Realising Transformative Change through the Evaluation of Urban Nature-Based Solutions: An Exploration of the Netherlands

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Date: 26-06-2023

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Acknowledgements

In front of you lies the master thesis ‘Realizing Transformative Change through the Evaluation of Urban Nature-Based Solutions’. The thesis was conducted and written in February until June 2023 in the Netherlands, to explore how urban NBS are currently being evaluated and how this relates to the transformative change that can be achieved by NBS. The thesis was written as part of the master Sustainable Development at Utrecht University, and with great pleasure.

I wish you a pleasant reading.

Anouk Jaspers

Vriezenveen, 26-06-23

Summary

The dual crises of climate change and biodiversity loss increase the vulnerability of cities, which are dealing with challenges of extreme weather events, degrading urban ecosystems and increasing temperatures. Nature-based solutions (NBS), which are actions that imitate and enhance natural processes in cities, can contribute to tackling these challenges whilst simultaneously improving the health and well-being of urban residents. However, trade-offs and issues of justice and equality limit the effectiveness of NBS to deliver their aspired multiple benefits to nature and all urban residents. It additionally hampers the mainstreaming of NBS in current urban infrastructure regimes, while their uptake is deemed crucial for the transformation of current regimes along more sustainable pathways. Currently, evidence remains scarce on the trade-offs and unintended consequences of NBS, which points towards the improvement of current evaluation processes to strengthen the evidence base of NBS. Enhanced evaluation processes can also foster the mainstreaming of NBS in practice by properly showcasing their potential. Therefore, this research aims to explore how evaluations of urban NBS currently capture the aspired multiple benefits of NBS, their possible trade-offs and issues of justice and inclusivity, and how this relates to the potential of NBS to contribute to transformative change.

The research developed six evaluation principles, which are argued to capture the contribution of evaluations to the transformative potential of NBS. Furthermore, the research is based on an explorative but non-representative quantitative as well as qualitative case study analysis of 42 evaluation documents of Dutch urban NBS, supplemented by 10 interviews with practitioners in the field of researching and/or evaluating urban NBS. The research reveals that, overall, most of the evaluations adequately aligned with the six developed evaluation principles, meaning that these evaluations to some extent contribute to transformative change. However, the research also demonstrates that more than a third of the evaluation sample made no or only a limited contribution to transformative change, whilst especially the principles of justice and inclusivity are poorly addressed in the evaluations. Additionally, those evaluations being solely based on quantitative research methods are characterized by a lack of inclusivity and insufficiently address the principles of multiple benefits, trade-offs, and justice. These findings underpin the proposed improvements in the evaluation of urban NBS to enhance the transformative potential and uptake of NBS in practice. This supports the transformation of current urban infrastructure regimes to realize sustainable, just, and equal urban living environments for all residents.

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1 - Introduction

1.1: Sustainability issue

'Working with nature' in urban planning has increasingly gained attention from scientific as well as political communities to deal with challenges of water, air quality, urban biodiversity, and public health sustainably and cost-effectively (Raymond et al., 2017). Cities are becoming more vulnerable to such challenges due to intensified climate impacts and biodiversity loss(Bayulken et al., 2021; Graça et al., 2022), on which several major environmental institutions have recently published global synthesis reports (Seddon et al., 2021). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reports a drastic loss of biodiversity and ecosystems at a rapid rate that is unprecedented (IPBES, 2019). Moreover, the Intergovernmental Panel on Climate Change (IPCC) reports that countries are not on track to limit global warming to the agreed 1.5 degrees target under the 2015 Paris Agreement (IPCC, 2022). Together, the IPBES and IPCC stress the interconnections between climate change and biodiversity loss, both driven by human activities and only solvable when dealt with together (Pörtner et al., 2021).

Within that context, nature-based solutions (NBS) are recognized as interventions that can simultaneously address the dual crises of climate change and biodiversity loss while also delivering social benefits (Seddon et al., 2021). The International Union for Conservation of Nature and Natural Resources (IUCN) defines NBS as 'actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature' (Cohen-Shacham et al., 2016, p. 2). By imitating and enhancing natural processes within urban areas, NBS can contribute to climate mitigation and adaptation, improve air quality, and help regulate extreme temperatures and weather events like floods, while protecting and enhancing urban ecosystems (Dumitru et al., 2020). Furthermore, through ecosystem services provision, NBS can also improve physical and mental health, and contribute to social cohesion and interactions while increasing a sense of belonging (Dumitru et al., 2020). Both the IPBES and IPCC underline the potential of NBS to address climate change while delivering benefits to biodiversity and humans (Pörtner et al., 2021).

