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Citizen participation in the governance of nature-based solutions

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Abstract

The last half-a-century has seen a marked demand for authentic citizen participation in public policy-and decision-making, not least in the field of sustainability. The depth and forms of citizen engagement in nature-based solutions (NBS), for example, and how such participation shapes their trajectories is gaining increasing attention. In this paper, we analyze current forms and implications of citizen participation in 58 NBS case studies conducted in 21 cities in the light of supporting wider sustainability goals. Our results show that while tokenistic forms dominate citizen participation across a variety of NBS contexts, collaborative multi-stakeholder forms of engagement do *not* automatically lead to enhanced ecological functions. Deeper forms of engagement, however, strengthen and diversify both expected and unexpected social outcomes, including social learning, enhanced sense of belonging, environmental stewardship, and inclusiveness and equity, in general. Driven by neoliberal austerity logic governments often cede power to NBS promoters whose interests predefine an intervention's vision of nature. Deeper levels of participation are hence limited by inherent institutional structures, neoliberal regimes and the lack of trust among actors involved. These limitations can be partially bridged by strengthening relational and reflexive capacities of public institutions. Focusing on the *process* of citizen engagement and creating multiple arenas for discussion could bring out new voices and narratives and also transform the culture of participation.

KEYWORDS
citizen engagement, nature-based solutions, participation, sustainability, urban governance

1 | INTRODUCTION

Nature-based solutions (NBS) have increasingly been promoted as a means to address sustainability challenges in cities (EC, 2015; Frantzeskaki et al., 2019; IPCC, 2014, 2018; IUCN, 2008; Kabisch et al., 2016; MacKinnon et al., 2008; Xie & Bulkeley, 2020). The increasing frequency of weather extremes and their consequences, such as flooding, heat stress, and water scarcity, are putting NBS in the spotlight of scholars, citizen groups and decision-makers for climate change mitigation and adaptation (Andersson, 2006; Huq et al., 2013; IPCC, 2014; Kabisch et al., 2016; Wilkinson et al., 2013). NBS, as deliberate interventions using the natural properties of ecosystems, are being employed worldwide to deliver diverse sustainability benefits (EC, 2015; Maes & Jacobs, 2015). Although the notion of

NBS is relatively recent (IUCN, 2008), it closely relates to established concepts, including urban green infrastructure and ecosystem-based approaches (Nesshöver et al., 2017; Pauleit et al., 2011). While traditional, linear, technocratic and often top-down governance approaches may help tackle some environmental challenges, they fall short on ensuring wider and longer-term sustainability if they fail to address questions of social inclusion, fairness and equality, or engaging multiple citizens (and subjectivities) in the design, planning, implementation and maintenance phases of sustainable interventions.

The complexity of NBS calls for more innovative and transdisciplinary practices, including collaborative governance and a genuine engagement with diverse local communities (Eggermont et al., 2015; Frantzeskaki, 2019; Kabisch et al., 2016; Nesshöver et al., 2017; Wamsler, 2017; Wamsler et al., 2020). The involvement of citizens in transdisciplinary governance processes has been widely acclaimed to increase relevance, fairness, acceptance, and, ultimately, sustainability (Adger et al., 2005; Burton & Mustelin, 2013; Lemos & Agrawal, 2006; Mees et al., 2015; Nesshöver et al., 2017; Renn & Schweizer, 2009). However, research that explicitly delves into the implications, or results, of a wide spectrum of participation practices in the field of urban NBS governance is scarce (cf. Glaas et al., 2015; Hegger et al., 2017; Mees et al., 2016, 2017, 2019; Waylen et al., 2015). Previous studies indicate that urban NBS are often embedded in environments of social exclusion, neoliberal governance and growth ideology (Kotsila, Anguelovski, et al., 2020; Sekulova et al., 2021). Recent literature shows, for instance, how urban green areas can fortify and amplify existing inequalities (Connolly & Anguelovski, 2021; Shokry et al., 2020; Triguero-Mas et al., 2021), or how marginalized social groups are usually underrepresented and their vulnerabilities may be exploited—further reducing the long-term sustainability of NBS projects (cf. Bulkeley et al., 2014; Button & Mattson, 1999; Cardullo & Kitchin, 2019; Hörschelmann et al., 2019; Kotsila, Hörschelmann, et al., 2020; Tozer et al., 2020). Moreover, under current institutional structures, certain trade-offs and approaches to citizen engagement can hamper the social and environmental sustainability of NBS (Haase et al., 2017; Wamsler et al., 2020).

Against this background, we explore the nexus of citizen participation and NBS, along a diverse gamut of projects and strategies. Using selective cross-sectional comparison, including place-specific types and forms of citizen participation, we analyze the depth and extensivity of the most common participation practices. In particular, we explore how dominant conditions enable or disable the expression and uptake of citizens' visions, needs and voices, while paying particular attention to underprivileged or vulnerable groups. Finally, we draw linkages between citizen participation and associated benefits (and harms) for a number of sustainability processes and outcomes.

This paper is organized into six sections. In Section 2, we engage with the literature on citizen participation and NBS interventions to unpack the term "citizens" in varied urban contexts and NBS projects. In Section 3, we describe the methodology and case studies used to conduct this research. In Section 4, we categorize prevailing patterns of NBS citizen participation seen in our case studies from 12 European and nine non-European cities, including key conditions enabling and/or limiting citizen participation. In Section 5, we discuss our main findings in relation to power dynamics and emerging governance practices (e.g., reflexivity) in view of their wider implications for socio-ecological sustainability.

2 | THEORETICAL FRAMEWORK

While the links between citizen participation in NBS and the accrued environmental and social sustainability outcomes are not always straightforward, it is important to recognize that involvement by itself, is a desirable and crucial approach to ensure social equity and long-term socio-ecological sustainability.

2.1 | Citizen participation and NBS

Citizen participation is used here as a term that describes the involvement of individuals or communities in the planning, design, implementation and maintenance of projects and policies, such as NBS. "Citizen" however is a heterogeneous and contested category that needs clarification in the context of this paper. We depart from territorialized understandings of citizenship as rights and obligations that pertain to people by virtue of their membership in a bounded community. To engage with questions of inclusion, exclusion and difference, we regard citizenship as a process of enactment (Isin, 2000). Cities are particularly relevant in this context, as they can enable enactments, for instance, by promoting participatory citizenship practices independent of formal membership (e.g., recognized national citizenship). This means that residents without formal recognition (e.g., as national citizens or immigrants with residency rights) can, and shall, nonetheless claim rights to the city. Participation can consequently be understood as both the act of claiming citizenship rights, and the practices that follow from such claims. Likewise, marginalized citizens whose formal social and economic rights are curtailed (cf. Kymlicka & Norman, 2000; Marshall, 1950) may actualize their right to the city through participation.

Participation has a long history in different urban domains, including urban planning (Cushing & Renata, 2015), and has played out differently across the world. Emerging from the urban planning discipline, Arnstein's (1969) ladder, a pivotal work on the classification of different levels of citizen participation, provides a robust conceptual basis, describing participation as a continuum from non-participation through tokenism to citizen control. In the past half century, many typologies of participation emerged from this framework. Some point to the powerful role of their promoters' and practitioners' motivations (Pretty, 1995; White, 1996). Others engage with key questions like who participates in what, and with what influence (Cornwall, 2008). Participation can differ significantly depending on where it takes place, whose visions it follows, whether it only follows pre-set agendas or also allows and enables dissent, conflict, confrontation, and bottom-up initiatives (Kesby, 2005; Staeheli et al., 2002; Unger, 2013).

Arnstein's ladder has been repeatedly reworked, applied and adopted in various urban domains, including ecological and

environmental planning (Tippett et al., 2007), environmental projects (Luyet et al., 2012), green infrastructure planning (Wilker et al., 2016; Willems et al., 2020) and recently in a review of NBS (Puskás et al., 2021). This review assesses the extent and depth of participation in NBS worldwide. Their results show the dominance of conventional participation levels (consultation and partnership) in NBS, while deeper participation where citizens control or are delegated more power, is less frequent (Puskás et al., 2021). Many factors can limit participation. Some of these are tokenism, civic paternalism, exploitation and alienation of citizen interests that are ignored or displaced by other agendas, the in-built limits to participation within existing structures. While volunteerism can be confused as deeper form of participation, both under- or over-reliance on voluntary work may end up exploiting marginalized groups and reduce the long-term benefits of NBS projects (cf. Bulkeley et al., 2014; Button & Mattson, 1999; Cardullo & Kitchin, 2019; Hörschelmann et al., 2019; Kotsila, Hörschelmann, et al., 2020; Tozer et al., 2020). On the other hand, provision of property rights, adequate finances, or space for advocacy of community interests can enable and strengthen participation. Forms of participation, such as community-based organizing, for instance, tend to emerge and establish amid shared histories of place-based social-political mobilization, activism, cooperation and trust (Sekulova, Anguelovski, et al., 2017). Nevertheless, changing the means and depth of citizen participation (in NBS) is an uneasy task, for it requires a cultural change at the level of perceptions, attitudes and relations with and within public institutions and society in general.

2.2 | Sustainability outcomes and NBS

The potential of NBS to foster long-term socio-ecological sustainability is a key research quest in academic and policy circles (Andersson, 2006; Huq et al., 2013; IPCC, 2014; Kabisch et al., 2016; Wilkinson et al., 2013). Inherent in their definition as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016, p. xii), NBS hold the promise to provide multiple benefits, or "functions and processes of ecosystems that benefit humans, directly or indirectly, whether humans perceive those benefits or not" (Constanza et al., 2017, p. 5). These benefits can be categorized as provisioning, regulating, cultural, and supportive ecosystem services (MEA, 2005) or economic, environmental and social sustainability benefits.

NBS are frequently presented as multifunctional (Ferreira et al., 2020). Their level of multifunctionality however depends on the way their so-called socio-ecological domains are conceptualized. Vegetated buildings (e.g., green roofs, walls, facades and balconies), parks, greenways, and waterways (incl. canals, lakes, ponds, and wetlands) enhance recreational opportunities, water management, temperature regulation, soil formation and education (Ferreira et al., 2020). Urban gardens contribute to food provision and enhance connections between people and nature (Rosol, 2012). Various green and blue areas, such as sustainable urban drainage systems, raingardens, swales and filter strips, are specifically designed for water regulation, but might also contribute to cultural and supportive services. Bottom-up community gardens and greening initiatives, for instance, can unlock socio-ecological citizenship benefits that have been limited by sparse government services, gentrification, power differentials, conflicts within communities and social exclusion (Barron, 2017; Ernwein, 2014; Ghose & Pettygrove, 2014; Kotsila, Hörschelmann, et al., 2020; McClintock, 2014; Pudup, 2008; Rosol, 2012; Staeheli et al., 2002). To tap onto these benefits, however, NBS interventions need to be socially-embedded and sustained. As part of the urban fabric, NBS interact with diverse human interests, needs, and perceptions of urban liveability, which are often unevenly represented and implemented. Deeper forms of engagement, through a consideration of multiple citizen perceptions and incorporating local knowledges into project formation for example, could promote a sense of empowerment or ownership (Frantzeskaki, 2019). Social inclusion, if considered and employed, inherently supports paths to longer-term socio-ecological sustainability and deeper forms of democracy (Cárdenas et al., 2021; Fisher et al., 2015; Gearey, 2020; Kabisch et al., 2016; Nesshöver et al., 2017; Raymond et al., 2017; Skodra et al., 2020).

