciplinary team. We therefore established our own working rhythm and pace.

4.2 Limitations of the study

With regard to the chosen time horizon of the scenarios (year 2050), there are certain limitations to this perspective. As the focus of the scenario study is on climate change adaptation, establishing such a short time frame could be somewhat problematic. While, some of the water-related climatic changes could be effectively managed within the envisioned adaptation arrangements, adapting to climate change impacts beyond this time frame might require even more profound structural changes. Such structural changes might involve significant public deliberation around very long-term projects spanning many decades, such as land buy-back or industrial transformation.

Besides from that, the study was specifically selected to focus on water-related adaptation measures for Hamburg. Which on the one hand is the strength of this study, as the selected interdisciplinary research team has in-depth knowledge on water-related topics from various fields. On the other hand, it would be worthwhile to focus in further studies how other (not water-related) adaptation measures would interfere and maybe change the presented results.

Another limitation of the study is the clearly subjective way of processing the scenarios. Although the expert group was an interdisciplinary group that brought in perspectives from different scientific fields, the work remained within scientific boundaries. A participatory approach that explicitly involves stakeholders from non-scientific background would bring more perspectives into the discussion and make it less technocratic.

4.3 Key lessons learned

- This scenario study shows how a future-making exercise that explicitly uses the potential of images can overcome collaborative challenges and promote learning within an interdisciplinary team.
- Scientific terms can create barriers, even between disciplines. For effective interdisciplinary collaboration, it is therefore important to constantly strive to create a working and learning environment in which individuals do not feel inhibited from expressing their points of view and using disciplinary terms and language. By creating conditions that foster learning through collaboration, shared meanings and language then emerge naturally.
- Art can speak to people's inner dimensions in a way that written texts cannot. Our "narrative images" serve as an integrated boundary object bringing together the different mental models of the participating disciplines. In this way, visualization promotes communication and supports the collective learning process between the different disciplines. The images thus create a tangible and shared entry point to the complexity of socio-ecological relations.
- In terms of practical applications, it is often difficult to distinguish between the three mayor types of responses to climate change in social-ecological systems (i.e., coping, incremental adaptation and transformative adaptation). The art-based scenario-building approach appears to be a suitable example of how to stimulate discussions that link the conceptual debate on transformative adaptation with the empirical and practical level.
- Collaborative and, above all, interdisciplinary work requires time and attention that is not always available in academia. So taking the time and focusing on this not only benefits the current project, but also influences the expertise of all those involved and opens up new scientific horizons.

5 Conclusion and outlook

This paper presents an innovative art-based scenario approach as a way of engaging with social-ecological futures. By considering different response strategies to climate change, we explore the tensions between possible and desirable urban water futures and open up the realm of the plausible. Using scenarios and explicitly "narrative images" as mental models works successfully for communication across disciplines while reflecting the co-existence of the diverse epistemologies, thus maximizing the benefits of interdisciplinary research. Applied to the city of Hamburg, the approach demonstrates that participatory scenario development and the use of images in particular have the potential to be an effective strategy for "learning to collaborate while collaborating" (Freeth and Caniglia, 2020, p. 1) within an interdisciplinary team.

In addition to stimulating learning in an interdisciplinary team, another goal of our scenario study is to motivate diverse local societal actors to engage with the complexity of (sustainable) urban adaptation and water management in a next step, with the "narrative images" serving as a starting point for imagining socially

constructed futures. Our scenarios are not intended to depict probable futures in which future urban risk is reduced, but rather to use them as a tool for imagining diverse pluralistic futures. They are intended to promote social learning and motivate both decision-makers as well as citizens to engage with the topic. The idea is to stimulate adaptive management characterized by "management as learning" rather than "management by control" (Pahl-Wostl, 2007, p. 56). In this way, this approach is especially intended to "putting society back into the future" and open up other ways of envisioning the future apart from the pathways offered by climate models (Hulme, 2011). The images should even go beyond capacity building; they should be seen as a starting point for a process of bringing together societal actors in novel configurations (e.g., the idea of a water advisory board consisting of representatives of civil society, scientists, engineers, business sector, and policymakers) to develop "pluralistic and actionable pathways" (Muiderman et al., 2020, p. 9) toward sustainable adaptation. And with this we seek to shape present-day governance.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

FH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. LM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. TH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. JO: Funding acquisition, Resources, Supervision, Writing – review & editing. JK: Funding acquisition, Resources, Supervision, Writing – review & editing. JS: Funding acquisition, Resources, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2024.1430257/full#supplementary-material

SUPPLEMENTARY MATERIAL S1
Detailed description of the implementation of the interdisciplinary scenario framework for Hamburg.

SUPPLEMENTARY MATERIAL S2
Structure of the World Café session of the expert works.

SUPPLEMENTARY MATERIAL S3
Template for the expert workshop on the MURAL platform used at each World Café station.

SUPPLEMENTARY MATERIAL S4
Guiding questions for the expert workshop used by the moderators at each World Café station.

SUPPLEMENTARY MATERIAL S5
Additional cross-sectoral information for each scenario.

SUPPLEMENTARY MATERIAL S6
The three "narrative images" in German.

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