Therefore, NBS can contribute to transforming cities into resilient, healthy, and sustainable living places, which has become a key global priority reflected in t he United Nations Sustainable Development Goals (SDGs) (Dumitru et al., 2020). The recently signed Kunming-Montreal Global Biodiversity Framework (GBF) also contains a specific target for the urban context, indicating the need to increase the quantity, quality, accessibility, and benefits from urban nature to contribute to inclusive and sustainable urban environments (CBD COP, 2022). Moreover, urban NBS play a prominent role in European policy, where NBS, in the form of green roofs, (pocket) parks or sustainable drainage systems, are promoted as solutions capable of dealing with a range of urban sustainability issues (Dorst et al., 2022).

1.2: Problem definition

However, in practice, trade-offs, and negative, unintended consequences of NBS are observed. Trade-offs emerge from choices and competition over land for either grey (e.g., housing) or green and blue land uses, which is being exacerbated by the lack of urban space in dense European cities (Dorst et al., 2022; Kronenberg et al., 2021). Trade-offs may also occur between different needs of urban residents, which can lead to an unequal distribution of the costs and benefits of NBS (Kronenberg et al., 2021). When NBS are seen as serving the needs of one group over the other, ignoring people's different values or needs of urban nature, this can lead to issues of recognition injustice (Toxopeus et al., 2020).

Besides, the cultural and embodied knowledge of residents is often ignored in the decision-making process of NBS, while their inclusion could enhance the effective and just implementation of NBS (Mabon et al., 2022; Toxopeus et al., 2020; Turner et al., 2022). Yet, greater involvement of residents does not directly result in just outcomes, for example when the voices of some are considered more than others, compromising the procedural justice of NBS (Mabon et al., 2022; Toxopeus et al., 2020). However, not sufficiently involving residents in the design and implementation of NBS reduces the legitimacy of the intervention and may result in an unequal distribution of benefits, limiting the effectiveness of NBS (Seddon et al., 2021). Indeed, the costs and benefits of urban NBS are often unevenly distributed across races, classes, genders, and age groups (Cousins, 2021). This unequal distribution may lead to unanticipated processes like green gentrification, where original residents are displaced from a neighbourhood due to rising property prices caused by the increased amount of green and blue spaces (Bockarjova et al., 2020; Tozer et al., 2020). Urban nature may in that case reinforce already existing inequalities within cities, or establish new forms of exclusion (Cousins, 2021; Tozer et al., 2020). Those trade-offs, injustices and unintended consequences undermine the potential of NBS to effectively deliver multiple benefits to all urban residents, especially to those marginalized groups that need them the most (Bulkeley et al., 2023).

1.3: Knowledge gaps

Trade-offs and unintended consequences may thus occur when NBS are not implemented in an equal and just manner, limiting the potential of NBS to truly transform cities into healthy, resilient, and sustainable living places for all. Studies indicate that such challenges constrain the mainstreaming or uptake of NBS in urban infrastructure planning (Dorst et al., 2021, 2022; Frantzeskaki et al., 2019; van der Jagt et al., 2023; Xie et al., 2022). The uptake of innovative NBS by various actors and sectors is difficult due to already existing urban infrastructure regimes with their traditions, rules, norms, and governance practices, historically embedded within society and resistant to change (Dorst et al., 2022; Xie et al., 2022). Concerns, therefore, remain on how NBS can become normalised in urban planning. Addressing such concerns are necessary because a careful planning of NBS is needed to safeguard the delivery of multiple benefits to all and to mitigate their trade-offs and unintended consequences (Xie et al., 2022). Moreover, the mainstreaming of NBS is deemed necessary to transform current unsustainable pathways towards more sustainable ones (Welden et al., 2021).

In addition, to strengthen the justice elements of NBS, such careful planning should consider distributive, procedural and recognition aspects of justice (Baró et al., 2021; Langemeyer & Connolly, 2020; Seddon et al., 2021; Toxopeus et al., 2020). Research on issues of justice and equity within NBS are still scarce, while implementing just NBS is critical to deliver equitable outcomes (Cousins, 2021; Langemeyer & Connolly, 2020; Toxopeus et al., 2020). Moreover, while trade-offs and unintended justice consequences of NBS are often discussed in the literature, few studies report evidence on them, while capturing such consequences can support urban decision-making on NBS and enhance their mainstreaming in cities (Dumitru et al., 2020; Frantzeskaki et al., 2019).