Against this background, in this paper sustainability outcomes are understood as expected or unexpected impacts of the NBS interventions, both in social, economic and environmental terms (Dimitrov, 2010). We treat sustainability here as a goal and a process, having both expected and unexpected outcomes. Social sustainability is hence understood both in the ways of producing NBS, as well as in terms of their final results. For instance, a green-infrastructure strategy might deliver physical measures with associated environmental, economic and social impacts, like increased greenery and biodiversity, enhanced educational activities or decreased unemployment (tangible outcomes). During the development, however, intangible outcomes arise, such as knowledge development, social learning, enhanced reflexivity, or social equality.

Overall, consensus is elusive on how much citizen participation contributes to sustainable outcomes in NBS. The nexus of citizen participation, NBS and sustainability outcomes is relatively new and unstudied (e.g., Mees et al., 2019; Wamsler et al., 2020) and mostly focused on methods and modes of participation, perception and acceptance of NBS (Ferreira et al., 2020; van Ham & Klimmek, 2017). Empirics on the advantages of citizen participation originate in fields of landscape planning (e.g., Clausen, 2016), environmental impact assessment (e.g., Glicken, 2000; O'Faircheallaigh, 2010), climate change mitigation (Bulkeley & Mol, 2003), resource management (e.g., Waylen et al., 2015), beekeeping (Purcell & Brown, 2005) and urban green governance (e.g., van der Jagt et al., 2016). A recent study of NBS for climate change adaptation argues that under current institutional structures, citizen involvement in municipally-led NBS projects can actually hinder sustainability outcomes (Wamsler et al., 2020). This paper aims to contribute to this body of literature by providing extensive empirics on the implications of citizen participation for socio-ecological sustainability.

3 | METHODOLOGY

3.1 | Research design and data description

This paper employs a multi-disciplinary comparative case-study research design (Bellamy, 2011) using within- and cross-case analysis of citizen participation in 58 NBS interventions from 21 cities. The selection and analysis of individual cases were guided by an analytical research protocol and case study template developed in the NATURVATION project (Sekulova, McCormick, et al., 2017). Guiding criteria for the iterative case selection process include the use of NBS in response to urban sustainability challenges, the presence of supporting innovation-, governance- and/or implementation frameworks and achieving a diversity of NBS domains. Furthermore, the protocol included research questions guiding each theme and underlining the thematic interviews. The major themes include the history, governance, public participation, and structural conditions enabling or constraining NBS development in different urban contexts, along with their socio-economic and environmental impacts. The latter data source was particularly important to address inclusion, accessibility and social justice among the forms and types of public participation.

Individual case studies were collected between 2017 and 2021. Three NBS interventions were studied in depth in each of the 18 NATURVATION cities and one to three NBS interventions each in the three Japanese cities. The Table A1 provides an overview of the 21 study cities and 58 NBS interventions. The data collection involved academic and gray literature review, least 15 semi-structured interviews per city, informal discussions with key actors and organizations, and on-site visits. Interviewees represented municipal, metropolitan and regional authorities, NGOs, community groups, research institutions, and various businesses. Interviews were audio recorded and/or partially, or fully, transcribed. One working paper with key insights and relevant quotes along the analytic thematic categories listed above was produced per city. In their production researchers systematically analyzed the 58 NBS making use of grounded theory approach (Glaser & Strauss, 1967). Despite the standardized data collection and analytical framework, individual case analyses vary somewhat in breadth and depth due to data availability and researchers' interpretation.

3.2 | Analytical frames and limitations

Our qualitative cross-case analysis is further guided by the adaptation mainstreaming framework (Brink & Wamsler, 2018) and citizen participation typologies in environmental projects (Luyet et al., 2012) and green infrastructure planning (Wilker et al., 2016). Furthermore, analysis of sustainability outcomes has been organized around ecosystem functions (see e.g., MEA, 2005) and social and environmental justice aspects of NBS (e.g., Heynen et al., 2016). The following paragraphs outline our key frames and definitions on (i) citizen participation; (ii) NBS domains; and (iii) sustainability outcomes.

1. *Citizen participation* is understood here as a continuum of interactions between institutions and people, and the different governance arrangements, and forms and methods which moderate these. We adapted the following categories of participation from Luyet et al. (2012) and Wilker et al. (2016): empowering, co-creating, collaborating, consulting and informing (Table 1). *Informing* and *consulting* are tokenistic participation, where participants "are heard" without any guarantee of influence over the NBS. These tick-the-box strategies often intend to legitimize or get public approval for an already decided plan, or create a forum for concerns. Deeper levels of participation, such as *collaborating*, *co-deciding* and *empowering*, are indicators of democratic processes allowing (a diverse range of) citizens to share and potentially control NBS development (Table 1). These types of participations are embedded within fluid governance processes, where actors engage in debates around issues of power, policy tools and institutions. Thus, the level of citizen engagement also depends on the governance arrangements, which we classify as top-down (municipality- or private sector-led), bottom-up (community or NGO/foundation-led initiatives) or collaborative. We recognize, however, that the boundaries of citizen participation and governance arrangements categories are blurry, and not always mutually exclusive. Furthermore, our assessment is somewhat limited by imperfect data on the range, or diversity, of citizen categories eventually represented in the participative processes around NBS.
2. *NBS domains* concern the physical structures of the interventions. We use the following categories (Kiss et al., 2019; NATURAVATION, 2020): (1) vegetated buildings (green roofs, walls, facades and balconies); (2) new habitats; (3) urban gardens (community gardens, allotment gardens, and horticulture); (4) parks, urban forests and greenways (including street trees, playgrounds, schools, parking lots, and institutional green space); (5) plans and strategies for urban trees, forests and parks; (6) waterfronts and riversides (including canals, lakes, ponds, and wetlands) and (7) green and blue areas for water management (sustainable urban drainage systems, raingardens, swales and filter strips) which we further differentiate into (a) eco-districts for flood alleviation and (b) water security measures. The NBS domains listed are not always mutually exclusive.
3. *Sustainability outcomes* are expected or unexpected impacts of NBS interventions, bringing about short- and long-term economic, environmental and social changes—through functions of ecosystems. These were assessed on a case-by-case basis including evaluation of their: *environmental impacts* (water, ecosystems, biodiversity, soil, air quality), with a reference to the types of ecosystem services (provisioning, regulating, habitat and supporting, cultural) eventually provided; and *socio-economic impacts* (such as social inclusion/cohesion, equity, justice, job-creation) along with the potential conflicts which were observed between specific project goals (economic, environmental and social). Notably, there is some overlap among the different types of sustainability outcomes, such as "cultural ecosystem services" which could be considered both an environmental and socio-economic outcome. This

TABLE 1 Levels and forms of citizen participation in NBS and implications for sustainability outcomes

	Description of participation level	Forms of participation[a]	Relevance to NBS and sustainability outcomes	Registered and potential trade-offs
Empowering	There is an intent (direct or indirect) to build long-term commitment and strengthen agency through the project.	Advocacy planning, capacity development, appreciative inquiry, public spirit workshops	By assessing and accessing community resources, these initiatives transcend NBS project phases. Activities focused on vulnerable groups foster and develop social learning and skills, strengthen livelihoods to increase citizens' decision-making power, and change established attitudes/norms, nurturing reflexivity.	Focus on environmental justice carries the risk of lessening short-term environmental benefits (e.g., lack of ecological evaluations) and/or mistrusting the engagement with certain societal actors, e.g., who could bring in long-term economic sustainability. Land-use rights, urban sprawl and lack of awareness of natural resources often challenge these NBS.
Co-deciding	Project leaders closely cooperate with citizens in NBS implementation.	Co-design workshops (e.g., participatory planning), citizen panels, joint planning groups, co-management (of certain) project aspects, task forces	The collaboration spans multiple NBS development phases. Activities often consider demographic representation. It fosters trust building in decisions, while developing social learning and improving mutual understanding of pressing issues, especially in planning, which also contributes to reflexivity.	Project-based practice is not automatically carried over to common municipal practices—e.g., due to lack of relational capacity and/or organizational learning. This can support path dependency favoring gray over green structures. Social groups with lack of assets and skills (e.g., language, culture) required for decision-making might be left out.
Collaborating	Project leaders present the project to citizens, take their inputs into account, and involve them in the implementation.	Specialized meetings, interactive workshops, district forums, focus groups, social media debates, drop-in Q&A, community-based activities, crowd-funding, participatory mapping	Usually better structured than consultations, often integrates various interests, engages with grassroots initiatives. In turn, local knowledge can improve project design. Citizens are often called on to donate money, labor or other functions to meet pre-set project goals. This can improve implementation, social cohesion and sense of place.	Activity-based resource mobilization can be exploitative and exclusive, e.g., by engaging only with selected social groups and/or highjacking projects to achieve certain goals, without long-term social or environmental benefits. Lack of funding and flexibility can further prevent deeper change, e.g., in attitude or behavior.
Consulting	Project leaders present the project to citizens, register their inputs.	Events, meetings (typically open space), e-mail feedback, interviews, surveys, citizen jury, geospatial decision support systems	Consultation is often legally required; the form of engagement depicts the project leaders' intention, e.g., tick the box, get public approval, gain legitimacy for a chosen plan, or create a forum for concerns.	Citizens often perceive consultation as a tick the box process, while authorities as confrontational. This often results in compromised sustainability outcomes, limited development of responsibilities and distrust to authorities, which in turn leads to a lack of belonging, and passive citizenship.
Informing	Project leaders explain the project to citizens.	Newsletters, reports, public presentations, online information, webpages, field visits with interactions	Citizens informed about projects are more likely to understand the NBS and its benefits. When coupled with informational education, it can promote future collaboration and build awareness on new issues.	This one-way communication carries the risk of exclusion leading to separation in citizens' personal spheres, while allows NBS to be dominated by powerful actors' political and economic interests, often sold by greenwashing.

[a]Higher categories can also include forms of participation described in the lower categories of participation, for example, both consultation and collaboration can take the form of meetings, but can also take place in higher levels; their intent, content and type of participation can differ enormously. For the purpose of this research, however, we focus on the additional specific forms of participation relevant to the respective categories.

examination helped understand how much the projects could claim to be inclusive, participative, and creating shared wealth.