Current research also remains scarce regarding evidence on the delivery of the promised, multiple benefits of NBS (Dumitru et al., 2020; Seddon et al., 2021; Welden et al., 2021; Wickenberg et al., 2022). Existing research has more extensively analysed the environmental benefits of NBS, while the research on social and health benefits remain low and fragmented (Frantzeskaki et al., 2019; Welden et al., 2021). Additionally, partly due to the lack of overarching and systemic methods to evaluate urban NBS, their actual impact on urban citizens and ecosystems remains uncertain (Wickenberg et al., 2022). These research gaps underline the need to build on the evidence base for NBS that are effective in delivering multiple benefits and to identify best practices from which other cities can learn to mainstream the practice of NBS (Frantzeskaki et al., 2019).

To build this evidence base, frameworks to evaluate the performance of NBS are essential (Dumitru et al., 2020; Frantzeskaki & McPhearson, 2022). Currently, evaluation methods for the performance of NBS vary greatly and need clarity (Palomo et al., 2021; Wickenberg et al., 2022). Enhancing the evaluation of NBS is also identified as critical for the mainstreaming of NBS, as showcasing and proving their multiple benefits can improve the awareness and uptake of NBS in practice (Xie et al., 2022). However, current methods of evaluating NBS within the urban infrastructure regime often rely on quantitative criteria and standardisations, while such methods of valuation are difficult to apply to context-specific NBS (Dorst et al., 2022). Moreover, limited knowledge exists on the relation between the transformative potential of NBS and their evaluation, while such knowledge can help to better understand the links between the design and implementation of NBS and transformative change in practice (Palomo et al., 2021).

1.4: Research questions

Considering all, this research aims to investigate how NBS are currently being evaluated in the Netherlands, and how such evaluations consider their multiple benefits, the trade-offs, and unintended consequences of NBS as well as their transformative potential. Thereby, this research scientifically contributes by strengthening the currently lacking knowledge on how the delivery of multiple benefits, trade-offs and unintended (justice) consequences of NBS are evaluated. Additionally, this research aims to enhance the understanding of how the evaluation of NBS can contribute to their transformative potential. The Netherlands is one of the countries where structural barriers against the mainstreaming of NBS are identified (Dorst et al., 2022), making it a valuable context to investigate if and how current evaluations of Dutch urban NBS address transformative change. Moreover, by 2035, 70 per cent of the expected Dutch population growth will take place in cities and their suburbs (PBL, 2022), underlining the societal relevance of enhancing the knowledge on how effective, just, and equal NBS can be implemented and maintained to benefit a growing urban population in the long-term. Besides, such NBS can contribute to international policy targets set under the Paris Agreement and the Kunming-Montreal GBF, both signed by the Netherlands. Moreover, NBS can support the achievement of European policy targets, including the European Green Deal and the Biodiversity Strategy for 2030, as well as Dutch policy goals, including the Nature Network Netherlands (Bulkeley et al., 2023).

Therefore, this research addresses the following research question:

> *To what extent do current evaluations of urban nature-based solutions in the Netherlands take their multiple benefits, trade-offs, and unintended consequences into account, and how can this be improved to support the transformative potential of urban nature-based solutions?*

The main research question is going to be answered through the following sub-questions:

1) To what extent and how are urban NBS currently being evaluated in the Netherlands?
2) How do the current evaluations of urban NBS in the Netherlands consider their multiple benefits, potential trade-offs and unintended (justice) consequences?
3) To what extent do these current evaluations of urban NBS capture the transformative potential of NBS, and how can this be improved?

Chapter 2 provides the theoretical clarification on the concepts of NBS, trade-offs, unintended consequences, and transformative change, whilst providing a conceptual framework. Afterwards, the methodological steps of this research are discussed, and summarized in a research framework. The results of the application of this methodology are discussed next, and thesis ends with a discussion and a conclusion.

2 - Theory

The theory chapter provides explanations and clarifications of the most important theoretical concepts used in the current research. First, the concept of NBS is further defined and their potential trade-offs and unintended justice consequences are discussed. Following, an elaboration of the concept of transformative change is given, after which the process of environmental policy evaluation, and the evaluation of NBS in particular, is discussed. The theory chapter ends with the development of an analytical framework that guides the methodology of the current research, which is further discussed in chapter 3.

2.1: Understanding the potential and pitfalls of NBS

2.1.1: NBS defined and their potential to address climate change and biodiversity loss

Working with nature to cope with climate variability is already an old practice but has only been given scientific and political definitions in recent years (Seddon et al., 2021). Other previously established but related concepts to NBS, that also embody the practice of working with nature, include Ecological Engineering (EE), Green/Blue Infrastructure (GI/BI), Ecosystem-based Adaptation (EBA), Ecosystem Services approach (ES), Natural Capital (NC) and Disaster Risk Reduction (DRR) (Faivre et al., 2017; Nesshöver et al., 2017). In that regard, NBS are mentioned as an umbrella term to encompass all these concepts which share the explicit recognition of the correlation between nature and societal benefits (Nesshöver et al., 2017; Seddon et al., 2021). The main difference between the aforementioned concepts and NBS is, however, the explicit focus of NBS on the provision of multiple benefits of one intervention, while the other concepts have a more specific focus on a single outcome, purpose, or type of intervention (Seddon et al., 2021). For example, re-naturing cities provides space for cooling, increases resilience to flooding, and decreases air pollution whilst delivering recreation and health benefits to urban residents (Seddon et al., 2020).

Therefore, the concept of NBS has been praised by the IPBES and the IPCC to address simultaneously the challenges of the dual crises of climate change and biodiversity loss (Pörtner et al., 2021). Whilst urban NBS may to some imply a single intervention in a specific urban environment, the contributions of NBS towards addressing the underlying drivers of climate change and biodiversity loss are also stated as a crucial part of their potential impact (Bulkeley et al., 2023). According to the IPBES (2019), these underlying drivers first include land use change and urbanization, referring to the re-naturalization of grey urbanized environments. Second, unsustainable production and consumption are identified as an underlying driver, where urban NBS can contribute to reducing greenhouse gas (GHG) emissions or promoting alternative travel modes or food networks. Lastly, values of nature are identified as an underlying driver, referring to the lost connection between people and nature and how human-nature relationships can be fostered through the implementation of urban nature. Whilst the interdependence between humans and nature is recognized in sustainability science (West et al., 2020), misconceptions still exist about urban areas as crafted landscapes driven by technological innovations and separated from nature (Kabisch et al., 2022). Therefore, fostering a reconnection between humans and nature through NBS can support transformations towards sustainability (Kabisch et al., 2022; West et al., 2020), and it is also argued to be crucial in realising effective NBS (Welden et al., 2021). Similarly, while the dual and interconnected nature of biodiversity loss and climate change is increasingly acknowledged in sustainability science, they continue to be addressed separately (Pettorelli et al., 2021). This can hamper the realisation of NBS that effectively deliver multiple benefits to both challenges, so it is urged to integrate biodiversity and climate change more jointly within research agendas (Pettorelli et al., 2021).

2.1.2: NBS and their trade-offs and unintended consequences

While the multifunctionality of NBS is identified as one of its main strengths (Dorst et al., 2019; Faivre et al., 2017), in practice, hierarchies and trade-offs between the different objectives exist (Dorst et al., 2019). This is often the case with desirable win-win situations in urban planning, where in practice hard decisions need to be made that result in trade-offs (Hansen & Pauleit, 2014; Kronenberg et al., 2021; Turkelboom et al., 2018). Especially in dense urban environments, conflicts emerge between urgent commercial, residential and transport developments, and the safeguarding and development of urban nature (Kabisch et al., 2022). Trade-offs occur when an intervention or a choice results in the increase of the provision of one or more ecosystem service(s) at the expense of other ecosystem services (Rodríguez et al., 2006; Turkelboom et al., 2018). In the context of NBS, such trade-offs can occur in the following situations (Kronenberg et al., 2021; Turkelboom et al., 2018):

- The co-use of two ecosystem services appears to be impossible, resulting in the trade-off between green/blue spaces (e.g., parks) and non-green/blue spaces (e.g., housing).
- The desired ecosystem services can not be both provided at the desired level, potentially inhibiting each other (e.g., related to broader land sharing (*extensive urbanization with separate natural space*) and land sparing (*compact urbanization integrated with natural spaces*) debate) (Stott et al., 2015).
- The costs and benefits of ecosystem services are not equally distributed over different actors (e.g., different levels of access between different urban residents).