For practical reasons, in this paper, quantitative analysis of environmental sustainability outcomes was measured through the presence of ecological functions, such as water and nutrient cycling, biodiversity, vegetation growth, regulation of air temperature and quality, pollination and habitat creation. Recognizing the multitude of social outcomes, we limited our quantitative analysis to social justice, assessed through the extent to which NBS were inclusive and participative throughout their development. The limitation of this approach is that we use the data collected and processed in the working papers, including summaries of interviews. In line with previous studies (see e.g., Dumitru et al., 2020), the impact evaluation methods applied to the different NBS differ across projects, typically including either only environmental or only social impacts. To address this issue, in the quantitative analysis, based on the above-described variables, we assessed each NBS via the expert judgment of researchers collecting the primary data and/or the authors of this paper. The consistency across sustainability outcomes however still varies. To quantitatively answer whether deeper levels of citizen participation lead to better social and ecological outcomes we used χ^2 tests implemented in R version 3.3.2 (R Core Team, 2016). For each of the seven types of outcomes (six ecological and one social), we constructed a separate matrix of the number of cases where a particular outcome was present and absent (rows) as a function of engagement level (columns). Thus, all seven matrices summed to 58 (the number of cases) and were used for the outcome-specific χ^2 test. In our qualitative analysis, we coded for broader social outcomes, such as knowledge development, awareness raising, social learning, employment, decision-making reflexivity, changes in attitudes and/or social norms, increased trust, and sense of place. This scrutiny helped unveil broader social sustainability outcomes beyond inclusivity.

4 | RESULTS AND ANALYSIS

In this section, we analyze citizen participation in different NBS contexts and how it translates into sustainability outcomes. Section 4.1 describes patterns of citizen participation in different NBS domains and suggests some potential linkages between participation and sustainability outcomes. Table A1 in the Appendix provides this data for all 58 NBS cases. Section 4.2 highlights key factors that enable or limit citizen participation in different NBS contexts, including both structural and relational conditions. In terms of structural factors, we show that existing institutional structures typically do not create space for participation, while sustainability framing can potentially bring in unheard voices to NBS governance. In terms of relational factors, ruling power dynamics along with a lack of trust are barriers to the authentic engagement of citizens, while strong agency and mediators have proven to enable more democratic participatory processes.

4.1 | Citizen participation and sustainability outcomes in different NBS contexts

A range of cross-cutting patterns about the relationship between citizen participation and sustainability outcomes were seen in the studied cases. The most prevalent of these are:

- The most common type of citizen participation in NBS is collaboration; the majority of collaborative cases are in the domains of waterfronts, parks and greenways and related strategies.
- Deeper levels of citizen participation in NBS do not necessarily enhance ecological sustainability outcomes;
- Yet, they strengthen and diversify both expected and unexpected social sustainability outcomes.
- The most frequent social sustainability outcomes of citizen participation include knowledge mobilization, social learning, enhanced sense of belonging and greater motivation for environmental stewardship.
- Upscaling of sustainability outcomes particularly benefited from citizen participation in the water security domain.

The studied NBS cases exemplify all possible levels and forms of citizen participation, ranging from passive or tokenistic forms to more active participation, but skew toward the former. These are assessed for their relevance to NBS development and sustainability outcomes (Table 1). Notably, this classification is based on types and forms of participation led by institutional actors. This is also because municipality-led governance arrangements dominate our NBS sample. While municipalities are the key actors in strategizing urban greening, for actual implementation they often partner with other public actors, private businesses, NGOs and citizens. Citizens are often called to donate funds or labor (e.g., voluntary tree planting) to meet pre-set project goals (*collaborating*). In several instances, they are engaged in co-design workshops, citizen panels, or joint planning groups, which extend to more than one phase of the NBS (*co-deciding*). NGOs and citizen groups also engage through bottom-up processes and initiatives *(empowering)* that extends to advocacy planning, capacity development, social learning, and supporting livelihoods to increase citizens' decision-making power with special attention to vulnerable groups. Importantly, many NBS initiatives change levels of participation among project phases using a variety of forms across levels. Therefore, these findings and the categories below should be treated as suggestions, allowing flexibility both across participation levels and sustainability outcomes.

Our cases show that enhanced engagement does not guarantee ecological benefits, although it is correlated with social sustainability outcomes (Figure 1). The statistical analysis showed no correlation between environmental sustainability outcomes and participation levels (Figure 1; χ^2 test, $df = 4$, $\chi^2 \leq 5.6729$, $p \geq .2249$). However, social inclusion was strongly correlated with deeper citizen engagement (Figure 1; χ^2 test, $df = 4$, $\chi^2 = 28.246$, $p = .00001$); this result is robust to excluding the vegetated buildings and eco-district domains which never had any examples of co-decision or empowerment (χ^2

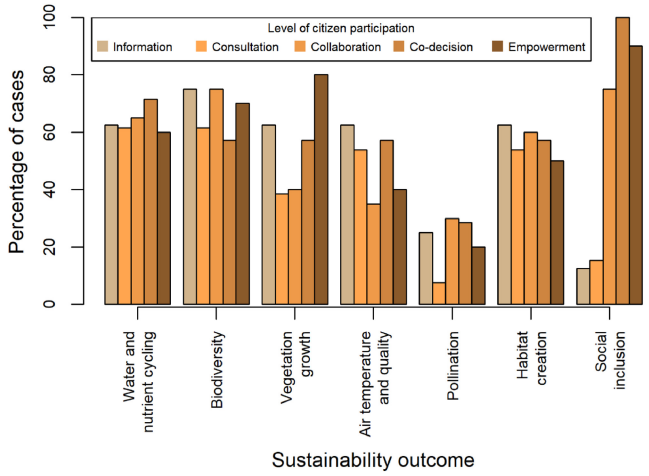

FIGURE 1 Citizen participation and sustainability outcomes. Percentage of cases achieving particular sustainability outcomes as a function of level of citizen participation. The first six categories are environmental outcomes (see main text) while the final category is the sole quantitatively-assessed social outcome. Among the levels of citizen participation, darker colors represent more extensive modes of engagement

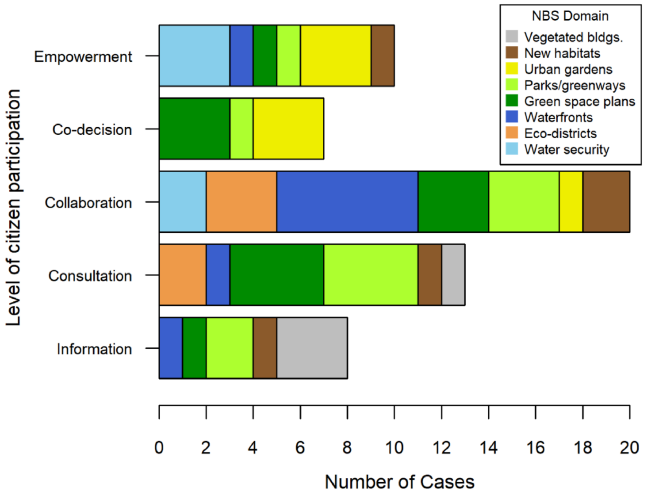

FIGURE 2 Citizen participation in nature-based solution (NBS) domains. The number of cases using different levels of citizen participation is on the *x*-axis. The engagement types listed on the *y*-axis are ranked hierarchically, from least (bottom) to most (top) engaging types. The colors within bars indicate the NBS domains

test, $df = 4$, $\chi^2 = 22.759$, $p = .00014$). On the other hand, the qualitative cross-sectional analysis suggests that initiatives adopting more co-creative, and less tokenistic engagement do offer more possibilities to achieve a wider range of impacts and more sustained change. While mobilizing citizens to achieve project goals may carry the risk of governmentalizing (Blakeley, 2010), it may also create opportunities for citizen stewardship, enhancing senses of belonging and leading to intangible outcomes in urban planning—a field with typically distant structures, rigid outcomes and slow processes. Results also show that engagement is more tokenistic around public green spaces and related strategies, waterfronts and eco-districts with flood-alleviation measures (see Figure 2). Participation processes, in these domains, are frequently in form of consultations, typically during the planning phase, and collaboration stretching from planning to implementation. In some cases, however, ecological sustainability does go along with functional or instrumental engagement. The following section provides examples of such linkages.

4.1.1 | Deeper levels of participation for water security and urban gardens

Despite the lack of statistical correlation between participation levels and environmental sustainability outcomes, the cases discussed below show that deeper participation can go along with ecological objectives. This is particularly true when these are among the intended NBS aims which citizens have actively shaped. The ecological impacts in question are linked to social and cultural impacts of NBS, such as increased awareness of local environmental features and history and traditional practices. In these cases, the interconnectedness between people and nature reinforces sustainability impacts and shapes the foundation for sustainable livelihoods. This is especially true for projects in the fields of water security and urban gardens.

In Mexico City, the *Water Forest* and *Chinampas for ecosystem restoration* initiatives strived to avoid ready-made top-down approaches. Local communities collectively govern their extensive lands in a context of weak law enforcement while actively developing, defending and enforcing sustainable livelihoods. Traditional community practices there contribute to provisioning and regulating ecosystem services, like water purification, flood regulation, carbon capture, temperature regulation, and habitat provision. Similarly, the *Atlantis Water Fund* (Cape Town) aims to ensure water supply by training and employing women in water preservation and invasive species removal from catchments. This social enterprise approach empowered women to become change makers in local communities with a sense of environmental stewardship, and also helped create locally run businesses by saving on water management costs.

The strongest association between social inclusion, deeper forms of participation and ecological sustainability outcomes was however observed for community gardens (in Barcelona, Győr, Athens, Dublin, Leipzig, Utrecht and Winnipeg). Most of the gardens studied here had small but tangible space-specific contributions to biodiversity preservation, the provision of green space and associated ecosystem services, and sustainable food production. These sustainability impacts intertwine with less tangible benefits like the social inclusion and integration, health improvements, and environmental education and awareness. Our research also indicated that urban gardens are a place for generating and retaining local and traditional knowledge, which frequently fostered community cohesion, especially where different socio-economic backgrounds mix. Tension and conflict often accompanied establishment of these NBS (Kotsila, Anguelovski, et al., 2020),

alluding to the social, hands-on, participative, discursive and political aspects of urban nature.

4.1.2 | Collaboration for sustainable waterfronts

Collaboration is the most common level of citizen participation in our data set (Figure 2). Up to one third of the cases with collaborative forms of participation are waterfronts. One example is the Munich *Isar Plan*. The primary goal was to transform an 8 km urban waterway from a highly engineered canal into a river with a more natural shape and function. Citizen participation there took place through a structured consultation process with the general public—mostly in the design phase, followed by a more collaborative process in the planning phase with a number of NGOs. Citizens' preferences were collected through interviews, helping guide planning for ecological, esthetic, and recreational preferences and led to some compromises. For instance, younger respondents preferred gravel banks for better access and older generations desired more grassland, which ultimately led to widening the river by 30% while maintaining 60% of the meadows. Citizens' opinions also led to a closer-to nature solution rather than gray infrastructure along a 1.5 km urbanized river section. This in turn made the riverside a popular place to live or visit. While these practices contributed to the NBS' delivery of expected climate adaptation, biodiversity, accessibility and recreation outcomes, they could not prevent all negative aspects of the inevitable growth of riverfront tourism.

4.2 | Conditions enabling and limiting citizen participation

NBS of all domains emerge in complex systems of institutional structures, governance arrangements, financial mechanisms, policies, practices and norms. Depending on the context, these conditions can limit or enable types and forms of participation (Table 2). These conditions lie at the intersection of municipal politics and practices and citizens' personal background, environmental awareness and beliefs (Wamsler et al., 2020).

4.2.1 | Limiting condition 1: Existing institutional structures and power relations

Existing institutional structures with formalized decision-making power relations often impede sustained and effective involvement of citizens as equal partners. Legal requirements for citizen engagement are usually limited to information provision and public consultation. Therefore, the way citizens are consulted largely depends on the interest or goodwill of powerful actors in NBS governance. These actors rarely want more than public approval, legitimacy for already decided plans, or simply an outlet for concerns. When participation is a box-ticking process, citizen engagement is virtually nil. A lack of professional staff with sufficient time, knowledge and experience also impedes public participation processes, while threatening the longevity of initiatives, and creating an uneven playing field (cf. Estrada et al., 2020; Kotsila, Hörschelmann, et al., 2020). This limitation is particularly apparent in large-scale NBS greening projects led or influenced by businesses viewing citizen involvement as counterproductive and less profitable. Some of the multiple structural barriers to achieving co-deciding or empowering forms of participation (Table 1) are described through the case studies below.

In Athens, the re-development of the *Hellenikon Metropolitan Park* was publicly consulted in a tokenistic way. The consultation allowed for only 30 days to provide feedback on a highly technical (2500-page) document, and no substantial changes in the initial design were considered despite suggestions from citizen organizations and academic associations. In Tianjin, *Ecovalley project* leaders allowed minimal public participation via a post-implementation online survey. Munich's *Climate Adaptation Strategy* consciously avoided citizen participation until its implementation, obstructing meaningful civil engagement. Likewise, while public consultations were binding in the planning phases of *Parc Marianne Eco-district* (Montpellier), *Little France Park* (Edinburgh) and *Porous Alley* (Boston), leaders regarded them as (potential) barriers to the further project development. This said, in most of these cases, local communities were not well-organized which limited their eventual engagement and follow-up with the design process. This was also the case in the *Passeig de Saint Joan Green Corridor* (Barcelona), where weak community organization at neighborhood level allowed businesses with a direct financial stake

TABLE 2 Limiting and enabling conditions of citizen participation for sustainability outcomes

Limiting conditions	1. Existing institutional structures and power relations	The constructive and sustained involvement of citizens can be constrained by existing institutional and power structures, such as lack of supporting policies, resources, non-supportive working structures, and traditional planning practices.
	2. Lack of trust and accountability	Lack of trust, accountability, or relational capacity and pre-existing conflicts or conflicting interests can impede effective engagement of citizens, which in turn influences sustainability outcomes.
Enabling conditions	1. Strong agency and mediators	Community activists, associations and NGOs (advocacy coalitions) are key actors to provide alternative means to achieve sustainability outcomes, often through trust-building, resource-mobilization, and knowledge development, resulting in empowerment.
	2. Political agendas and sustainability framings	Citizen-inclusive collaborative governance gains increased attention to sustainable and just cities' political agendas and sustainability framings, enabling multiple benefits for a variety of actors.

in the project to capture and dominate the informative and consultative meetings organized by local district authorities. Eventually locals lost out on a potential design with a larger and less-commercialized green space.

When collaborating organizations have financial interdependencies or project goals favor powerful interests, other types of compromises arise. The *Greening Office* (Munich) is an independent operation under a well-established NGO, but depends heavily on municipal funding. This institutional structure has shifted the Office from engaging with citizens on greening strategies to working only with professional actors. Institutional rigidity was similarly apparent in Dublin during the implementation of the *Liberties Greening Strategy*. When planners intended to include gardeners, who had occupied land in Bridgefoot St. Park, tensions arose over the terms of co-management structures. This process revealed conflicts between the rigid park-management structures and the more flexible governance requirements of community gardens.

4.2.2 | Limiting condition 2: Lack of trust and accountability in neoliberal set-ups

Lack of trust often impedes effective citizen engagement. Rifts between civil groups and municipalities, poorly designed public consultation strategies, histories of failed civil cooperation or pre-existing contestations, and the perceived sense that consultation will not affect a proposed plan largely limit public participation.

In the *Newcastle's parks* case, the municipality and a research lab conducted a two-stranded consultation process. Citizens felt that the approach was a top-down exercise to gain legitimacy for the plan rather than to truly engage with the ideas and concerns of different fractions of society. The consultations focused solely on implementing a new business model for city parks despite citizen and community groups' request that the city fund parks as public goods, and concerns about creeping privatization and commercialization. Civil groups worried that the charitable trust's proposal to run the parks would not be democratically accountable. In this context, applying austerity-driven governance models meant the new business plan for the management of the park was primarily evaluated for its financial performance.

In Barcelona's *Collserola Park*, despite an inclusive small-group format, meetings for citizens to comment on the new expert-drafted management plan, participation was obstructed by last-minute engagement, poor dissemination, low turnout and a non-negotiable meeting agenda. Similarly, investor-led co-design workshops around the *Two Rivers Urban Park* (Cape Town) constrained participation and led to limited engagement. In response, neighborhood associations and NGOs initiated an independent participation process, developing an alternative scenario that stood in stark contrast to local and provincial governments' vision of a densely populated residential area. Ultimately, the engagement process was restarted under a new legal public participation framework, whose results are yet to be seen.

4.2.3 | Enabling condition 1: Strong agency and mediators

Mediators can help address some of the limiting factors identified above, even when institutional structures and social inequalities are difficult to tackle. These can be institutional actors like municipal staff managing and lending expertise to participatory processes, NGO representatives, social entrepreneurs, community organizers and activists. Mediators facilitate communication among interests and perspectives, while also seeking to mitigate power differentials resulting from unequal expertise and material resources like funding and finance, organizational space, lobbying power, access to published materials and media networks.

Trust building through mediators

Some NBS actively address mistrust among actors by experimenting with new governance structures for more genuine engagement with citizen groups. This is particularly relevant in zones with pervasive corruption. The *Water Forest* initiative (Mexico City), for example relied on a committed individual, who worked toward building a coalition to restore local forests. The personal trust- and relationship-building approach among communities, subsistence farmers, NGOs, academics, and government officers culminated in federal and state recognition and protection for the NBS.

The *Water Funds* multi-actor projects in *Mexico City and Cape Town* initiated by a large-scale conservation NGO arguably provided a more trustworthy format to sustainably manage the local water systems than formal governmental structures. Besides unlocking private funding, they fostered interaction, contributed to the development of shared visions across agencies, and perhaps slightly influenced political dynamics. This said, engaging with multinational companies in developing and funding NBS (like in the case of the *Mexican Water Fund*) can contribute to greenwashing by obscuring other socially, or environmentally unsustainable actions.

NGOs have also taken trust-building roles in waterfront-related NBS. In case of the *Isar Plan* (Munich), an alliance of Germany's largest NGOs represented citizen groups in the joint planning group and helped align ecological and social (recreational) interests in the river's re-naturalization process. The engagement of an NGO, however, does not guarantee trust-building. *Restoration of the Luppe River* (Leipzig) intentionally renegotiated workable division of tasks and physical spaces between the municipality and an NGO, who shared federal funding. The NGO was "brought in" to help gain trust and community support for the project (e.g., by organizing events, raising awareness of the project's implications, managing citizens' aspirations and concerns). It also pressured the city to engage with a wider sustainability discourse on social, environmental and economic implications of the river's restoration. Nevertheless, public authorities chose technical flood protection measures favoring local water utilities over the NGO's comprehensive river re-naturalization recommendations.

Lobbying and resourcing through civil society action

Civil society organizations can initiate and oversee NBS projects in attempts to counterbalance particular types of inequalities. In some

cases, the pressure of civil society organizations catalyzed municipal engagement with greening strategies (e.g., in Boston, Dublin, Leipzig, Sofia). In other cases, civil society organizations adopted community management roles within NBS projects, which commonly included planting, cleaning up, and environmental education.

The *East Boston Greenway* had a grassroots origin. Local residents formed the Friends of East Boston Greenway to lobby city agencies to convert an abandoned railway into a green amenity for the community. The citizen mobilization there is actually tightly linked with a historical neighborhood fight against the noise and territorial expansion of a nearby airport. After the corridor's ownership was transferred to the City of Boston, maintenance responsibilities were distributed among various public agencies, including the local association. Yet, the NBS is currently nested in an East Boston gentrification trend (also driven by its green profile) to the detriment of socio-economically vulnerable residents.

In Leipzig, civil society organizations have long advocated for more green space, leading to municipal strategies like the *Roadside Tree Program*. The civil groups have also contributed to environmental awareness-raising activities and facilitated the identification of tree-planting locations with local residents. This process has created a new collaboration pathway and contributed to building trust between the city administration and civil society groups. This said, lack of structural and policy support and land-ownership conflicts can hamper NGOs' activities. In Sofia, a civil society group initiated a new park as a way to address high levels of atmospheric contamination *(The City Forest)*. The group undertook visioning, planning, coordination, and fundraising activities, while actively searching for municipal support for future greening actions. Confronted with the limited interest of public authorities the civil society's enthusiasm faded away, along with trust in local institutions, and the NBS has not achieved its multifaceted sustainability objectives.

Knowledge and livelihood development through activist academics

In grassroots initiatives, such as the *Chinampas* in Mexico City and the *seawall projects in Sendai*, activist academics help enhance ecosystem services through local knowledge and traditional practices. Mexico City's *Chinampas* (traditionally cultivated places) located on heritage sites suffer regulatory confusion, undermining protection efforts. Recognizing this, academic activists along with conservation organizations engaged with *chinamperos* (traditional cultivators) to maintain sustainable practices, and find livelihood-supporting markets. Importantly, this got decision-makers' attention to rework related policies and resolve the regulatory unclarity.