Also, unintended consequences can emerge from the implementation of NBS. This is because NBS are intervening within social-ecological systems (SESs), which are characterized by uncertainty and complexity, a high number of stakeholders, and long temporal scales (Nelson et al., 2020; Ostrom, 2007). Within urban planning, characterized by development pressures and a scarcity of land in which multiple sectors are involved, the distribution of the benefits of nature becomes a political struggle that often results in unjust and unequal outcomes (Ernstson, 2013; Langemeyer & Connolly, 2020). Environmental justice literature has traditionally dealt with unequal exposure to environmental risks, as well as the unequal distribution of benefits (Ikeme, 2003). As indicated by Ikeme (2003), environmental justice is aimed at the equal distribution of environmental costs and benefits through fair and just decisions. However, many urban nature interventions do not pay attention to the complexity of SESs over time and space, often (re-)producing forms of injustice (Baró et al., 2021; Langemeyer & Connolly, 2020; Toxopeus et al., 2020). Due to the high complexity and uncertainty surrounding environmental problems, interventions trying to address environmental problems often tend to have unintended consequences in both the environmental as well as social realms they impact (Mickwitz, 2006).

Such environmental injustices have been conceptualized along three interrelated dimensions of justice (Baró et al., 2021; Fraser, 2007; Langemeyer & Connolly, 2020; Schlosberg, 2007; Seddon et al., 2021; Toxopeus et al., 2020), summarized in table 1.

Table 1

The three dimensions of justice

Justice dimension	Definition	Applied to urban NBS
Distributive justice	Related to the question of who benefits and who loses.	Neighbourhoods characterized by a high-income level and a white population often benefit the most from urban nature interventions.
Procedural justice	Related to the question of who is able to decide and for whom.	Socio-cultural hierarchies and dynamics of power within urban contexts often determine access to and

		outcomes of participation processes.
Recognition justice	Related to the question of whose values, needs and preferences are recognized and considered.	Certain types of urban nature can ignore certain needs related to religion, safety, or different values of nature.

Note: Adopted from Baró et al. (2021), Seddon et al. (2021) & Toxopeus et al. (2020).

Involving various stakeholders in the decision-making and evaluation process can foster the realization of just urban NBS, as well as the mainstreaming of NBS (Kiss et al., 2022; Mabon et al., 2022; van der Jagt et al., 2023). Being part of the complex and culturally diverse urban fabric implies including various values, interests and needs from a heterogeneous group of actors (van der Jagt et al., 2023). However, the literature review of NBS by Turner et al. (2022) finds a limited inclusion of different actors with various types of knowledge in decision-making process of NBS, especially local knowledge, resulting in a lack of knowledge diversity. Moreover, a recent review of participation in urban NBS reveals that conventional participation approaches, reliant on consultation with the local government as the main decision-maker, are still dominant (Puskás et al., 2021). Similarly, the study by Kiss et al. (2022) of 58 NBS across 21 cities reflects a skew towards more passive or tokenistic forms of participation. Deeper levels of participation reflecting more citizen control and power remain scarce, while such levels are deemed necessary to address complex problems through NBS whilst increasing environmental stewardship (Puskás et al., 2021). Participation has been widely discussed within urban planning literature and particularly influenced by the ladder of participation developed by Arnstein (1969). Here, participation is described as a continuum, ranging from non-participation to tokenism to citizen control, resulting in the classification of different levels of participation. Many classification frameworks have emerged from the work of Arnstein (1969), as well as the typology used by the research of Kiss et al. (2022), exploring citizen participation in the governance of NBS. This typology is summarized and applied to the context of evaluations in table 2. The levels of informing and consulting reflect tokenistic participation approaches while collaborating, co-designing and empowering approaches represent the deeper levels of participation that allow actors to influence the evaluation process of NBS (Kiss et al., 2022). Based on the study by van der Jagt et al. (2023) on the assessment of urban NBS, such an evaluation process consists of the following stages:

1) The definition of evaluation goals and objectives.
2) The selection of indicators.
3) The collection of data.
4) The analysis of the data and the consequent evaluation of the urban NBS.