Similarly, in Sendai, environmental academics lobbied to conserve ecosystem services, while engaging with local communities in the context of a top-down technocratic government. After the 2011 earthquake and tsunami, the Japanese government has built hundreds of kilometers of concrete seawalls along the east coast of Honshu, heavily disrupting coastal ecosystems and livelihoods. Through engagement of committed individuals, some seawall segments and adjoining municipal lands are spared for experimenting with natural revegetation. Local volunteers have joined the effort, planting vegetation and re-starting traditional forest management practices (*satoyama*).

4.2.4 | Enabling condition 2: Political agendas and sustainability framing

Official political agendas around sustainability are increasingly concerned with social inclusivity. Many NBS now experiment with citizen-inclusive collaborative forms of governance, involving a variety of actors, with different decision-making powers and institutional or cultural settings. These NBS are often led by municipal authorities in partnership with intermediaries and/or civil society organizations, who lead or facilitate citizen engagement. Some projects aim to go beyond legally established participation minimums, incorporating people of different needs and socio-economic status (e.g., Malmö, City of Melbourne, Boston).

Citizen-inclusive collaborative governance was actively supported by the sustainability framing and public funding in *EcoCity Augustenborg* (Malmö). The municipality consistently, informally and creatively engaged citizens by employing a community manager and local residents in all NBS phases, organizing workshops and community events, and supporting various social integration-oriented grassroot initiatives. Learning from this, district authorities and municipal strategies have gradually adopted participation practices (Kiss et al., 2021). Sustainability framing, however, made the area more desirable, and at risk of gentrification.

The City of Melbourne's *Urban Forest Strategy* also takes a multi-level, open and collaborative governance approach. Its design and implementation balance technical expertise and local (citizen) knowledge. The municipality actively sought input from frequently ignored voices, such as children, the elderly, and socio-economically diverse populations, and trained citizens to become urban tree experts. The different activities slowly contributed to trust-building, which facilitated an informed resource allocation, enhanced environmental learning, built a sense of place (Bendt et al., 2013) and fostered citizens' rights and responsibilities (Buijs et al., 2016; Fors et al., 2015; Williams, 2014).

In this vein, the Barr Foundation's *Waterfront Initiative* in Boston works toward equity and justice, facilitating access of vulnerable or socially unprivileged individuals to Boston's waterfront. However, structural inequalities, such as who can afford waterfront property, remain unresolved.

These enabling factors have limited impact where rigid structural conditions and power distribution elevate rent-seeking behavior above vulnerable communities' needs. Mediators, civil society lobbies, activist researchers or justice-oriented politics and governance approaches can only moderate the unevenly borne costs and benefits of NBS. Transformational change in the field of NBS is therefore not only a question of "bottom-up" versus "top-down" styles of management, but an emergent process of awareness building pressuring changes at all organizational levels.

5 | DISCUSSION

The cases presented in this study show that deep citizen engagement can benefit, but does not guarantee, achievement of sustainability objectives. In the following sections, we discuss how power dynamics, reflexive governance and citizen empowerment each affect sustainability outcomes in unique ways.

5.1 | Power dynamics in a neoliberal status quo: Limited engagement, compromised outcomes

Though the level of engagement of civil actors depends on many historical, social and geographical factors, the neoliberal turn in nature governance justifies and deepens mistrust in institutional processes and politics (Castree, 2008; Kotsila, Hörschelmann, et al., 2020). Public participation is then often captured and encapsulated by neoliberal logics that subordinate ecological and social goals (inclusiveness, democracy) to economic/financial objectives. Some emblematic examples are *Newcastle's new park management model*, based on a charitable trust acting as a social enterprise yet outside democratic accountability; the *Hellenikon Metropolitan Park* in Athens, which emerged amid pressure to privatize public property and attract investment during an economic crisis. As a result, land was sold for a fraction of its value to international investors and developers, with questionable benefits for the Greek public; the *Water Fund* in Mexico City developed in collaboration with private investors, with questionable transparency about their responsibilities for a common public resource. Likewise, the *Stavros Niarchos Foundation cultural centre* (Athens), was a non-profit foundation's donation to the Greek state under a specific legal framework. The project's huge maintenance costs now represent a huge burden for the state.

In all these cases, citizen participation is tokenistic, aimed to legitimize governments' decisions without delivering a transparent, accountable and democratic process, contributing to environmental injustice. These processes deepen distrust, non-cooperation and civil disinterest, (Meijer, 2016; Woroniecki et al., 2019), which handicap the sustainability of future participation processes and democracy in general. Such examples demonstrate how decisions favoring rentier-oriented profit-seeking undermine transparency, accountability, justice and democracy, particularly around costs and benefit distribution. Creating and defending spaces for open discussion and unveiling, acknowledging and rethinking power relations are essential to counteract consequences of neoliberal governance (Sekulova et al., 2021).

5.2 | Nurturing reflexivity and creating a new culture of participation

Giving citizens real control, through "co-decision" and "empowerment," is one of the underlying proposals behind reflexive governance. Beyond top-down approaches that perpetuate unequal power relations, reflexive governance engages a set of actors with diverse and divergent views urging all involved to reconsider their assumptions and practices. If applied in an authentic manner, reflexive governance could lead to deeper forms of engagement carving the path toward a more just and sustainable urban development (e.g., van der Jagt et al., 2021). Nurturing and sustaining reflexivity is challenging, but crucial to generate a culture of participation, especially *within* public institutions (Voß & Kemp, 2006).

Some of our cases contain seeds of reflexive governance practices. NBS in the City of Melbourne, for instance, showcase that it is possible to transform current institutional structures into partnerships, and proactively engage with citizens in challenging discussions on urban re-naturing and climate resilience (Coenen et al., 2020; Gulsrud et al., 2018). Place-based storytelling created space for collaborating actors "to affect the construction of the objects of governance" (Feindt & Weiland, 2018, p. 663), while allowing them to continuously question and adapt to the changing environment. This process has promoted ecological sustainability outcomes, inclusion of vulnerable groups in decision-making, and continuous learning about the unintended (often negative) consequences of existing sustainability approaches. By legitimizing diverse and contested local perspectives on urban ecosystems, the City of Melbourne facilitated knowledge co-production and reflexive decision-making (Cote & Nightingale, 2012; Gulsrud et al., 2018).

Involving diverse civil society stakeholders in all project phases is crucial though challenging in large-scale NBS, such as waterfronts, parks, greenways and eco-districts, embedded in traditional urban structures. The Munich *Isar Plan's* iterative, interdisciplinary and participatory goal formulation and strategy implementation pooled resources from disparate actors. The public supported re-establishing the river's alpine character while enlarging its banks, keeping flood meadows and existing vegetation and improving access for different community groups. Yet it overlooked long-term impacts on the neighborhood, like more visitors and gentrification. Systematic analysis of long-term effects through deeper engagement and deliberation, could have forecasted, prevented, or otherwise addressed social inequality.

5.3 | Relational and structural capacities to foster empowerment

Overall, our qualitative observations indicate that deeper forms of citizen participation could address social inclusivity challenges in NBS. Deeper engagement is particularly important in sustainability planning where local knowledge on socio-eco-technical systems is held by non-experts whose voices are often unheard: young or elderly people and ethnic minorities. Our study suggests that socio-cultural and demographic groups vary profoundly in their preferences and patterns of NBS use. The way these can be empowered is very context specific. If "power" is defined as "the ability of actors to mobilize resources to achieve a certain goal" (Avelino & Rotmans, 2009, p. 550) and "empowerment" as the process of

gaining power (Avelino & Wittmayer, 2016) or decision-making capacity (White, 1996), the conditions for unfolding these processes require attention.

Many of the conditions that hinder participation are structural. Participation is before all time-intensive, making it accessible for a limited number of time-privileged individuals. Likewise, having information access and co-creation capacity often limits participation to those local residents with particular social skills or abilities. These competencies (e.g., disciplinary training, language and computer skills, public speaking, argumentation, writing) can be an asset, but also a form of privilege, creating exclusion.

Whenever NBS act as environmental "fixes" subordinated to the logic of economic growth (Kotsila, Hörschelmann, et al., 2020), authentic civil participation is a virtually non-existent. Driven by neoliberal austerity logic, governments often cede power to NBS promoters whose interests predefine an intervention's vision of nature. Institutions and local communities can have very different visions of urban nature. Such clashing views can grow from histories of racism, exclusion, and dispossession; involved actors are not always prepared to productively deal with these emotionally laden complexities (Mair et al., 2019). For instance, indigenous communities were focal actors for the Mexico City *Water Forest* initiative, but were initially excluded, and ended up contesting the grounding and validity of this NBS. Acts of resistance are important for climate governance, not only to open spaces for new "forms of nature," but also for ways of engagement that return resources to community control. To develop relationships of mutual trust with civil society and citizens, decision-makers need new qualities and relational capacities, ones that consider subjective personal views (Wamsler et al., 2020; Wamsler & Raggers, 2018). While outsourcing trust-building to mediators and NGOs is a common practice in NBS management, internalizing and institutionalizing mindful decision-making have a greater potential to eliminate personal insecurities that currently impede deliberate governance, and just sustainability.

6 | CONCLUSIONS

Amidst increasing calls for collaborative governance to support sustainability transitions, there is little empirical evidence regarding the actual contribution of diverse forms of citizen participation to achieve sustainability objectives (see e.g., Hegger et al., 2017; Mees et al., 2019; Wamsler et al., 2020). This paper addresses this gap, finding clear equity benefits, but unclear environmental outcomes. The poor association between environmental features (such as vegetation growth) and citizen engagement holds especially strong for tokenistic (information provision, consultation) and collaboration-based forms of participation.

We find that the equitable distribution of NBS gains across social groups and places, or distributive justice, is deeply related to how participation is enacted. While the structural barriers to deeper levels of participation (hence co-decision and empowerment) in NBS are hard to overcome, the process of citizen engagement could bring out new and transformative voices and narratives. Tapping this potential requires recognizing and creating multiple arenas for discussion and dialog. Reflexive and collaborative governance approaches involving heterogenous sets of actors could tackle wicked socio-environmental problems, by acknowledging and questioning existing power relations and the neoliberal status quo. In this sense, acts of contestation and resistance against NBS initiatives represent fertile learning grounds for rethinking the economic models that drive urban greening, and for identifying the times and places where new, more inclusive, just, lasting and reflective forms of socio-natures can sprout. In that sense, deeper forms of participation need to represent an equal element of the sustainability transitions, along with reaching climate and biodiversity targets.

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APPENDIX

TABLE A1 Citizen participation in 58 nature-based solutions in 21 cities[a]

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
Vegetated buildings	Stavros Niarchos Foundation Cultural Centre (Athens)	The first large-scale sustainable public building in Greece, run by a public-private partnership; its board is appointed by the government.	Visitor Centre in the construction phase to inform the general public. Possibility to send post-implementation feedback via e-mail.	Due to the governance arrangement, limited ecological outcomes, limited access to the general public. No citizen inclusion in or influence on sustainability outcomes.
	Belvedere College—Urban Aquaphonics Farm (Dublin)	Run by students with the help of trained personnel, testing sustainable farming, providing education and practical experience.	Started by a school teacher, in the initial phase in collaboration with a successful grassroots community garden in an unprivileged neighborhood.	Including sustainability in the curriculum and learning sustainable farming techniques. The initial knowledge exchange with the community garden ceased due to class differences.
	BiodiverCity (Malmö)	Municipality-run project (2012–2017) to increase biodiversity via new products, services and processes, through 30 pilot cases of urban biotopes, green roofs, green walls and mobile plant systems.	Designed and implemented in multi-disciplinary working groups through collaborations among ecologists, landscape architects, scientists, entrepreneurs and building developers from different private and public organizations, but no collaboration with citizens.	Good ecological outcomes and basis for evaluation, learning, and dissemination of innovative urban greenery among practitioners, with the trade-off of social exclusion. In a few cases local residents have been informed and/or consulted.
	Château le Lez (Montpellier)	One of the city's first vegetated buildings (2000) initiated by architects, serving as a model for green buildings.	No participation; diverse residents in terms of age, gender, political views, but not in terms of economic status.	Limited ecological impacts; due to the broken watering system, not all kinds of plants can grow on the facade. Due to enhanced neighborhood esthetics was unaffordable for low-income people.
New habitats	John Muir Pollinator Way (Edinburgh)	Implemented by an NGO in partnership with local authorities and other NGOs aiming for sustainable insect populations by creating green spaces (e.g., schools, parks, churchyards) along an existing 215 km walking and cycling route.	Mapping and first steps of implementation have been done together with citizens and other local stakeholders. Through educational packages, local schools are involved in long-term implementation and maintenance.	Although no evaluation has been done yet, both ecological and social outcomes are promising, through the participation of schools and volunteers, along with additional benefits of e.g., increased well-being of school kids from socially-deprived areas, increased environmental awareness, stewardship.
	Square meter for butterflies (Edinburgh)	Run by the Royal Botanic Garden Edinburgh and the Butterfly Conservation Trust in partnership with businesses (2016-) to create a green network of rooftop habitats for threatened butterflies.	Participation of employees is encouraged by giving ecology-oriented training to partnering organizations to monitor butterflies on the roof gardens. As these are mostly private roofs, there is little engagement with a wider public.	Engaging with businesses limits accessibility for the general public, but provides deeper ecological knowledge development and awareness raising for employees. Organizational learning for the conservation trust on engaging with urban residents.

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	Beekeeping at Audi Hungaria (Győr)	Privately-funded project (2015) on the factory site in collaboration with the University of Sopron, includes aspects of ecosystem management with native species, awareness raising and education.	Participation is through awareness raising and sensitization of employees, education of school children through interactive workshops, and honey branding.	The core initiative has been complemented by pollution-reduction research, using bees as bioindicators.
	Beehives in the city center (Newcastle)	Community-led initiative, honeybees at a number of locations in the city, including church roofs, university sites and a retail store. Resource-mobilization via grants, membership fees, charity events and donations.	Citizen-led initiative, though citizens belong to certain organizations, e.g., churches, schools. However, beekeeping actors did not consult the general public about the initiatives.	Valued social outcomes include community cohesion, presence of beekeepers in the community and ecological learning. New technologies from the University of Newcastle help monitor the health and productivity of beehives. Locally-produced honey is also appreciated by the different communities.
	I have a bee (Sofia)	Started up by three enthusiasts who offer "amateur-type" hives to hobby beekeepers to install in backyards and terraces (2015) to address pollinator decline.	Citizen participation through volunteers offering a product-service system; start-up package includes beehive, delivery, bee family, settlement, accessories, instructions and 1 year free-of-charge professional advice.	Additional benefits include awareness raising about bees and related ecosystem services, recreational activity. Despite a high number of Facebook followers (10,000), there were few actual investors (50).
Urban gardens	Municipal gardens—Marousi and Agios Dimitrios (Athens)	Municipally-assisted community gardens (2012) with the aim to provide relief for vulnerable groups, strengthen social solidarity and mental health—through two different participation models.	A mix of non-vulnerable and vulnerable groups (i.e., unemployed, retired, low-income, single-parent and large families) practice organic gardening based on either the individual- or the collaborative-plot model. In the latter case, the plots, produce and yields are shared.	A mix of ecological, social and cultural benefits have been achieved, including organic food production, increased soil fertility, reduced erosion, changing behaviors, increased contact with nature, enhanced solidarity, collaboration and education.
	Pla Buits urban gardens (Barcelona)	An urban space co-management (or social entrepreneurship) initiative fostered by the City Council that gives opportunity to public entities and non-profit organizations to develop temporary uses (3 years) of unused spaces to promote social activism and cohesion in different city neighborhoods.	Truly participatory intervention—for locals only, especially local family groups, which are organized through a civic center and associations working with social exclusion. Participation in gardening activities varies from garden to garden, some limited to members, others welcome new people. Member profiles vary by gender and social class, but not national/ethnic origin.	The socio-cultural and ecological benefits, including educational and health gains, awareness-raising about food production and consumption and community enhancement, (e.g., meeting place, food growing, social bonding), outnumbered the typical constraints. However, due to language or cultural limitations, immigrant families did not participate.

(Continues)

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	School gardens (Győr)	A dozen interconnected grassroots and self-governed initiatives emerged since 2013 being implemented by teaching and learning communities across the city as a tool to enhance sustainability education.	Teachers, school staff, students and their parents are often involved in the visioning, planning, designing of school gardens, they also contribute materials. Kindergartens, elementary schools, and universities. The Foundation for Hungarian School Gardens organizes trainings and knowledge-exchange events.	Although there are observable biophysical impacts, including lush vegetation improving the microclimate, the real impact lies in education, awareness raising, community-based working, sensitization, social relations. Creative learning environment, living laboratories with interdisciplinary lessons.
	Green spaces in East Quarter (Leipzig)	In collaboration with the city and other stakeholders, two communal gardens were initiated by citizens to retain green spaces in the process of revitalizing one of the most structurally disadvantaged, yet most culturally vibrant areas through ecological and social activities, social cohesion and interaction.	The gardens are open to all residents, but particularly those without access to private green space/ gardens, residents from migrant communities and children and youth from nearby schools and from disadvantaged socio-economic backgrounds. Gardening, workshops, trainings, cultural events and collaboration with child-care centers.	Social integration, cultural interaction, safe spaces for new residents (including refugees) with associated therapeutic values, leisure, enhanced well-being. Retention of green spaces, raised area profile. Educational and social values: sustainability trainings (e.g., local plants, biodiversity, bee-keeping), engagement with community politics, food provision. Long-term network of refugees is hard to maintain.
	Food for Good community garden (Utrecht)	A bottom-up, community driven organic vegetable garden emerged as a partnership project between three foundations in 2012 on public land with the aim to provide social care to vulnerable people with support needs through sustainable food cultivation.	Participation through enhancing connections of vulnerable people from different backgrounds (who have become disenfranchised from society because of their age, disability or personal circumstances) to nature (food growing), to themselves (work therapy) and other socio-cultural groups (integration).	Environmental stewardship and social care: sustainable food cultivation as a tool for self-development, well-being, recreation, community building, employability skills, ultimately leading to societal reintegration. Biodiversity benefits, neighborhood esthetics, and empowerment.
	Roerplein pocket park (Utrecht)	An initiative of Utrecht municipality's Neighborhood Green Plan to support neighborhoods' bottom-up small-scale greening (public-citizen partnership).	The participatory process was assisted by a social entrepreneur (flyers, door-to-door visits, meetings), which resulted in a citizen-initiated self-management group of local residents that later turned into a formal foundation to maintain the garden. Local schools also provide stability in terms of developing ideas and as a user group.	Increased social cohesion, community identity, and increased neighborhood attractiveness, reduced vandalism. Environmental education and knowledge development. Improved relations between locals and municipality. No ecological evaluation (heat stress, biodiversity).
	Indigenous nature-based solutions (Winnipeg)	Community-led neighborhood plans, through which neighborhood associations use vacant urban spaces and encourage indigenous communities to maintain green leisure	Plans are created through focus groups, consultations, meetings, surveys and community testimonials. Neighborhood associations working with disadvantaged, urban indigenous communities in 12 community gardens, gardeners (60% indigenous) involved in planting,	Building community resilience, crime reduction, nurturing living environment, through e.g., using traditional knowledge in food production, land-based education, traditional events, knowledge center for partnerships with experts, supporting women developing collaborative, innovative social

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
		spaces, "tot lots," and a network of community gardens on public land with support from partnering businesses and organizations.	maintaining, and harvesting food. Collaboratively designed community-led indigenous "healing lodges" help at-risk indigenous youth heal from trauma and build resilience.	enterprises. Incorporation of indigenous perspectives into urban development.
Parks, urban forests and greenways	Passeig de Saint Joan (Barcelona)	The redevelopment of the downtown promenade into a green corridor was a municipal initiative to increase ecological and social connectivity.	Targeted consultation of local actors (citizens and businesses) in the implementation phase via events, meetings and feedback emails.	The climate goals were reached, but due to the dominant participation of local businesses, a sidewalk-style avenue was implemented where green space serves the private sector.
	Porous Alley (Boston)	A public-public partnership runs this pilot project for flood prevention under joint funding from the city and environmental state grants.	Consultation in the design and implementation phase via open space meetings, presentations, face-to-face consultations. Focus on information provision and inquiry about citizens' concerns.	Although there was an educational element required by the funding, it ended up focusing on citizens' concerns about parking, noise, and potential basement flooding.
	East Boston Greenway	The land of the former railroad is owned by the city and the airport operating corporation. Maintenance is distributed among public agencies across the sections of the greenway.	Citizens were engaged via the Friends of East Boston Greenway NGO throughout from project appraisal to evaluation. The NGO is in charge of monitoring the work of the city and engages with the community via clean-up and planting activities.	Citizens are stewards of the area, developing a sense of place and responsibilities over urban nature. The NGO oversees the city's work as it further develops climate resilience infrastructure along the greenway. Gentrification dynamics are underway.
	Two Rivers Urban Park (Cape Town)	Two different proposals were circulated by external consultants, government agencies, academic think tanks, and grassroots community for the development and governance of the area.	Contestation of the scale and impact of development. Locals were engaged through an intermediary in an interactive and inclusive co-design workshop process in the planning phase. According to a new law public participation is legally required, but its form is still unknown.	The co-design workshops resulted in a third new plan, which was more or less favored by the citizens, but the new law halted its implementation. It tapped into discourses of values for nature, gentrification, economic development, and participation.
	Liberties Greening Strategy (Dublin)	This municipal strategy seeks to improve the recreational amenities of the Liberties area through creating new green spaces (parks) as opposed to further housing development.	Consultation from visioning to implementation (brainstorming, list of choice workshops) led by landscaping companies with attention to communication and timing to ensure inclusivity. Before planning, citizens campaigned for more green space.	Community cohesion, sense of place. Weaver Park reflects the community's demand. For Bridgefoot Park, despite the envisaged co-management model, the process was high-jacked by "cultural gentrifiers," leaving out the initiating gardeners.
	Tolka Valley—wetlands and greenway (Dublin)	Municipality-driven water treatment wetlands and off-road cycling greenways to connect neighborhoods while offering ecosystem services in the vicinity of a newly-built housing complex.	Extensive public consultations with residents' and recreational associations on the biophysical and economic challenges (e.g., floodplain not suitable for use as a soccer pitch, fishing spots) in two stages. Contestations on linking different socio-economic communities affected fencing (hedgerows). Well-off residents feared opening up to "anti-social behaviour" in the park.	While the 1st stage was inconclusive (2005), the 2nd stage resulted in an agreement (2009–2010), accommodating divers local desires, including both active (e.g., soccer fields) and passive (e.g., biodiversity-orientation) recreation. Biodiversity increased, (vegetation diversity, hedgerows, trees, wildflower meadows, invasive species control). Flood control via soft engineering. Water quality increased.