Table 2

The levels of participation and their implications for the evaluation process

	Level of participation	**Description**	**Forms of participation**	**Implication**
Non-participation	**Informing**	The evaluator elaborates on the evaluation to stakeholders in a one-way direction.	Distribution of newsletters, reports, public presentations, online information on webpages, field visits.	The information helps stakeholders to better understand the evaluation of NBS, but one-way communication risks exclusion and allows powerful actors to dominate NBS.
	Consulting	The evaluator presents the evaluation to stakeholders, noting their inputs.	Events, meetings, email of feedback, interviews, surveys or polls, citizen jury.	Often stemming from a legal requirement as a tick-the-box exercise or to enhance public approval and legitimacy.

	Collaborating	The evaluator presents the evaluation, considers stakeholders' inputs and involves them in the process.	Specialized meetings, interactive workshops, focus groups, social media debates, step-in Q&A, community activities, crowdfunding, participatory mapping.	More structured than consultations, including various interests and types of knowledge where citizens are often asked to donate money, labour, etc., can foster social cohesion and a sense of place
	Co-deciding	The evaluator closely cooperates with stakeholders.	Co-design workshops, joint planning groups, citizen panels, co-management of (parts of) evaluation, task forces.	Spans multiple stages of the evaluation and builds trust while enhancing mutual understanding of the NBS which fosters social learning.
Citizen power	**Empowering**	The evaluator intents to build commitment in the long term and strengthen the agency of stakeholders throughout the evaluation.	Advocacy planning, capacity development, appreciative inquiry, public spirit workshops.	Develops social learning and skill building by increasing the decision-making power of stakeholders and changing established routines, nurturing reflexivity.

Note: Adopted from Kiss et al. (2022)

As already indicated in the introduction, the potential trade-offs and unintended justice consequences are often not captured when evaluating urban NBS (Baró et al., 2021; Dumitru et al., 2020; Frantzeskaki et al., 2019). However, such assessments should holistically consider the three interrelated dimensions of justice, as well as potential trade-offs, to improve the realization of just and equal NBS (Baró et al., 2021; Kronenberg et al., 2021; Langemeyer & Connolly, 2020). While these intangible aspects of NBS are more difficult to obtain from quantitative valuation methods, they play a crucial role in deepening our understanding of the justice implications of urban nature as they shape the values of urban environments by residents (Amorim Maia et al., 2020). Moreover, addressing the unintended justice outcomes and trade-offs in the evaluation of NBS can support the mainstreaming of NBS, a concept that will be elaborated upon in section 2.2: Transformative change through NBS.

2.2: Transformative change through NBS

The process of transformative change through NBS, for which the mainstreaming of NBS is necessary, has already been touched upon in the introduction. Compared to technological or grey approaches in urban planning, NBS offer alternative approaches to the realisation of more sustainable, healthy, just, and equal cities, representing seeds for transformation (Wickenberg et al., 2022). However, NBS, as new and innovative interventions, are materialised in already existing urban infrastructure regimes (Monstadt, 2009). The concept of urban regimes is defined as 'the stable configurations of institutions, techniques and artefacts which determine normal socio-technical developments in a city and thus shape general urban processes and the urban metabolism' (Monstadt, 2009, p. 1937). These regimes are historically embedded within society and characterized by a strong internal alignment, which makes these regimes appear to be difficult to change towards more sustainable pathways (Bulkeley et al., 2014). Research practice within such regimes reflects the continued existence of dichotomies where

human and natural components are identified as distinct entities of a system (West et al., 2020). These dichotomies reveal a modernist paradigm where people wish to bring order to the complexity and chaos experienced in our interconnected and constantly changing world (West et al., 2020). Furthermore, the current urban infrastructure regime is characterized by a focus on grey infrastructures, the preferred use of engineering and technical expertise, and the reliance on quantified data to achieve economies of scale (Dorst et al., 2022). However, such forms of knowledge and types of data are difficult to apply to context-specific urban NBS, implemented in complex and diverse urban environments (Dorst et al., 2022). Therefore, NBS do not represent one-size-fits-all interventions that can be standardized, optimized, and copied from one place to the other (van der Jagt et al., 2023), which underlines the notion that mainstreaming NBS in such urban infrastructure regimes means disrupting and reconfiguring current regimes to enable the embedding of new, innovative practices (Xie et al., 2022). This requires a transformation of the established ways of thinking and doing, the flows of power and resources and institutional and social norms, to catalyse transformative change and the mainstreaming of sustainable innovations like NBS (Xie et al., 2022). This also crucially entails changing and reconfiguring the way NBS are monitored and evaluated within the current urban infrastructure regime, the last point this theoretical framework addresses.