(Continues)

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	Little France Park (Edinburgh)	Municipally-initiated, public-private partnership, led by a trust to develop new parkland for a socio-economically disadvantaged community in connection with the adjacent hospital and research campus (under construction).	Consultation in the planning phase was run in parallel by the city and the developers on design, functions, and layout of the park with the future aim to appoint a woodland engagement officer to engage the local community.	Citizen knowledge was sparsely used in designing green areas to provide most benefits. Recognizing the lack of community cohesion and activism, and split views on area development, the aim is to create a Friends of the Little France Park community group.
	Green and Blue Urban Network (Montpellier)	Municipal green plan, mapping and linking green and blue areas with a focus on biodiversity (habitat continuity and maintenance) to counterbalance ongoing urbanization, to improve urban living and the functioning of urban ecosystems.	Public meetings were planned to keep people informed of the different stages of the project and to take into account their ideas and comments.	Although the plan is to promote ecological continuity via local vegetation across the city, in reality, the city being very dense, the network is mostly outside the city, not fully connected, and changing priorities (e.g., promoting agro-ecology as biodiversity) contradict the original goals.
	Vrana Park Museum (Sofia)	The successors of the royal family partially donated the park to the municipality who opened it to the public (2013).	Volunteers and students are involved in maintenance and cultural, educational activities. The park is partly open for the general public (affordable entry fee), and citizen involvement in clean-up and maintenance is encouraged via well-established communication channels, e.g., easy to access website for volunteering.	Maintenance of a wilderness area biodiversity hotspot (untouched nature, rare species, historical significance). Increasing number of activists bringing new ideas regarding activities in the park. However, the park management and maintenance remain controversial and financially difficult.
	Wuqing District—Integrated green and blue infrastructure (Tianjin)	Based on national plans, the municipally-driven suburban "Garden City" development with rich ecological values (rivers, reservoirs, forest reserve) and over 36% green coverage. Pilot national ecological demonstration area (2014) for blue and green infrastructure projects.	No model for community participation in urban development, decisions are considered to be the domain of political and expert committees. In Wuqing, local residents were consulted when being affected by the proposed development (e.g., land-use change, refurbishment). NGOs go along with government plans. The use of public space, once completed, is organized bottom-up by local residents.	Positive ecological outcomes (green belts, green space per capita, green accessibility), but increased real estate values, hindering social inclusion. Uniformity in (1) who is involved in urban planning (young, childless men), resulting in under-represented public needs; (2) landscape architect models not considering ecological processes, (e.g., pollinators, birds).
	Community-based renaturalization (Winnipeg)	Over a dozen public areas in the city have been turned into greenways, wildlife habitats by local communities, supported by the municipal Naturalist Team and a network of change agents.	Participation management varies across the cases, some were initiated by the city applying extensive consultations, others were community initiatives, but most became community-driven and has empowered local communities and students (e.g., summer jobs through the Urban Green Team program—bridging the gap for the lack of volunteers).	Diversity of ecological and social functions, additional benefits of awareness raising and creating a sense of place. Land-use issues and maintenance practices (e.g., no mow) among different social groups as well as the lack of (human and financial) resources were major barriers to development.

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
Plans and strategies for urban greens	Hellenikon Metropolitan Park (Athens)	Private sector-driven mixed-use development spanning an important portion of the site of the former international airport, aiming to boost greenery and local ecosystems, while minimizing natural resource use.	Obligatory public consultation in the planning phase took the form of citizens' commenting on a technical document over a limited period of time. Expert group consultation with academia/architects.	Expert consultation resulted in promises of connectivity, reduced built areas, improved green corridors, social spaces. These benefits however risk being restricted to an elite audience. Some assessments conclude the development's overall negative contribution to climate change.
	Collserola Natural Park Plan (Barcelona)	Jointly managed by a consortium of public actors, including the Catalan government, Barcelona Provincial Council, Metropolitan Area of Barcelona and adjacent municipalities to increase the park's ecological, urbanistic and socio-economic values.	Multiple-stage consultation in the planning phase: (1) individuals' comments on published documents, (2) third-party organized municipal meetings with pre-set agendas, (3) meetings with interest groups.	Participatory meetings induced improvements in e.g., the participation process, including the needs for environmental awareness raising, attending to the plan's shortcomings, and new consultations; social goals—being contrary to environmental goals- might still be excluded from the draft plan.
	Environmental Education Trust (Cape Town)	A non-profit environmental education organization in partnership with the city, to improve the inclusiveness of urban nature reserves and the effectiveness of biodiversity conservation by connecting disadvantaged communities with municipal nature reserves via education.	Participation of low-income communities, who have previously been excluded from these spaces, through a "crèche to career" approach, youth environmental education in nature reserves, job skills training in the conservation sector, and employment in roles like conservation monitors. Environmental stewardship is a key form of practice.	Tackle the challenges of biodiversity protection and extremely high unemployment level, structural inequality offering opportunities to marginalized communities by mindset-change: showing children the different values of nature conservation, and offering skill training. Challenges include land use and sustenance (food and water access vs. conservation).
	Urban Tree Planting Programs (Leipzig)	Part of the municipal climate change program. Two tree-planting schemes responded to calls by environmental NGOs and citizens for more urban greenery and political pressure to improve air quality and reduce noise.	Roadside tree concept: third-party moderated public forums in the beginning and at the end of the project, one workshop in the middle; *Baumstarke Stadt*: collaborative involvement through donations from citizens and businesses. Tree locations recommended by citizens.	Citizen knowledge to select tree locations. Greening discourse (which the NGO continued running) to increase the municipal budget for tree planting. Activities open up to other environmental discourses and learning on citizens' rights, urban development. Tree planting interferes with existing gray structures.
	Tree Strategy (Malmö)	The vision of the municipality's recently-proposed strategy is to become one of the world's largest arboretums through attitude change.	Envisaged continuous city-citizen dialog. Functional participation through donation, tree inventories, and guided tree walks.	Knowledge dissemination on the values of trees among various actors. The long-term objective is to change individuals' attitude towards greenery and the urban nature discourse.

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TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	Urban Forest Strategy (Melbourne)	This strategy is a central part of the City of Melbourne's innovative overarching policy framework based on an ecosystem approach to climate adaptation with deliberate community engagement.	Multiple forms of collaboration throughout, including local forums, on-line infographics, an online tracking system for implementation progress, youth art competition, place-based storytelling, e-mail-a-tree campaign. Explicitly seeking out unheard voices via different platforms.	Social learning, reflexive governance, new ways of co-management of public spaces through stewardship building opening up to broader discourses: climate change, resilience. Organizational change: training for municipal staff about community management.
	Urban Forest Fund (Melbourne)	The city launched this fund to support new greening projects on privately owned land which entails 75% of the city's total land area.	Private people were involved in the design phase of the program. The fund targets privately owned real estates through partnering or donation (including from individuals) in the implementation phase.	Inclusion of businesses and private land owners, as new actors in municipal greening strategies, complementing policy for the public realm, with limited participation and ecological outcomes.
	Green Your Laneway (Melbourne)	Complementary to the Urban Forest Strategy, it addresses smaller laneways with the potential to become the city's backyards with active citizen engagement.	Consultation with the broader public in the planning phase via the "Participate Melbourne" homepage. Visioning phase: individual meetings, design workshops. Implementation: face-to-face consultations, mediation between locals.	Improved social cohesion, better understanding of decision-making and knowledge development through common designing processes. Creating new mindsets about co-greening, and co-maintenance.
	Greening Office (Munich)	It is part of a historically strong environmental NGO, supported by the City Council as part of its climate protection program. It aims to increase awareness on and engage private actors in greening private plots.	Individual face-to-face consultation and tailor-made information provision. First phase: citizen focus, outreach through specific events, supporting already interested citizens. Second phase: industry focus via organizing expert events.	First phase: in depth learning, awareness raising on climate adaptation. Lack of coordination with municipality, who provides funding for similar actions. Second phase: focuses on knowledge development and exchange among professionals. Political dependence defines activity focus.
	Climate Adaptation Strategy (Munich)	In 2013, the city council put adaptation on the agenda and employed an adaptation manager to develop the strategy (2016), including a total of 26 mostly green or blue multi-purpose adaptation measures.	Obligatory consultation on the enforced strategy. Citizen engagement is deliberately avoided in the planning phase. The process was kept internal, the topic claimed to be too technical for public consultation.	Creating new municipal practices and institutional structures to integrate NBS knowledge in comprehensive and detailed planning. Policy learning. Despite citizen groups' activeness in climate adaptation, they were not connected to this strategy.
	Business Plan for Newcastle's Parks	Induced by austerity, this plan transfers responsibilities to a charitable trust to generate revenue for maintenance through sales of services on municipal land. Citizens are also envisaged to be engaged in voluntary maintenance.	Structured consultation process in the planning phase, run by two organizations in parallel. Municipal engagement via online survey, e-mails, directed events for young and elderly, drop-in Q&A. Research group's process via workshops, board games, website, twitter debates and feedback sessions on the proposal.	Through the process, future scenarios and discourses were touched upon, aiming to develop a sense of place, ownership, and social cohesion. Parks in more affluent areas benefit more from such a business-oriented model than those in poorer neighborhoods.

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	City Forest Plan (Sofia)	This plan is envisaged as a community tree park on a cultural heritage site. Outcome of a greening movement, initiated by NGOs, it relies solely on citizen engagement.	Citizen engagement via voluntary participation in implementation and maintenance, such as tree planting and donation, with the intention to engage with businesses.	Awareness raising, creating ownership and responsibility over public green areas and culture. Land ownership and the division of responsibilities across city departments halted progress.
Waterfronts and riversides	Waterfront Initiative (Boston)	This is an initiative of a local philanthropic foundation (Barr Foundation), which is consciously trying to fill a gap in current public climate planning efforts in the seaside areas of Boston.	Engagement in the implementation phase through supporting organizations organizing community-based activities with focus on the inclusion of previously excluded vulnerable groups, e.g., through an art project, creating a greenway along the water, and environmental education.	Difficult to reach vulnerable groups, who feel alienated from public spaces. Awareness raising, creating a sense of place and ensuring water front accessibility for all, while aligning the initiative with the Climate Resilience Strategy.
	Moson-Danube project (Győr)	Publicly funded large-scale flood adaptation project in the city centre, channeling the Danube into a concrete corset, along with adjacent redevelopments on the riverside.	Traditional consultation process, entailing state-led community surveys and citizen forums. Environmentalists contested the need for riverbed narrowing as unnecessary and unsuitable for flood adaptation.	Access to the river for specific groups has become less frequent and less comfortable. Public agencies' technical visions were difficult to influence by non-institutional actors. The consultation process alienated NGO involvement in later projects.
	Post-industrial waterscapes (Leipzig)	Through a public-NGO partnership, the focus is on the re-naturing of the Luppe River ("Lebendige Luppe"), with shared tasks and responsibilities among partners.	Citizens are represented through an NGO, which is responsible for organizing community-based activities, e.g., awareness raising by nature trail walks and handling citizens' concerns.	Citizens' support for the NBS increased through NGO participation. The NGO's suggestions were not always accounted for, but kept the naturalization discourse alive over technology-based solutions.
	Isar Plan (Munich)	Financed by the municipality and the region, a multi-stakeholder project group (1995) planned the re-naturalization of the Isar river by transforming it from an artificial canal bed into a more naturally-shaped stream with sustainability benefits.	Structured consultation process via dialogs with locals in the pre-planning phase, internet platform, info points, brochures, media, excursions, site visits, mediation, workshops, lectures, round-table discussions. In the joint planning group citizens are represented via an alliance of NGOs.	Consideration of multi-generational preferences in physical structures. Mediation helped to identify optimal physical solutions: on one stretch a nature-based approach was chosen over gray infrastructure. Social learning through multi-actor collaboration. Some steps of the implementation were not consulted.
	Green Seawall (Sendai)	NGO-initiated community planting complements governmental efforts in establishing disaster prevention measures, both nature-based (forests) and gray infrastructure (seawalls) along the coast.	Citizen engagement through voluntary planting activities, along with environmental education through the inclusion of schools and students and awareness-raising community workshops.	Awareness raising on nature's role in disasters. Empowerment, knowledge development and livelihood enhancement by restarting traditional practices on post-disaster land. Diverse land ownership and management hinders development.

(Continues)

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	Ecosystem-based disaster prevention (Sendai)	A bottom-up initiative, high school students' cultural heritage and ecosystem-based plan as an alternative to gray seawall infrastructure promoted by the national government's reconstruction logic.	High-school students developed alternative plans for the post-disaster area. They engaged with locals (face-to-face interviews, information provision), local authorities (proposals, rehearsals) and businesses.	Increased sense of place and identity, increased responsibility for natural and cultural resources. Engagement with local knowledge, awareness raising (citizens), increased learning and empowerment (students). Only a few elements were considered.
	Ecological Wetland Park (Tianjin)	The municipality is engaged in a large-scale public–private partnership project on wetland protection to minimize wastewater and pollutant discharge, to increase biodiversity and liveability in a manufacturing and logistics hub.	No community groups were consulted in the planning and development phase. Since 2013, the Wetland Park is a space for recreation, research, education and community engagement through marathon events, walking trails, gardens, sculpture parks attracting some 800 visitors per day in spring and summer months.	Strictly top-down steered ecological restoration of a salt marsh resulting in biodiversity (120 species of wetland plants), habitat creation (return of migratory birds), increased water quality, to make residential life more attractive in a rapidly-developing industrial district w/o any public consultation.
	Kamagawa Promenade (Utsunomiya)	Municipality-funded nature-based social activities around the Kamagawa river are implemented by NGOs and local civic groups as part of the city's multifaceted revitalization.	Citizens, including vulnerable groups, e.g., elderly and local schools, are engaged as volunteers in various beautification, greening, gardening, cleaning-up, environmental education and visioning activities—using the river as a common platform.	Social integration, increased economic activities, enhanced cultural and environmental awareness, forming social spaces, creating a sense of place among locals and a different mindset about the river. Activities strongly depend on municipal funding.
	Seasonal river use (Winnipeg)	On the city's frozen river, community activities and local enterprises, including the longest naturally frozen river-skating trail, are supported by a company in partnership with the city.	Consultation via neighborhood workshops and public open-house. Engaging with citizens in new ways via entrepreneurial and community-driven activities.	Via consultation on challenges, opportunities, and potential future directions, there is a change in the sense of place, shaping different lifestyles and mindsets, (e.g., about winter activities), increased community connections and new partnership type.
Water management: Ecodistricts	Augustenborg EcoCity (Malmö)	One of Sweden's largest municipality-driven sustainable neighborhood regenerations, benefited from public funding and intense collaboration among multiple stakeholders, including local residents (1998–2002).	Open and inclusive consultations, workshops, community events to inform, inquiry preferences and concerns and consulting on ideas throughout from the conceptual phase to implementation via a municipally-employed community manager. Prioritized local interests.	Municipality's learning on community management, citizens' learning on participatory opportunities, resulting in new business ideas, employment, sustainability knowledge, and an enhanced sense of place and identity. Ecological spill-over effects to other sustainable projects, e.g., PV, car and bike pool.
	Parc Marianne Ecodistrict (Montpellier)	Developed in a public-private partnership (2010–2018) addressing a few sustainable development goals, including socially-mixed housing.	Legally-required consultation meetings in the planning and visioning phase focusing on information provision. No success in reaching out to broader public, always the same participants, representing the same views and interests.	Due to a lack of culture of public participation, developers perceived consultations as confrontational, halting the development; social mix negative in terms of difficulty selling apartments in mixed buildings.

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	Ouseburn Catchment Sustainable Drainage System (Newcastle)	This NBS includes the Ouseburn River restoration and Brunton Park flood alleviation projects, both are implemented in partnerships among public actors.	Ouseburn: continuous dialog with locals via resident association, tree planting with local volunteers. Brunton: information provision via newsletters, webpage, community events with focus on only directly affected stakeholders, such as the golf club and local households.	Ouseburn: use of local knowledge (resident-designed aspects). Brunton: new ways of thinking, knowledge development, including natural water flow in a manicured golf course. Biodiversity loss due to affluent neighborhood development.
	Ecovalley (Tianjin)	A government-to-government flagship project between Singapore and China based on the sponge city concept.	An online evaluation survey was sent out to the residents (70,000) after the first phase of the project.	It was reported to be unlikely that the results of the survey would be taken into account or that the plans will be changed.
	Leidsche Rijn (Utrecht)	Municipality-driven urban new development (30,000 homes) with a sustainable closed-circuit water system (1997–2025).	Public consultation, information provision, educational activities and reporting of failures, e.g., on invasive species, water level fluctuation, garden design, car washing.	The engagement's aim is to avoid civic disobedience, e.g., when the water quality got good, education stopped. The water system became part of the local primary school's curriculum.
Water management: Security	Atlantis Water Fund (Cape Town)	Pilot run by NGO, part of creating a public-private fund, to convene governmental and business actors to find new ways to fund and coordinate efforts to clear invasive plants as a water supply strategy.	Citizens are engaged through The Nature Conservancy (NGO) in the implementation phase and beyond. Vulnerable local communities, (especially women in the pilot program) are trained to clear invasive plant species that take up a lot of water.	Participation is the core of achieving sustainability outcomes. In parallel, individual skill development, contributing to long term independence. Empowerment. Stewardship, business opportunity. Critical issue is to secure long-term funding.
	Groundwater recharge projects (Kumamoto)	Regionally-initiated Kumamoto Groundwater Foundation engaging with businesses and local community groups in groundwater conservation, e.g., winter flooding of rice fields, forest management.	Collaboration with local community groups, e.g., farmers' associations, schools to flood rice fields in non-cultivation periods. Engaging with businesses in payments for ecosystem services.	Increased biodiversity and habitat, educational activities, monitoring and awareness raising about rice fields as ecosystems. Difficulty engaging citizens in farming and farmers in organic cultivations, resulting in questionable water quality.
	Water Fund (Mexico City)	Initiated by The Nature Conservancy, and led by another NGO, in partnership with public and private actors to attract funding from downstream water users for upstream nature conservation.	Collaborating with targeted local communities who carry out restoration and conservation measures; not engaging common public yet. The initiative also engages with businesses, whose employees are encouraged to volunteer in activities to build evidence and trust through a pilot.	The initiative aims for transparent water pricing, which challenges an often opposed and sensitive issue—how different stakeholders think about water. It calls for a change in mindset and opens up a new type of discussion about a public resource.
	Water Forest (Mexico City)	NGO-led multi-actor collaboration to restore local water and ecosystem services and enhance livelihoods. States, academics, local municipalities, communities, and civic organizations.	Three levels of engagement from planning to maintenance include local community stewardship, co-designing with farmers, NGOs, wealthy individuals, and awareness raising for general public. Activities include research, demonstration projects, awareness raising.	It is a collaboration- and trust-building exercise creating a shared narrative, reaching out to the private sector, and engaging them as trusted partners in a generally corrupt realm. The lack of awareness of water and land use challenge the NBS development.

(Continues)

TABLE A1 (Continued)

NBS domain	NBS case	Description and governance	Citizen participation	Sustainability outcomes and trade-offs
	Chinampas for ecosystem restoration (Mexico City)	Community-led collaboration between *chinampa* agriculturalists and academics to use traditional food cultivation to restore ecosystem and social-hydrological resilience.	*Chinampa* agriculturalists are engaged as promoters of ecosystem services through sustainable livelihoods. The general public is engaged as consumers of local produce, ecotourism, education, voluntarism.	Sustainable livelihoods, cultural heritage preservation. Awareness raising on the links between water supply and traditional cultivation. The discourse of development with environmental considerations is challenged by urban sprawl and unclear land use rights.
Type of citizen engagement:		Informing	Consulting	Collaborating	Co-deciding	Empowering

[a]More information on the NBS cases can be found on the "Urban Nature Atlas" website (https://una.city/), which includes about 1000 NSB cases in Europe, where website links for the NBS projects located in Europe can be found.