2.3: The evaluation of NBS

Policy evaluations are defined as assessments of the worth and value of policy interventions guided by a certain set of criteria or principles (Crabb & Leroy, 2012; Vedung, 2005). The evaluation of policies is considered one of the stages of the policy cycle, the latter containing different analytically distinguished stages to simplify the process of policy-making (Crabb & Leroy, 2012). By assessing the performance of policy interventions, the results of a policy evaluation can feed back into different stages of the policy-making process, for example problem definition or policy design, to improve its performance (Crabb & Leroy, 2012). Related to the field of environmental policy, such evaluations assess the implementation and effects of an environmental policy intervention (Kunseler & Vasileiadou, 2016), and can be undertaken by various actors, including scientists but also non-scientific actors such as municipalities, consultancy firms or lobby groups (Huitema et al., 2011). The meaning and purpose given to policy and the role of evaluations within policy-making have changed but have also been institutionalized over the years, which can explain the way current evaluations often inhibit an integrative and effective assessment of context-specific NBS.

2.3.1: The history and evolution of environmental policy evaluations

Neo-liberal public reforms, which fostered processes of privatisation, specialisation of public sectors and a focus on better regulation, influenced the rise of policy evaluations in 1990 (Crabb & Leroy, 2012; Mickwitz, 2006). This included environmental policy evaluations, that were born out of modern ideals of neoliberalism and rationalism, focusing on the prevention or reduction of environmental issues (Adelle & Weiland, 2012). Within this context, policy is regarded as a rational problem-solving activity, where the purpose of evaluations is to assess whether the objectives of the policy are obtained, using clear indicators, mainly from a cost-effective perspective (Crabb & Leroy, 2012). With the 6th Environmental Action Programme for the EU of 2002, the EU articulated, for the first time, the need and requirement to conduct evaluations of environmental policies, with an explicit emphasis on policy effectiveness (European Commission, 2002; Mickwitz, 2006).

Due to influences of reflexive modernization (Beck et al., 1994), and more critique on the rational approach to policy, policy evaluations started to also incorporate criteria such as legitimacy, public acceptability, and transparency, as well as more participatory approaches (Crabb & Leroy, 2012; Højlund, 2014). Moreover, policy itself became to be seen as a complex and chaotic process involving many actors with various interests on multiple levels (Adelle & Weiland, 2012). By embracing this complexity and uncertainty, environmental policy evaluation

gained influence as a continuous process of reflection upon, and learning from, environmental interventions (Kunseler & Vasileiadou, 2016). The reflexive approach to evaluations gives citizens more real control over the evaluation by facilitating co-decision and empowering processes, resulting in deeper forms of participation which support more inclusive and just urban sustainable developments (Kiss et al., 2022).

It becomes clear that both the rational and reflexive perspectives on policy assign different meanings and purposes to policy evaluations. The rational perspective is underpinned by modernist ideals of rationality and control, characterized by a technical and economic way of thinking, where evaluation is seen as a mechanism for accountability and assessment of performance. On the other hand, the reflexive perspective is driven by ideals of learning and reflection, emphasizing the participation of various actors while acknowledging that evaluation is not an objective and straightforward process, but depends on the visions and interests of the actors involved (Kunseler & Vasileiadou, 2016). Both perspectives justify evaluations for different reasons. Within the rational approach, evaluations are about ensuring the liability and accountability of those institutions or individuals entrusted with the implementation of an intervention, assessing if the stated objectives were achieved and resources wisely used (Mickwitz, 2006). For the reflexive approach, evaluations offer opportunities to learn from and reflect upon the goals, the process and the performance of an intervention which ideally leads to policy improvement (Mickwitz, 2006). However, a simple correlation between policy evaluation and learning should not be assumed, as evaluative insights and recommendations can be used selectively or participation is primarily deployed instrumentally to improve policy support and impact (Crabb & Leroy, 2012; Kunseler & Vasileiadou, 2016). Indeed, the practice of policy evaluation reveals that stakeholders are often only instrumentally and marginally involved (Adelle & Weiland, 2012). Therefore, Schoenefeld & Jordan (2019) identify political opportunity structures as a third reason for conducting and using evaluations, referring to how evaluations are merely used to advance someone's own political goals or to simply appear legitimate.

2.3.2: The institutionalization of environmental policy evaluations and the implications for the evaluation of NBS

While the increasing awareness of the complexity and multi-actor character of policy-making has led to other perspectives on and reasons for using evaluations, studies indicate that the traditional and rational policy approach remains dominant in the practice of evaluations (Adelle & Weiland, 2012; Højlund, 2014; Kunseler & Vasileiadou, 2016; Nykvist & Nilsson, 2009). Over time, policy fields have become institutionalized, characterized by established, familiar, and routinized ways of policy-making (Crabb & Leroy, 2012). The level of institutionalization, which refers to historically and socially constructed patterns of values, norms, rules, and principles that give meaning to different concepts and practices, also defines which evaluation approaches are deemed appropriate (Højlund, 2014; Kunseler & Vasileiadou, 2016). Therefore, the practice of evaluation is largely guided by and embedded within rules and routines underpinned by rationalistic and modernist ideals, taken for granted by many actors to not deviate too much from what is understood as legitimate action (Højlund, 2014; Nykvist & Nilsson, 2009). The historically and culturally embedded characteristics of European environmental policy, including strong legislative roots and sectoral divisions, reinforce and maintain those routines and rules (Kunseler & Vasileiadou, 2016). This is also evident in the Netherlands, exemplified by the PBL Dutch Environmental Assessment Agency. The PBL has made efforts to include more reflexive principles into its evaluation practice but keeps being focused on its 'facts and figures' ideal, a modernist approach that gives credibility and legitimacy to the role of the PBL in the Netherlands (Kunseler & Vasileiadou, 2016; Petersen et al., 2011).

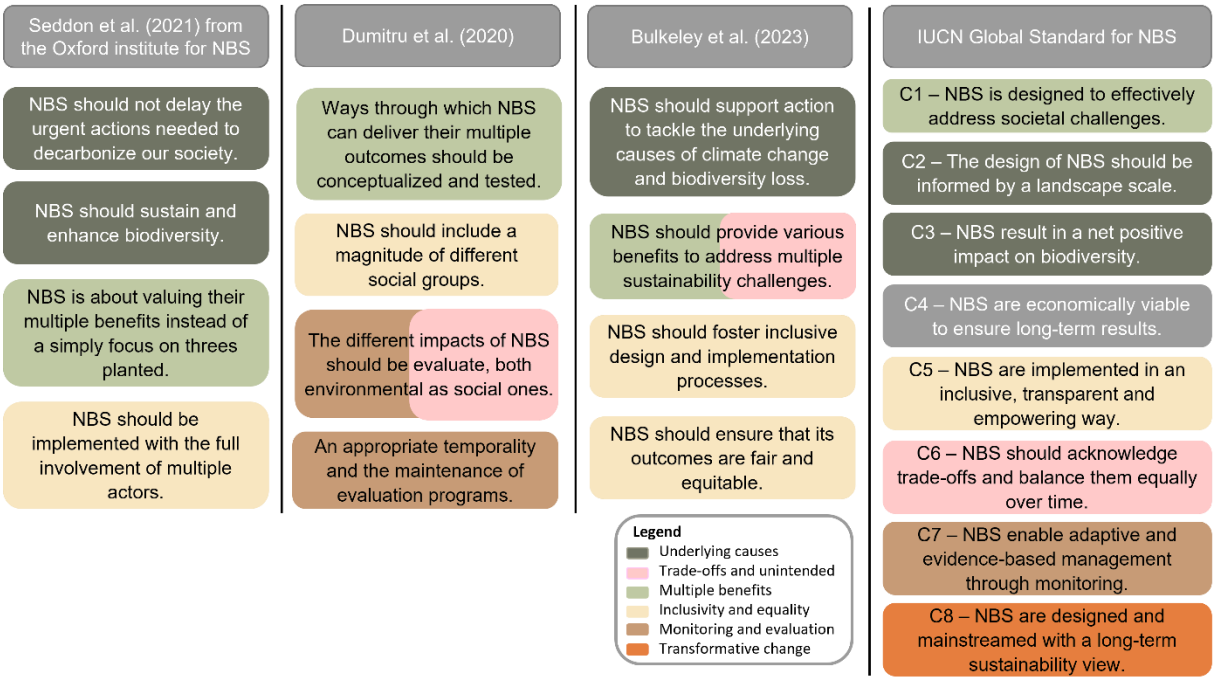
The institutionalized role of the modernist perspective within policy evaluations can explain why current evaluation methods of NBS are still often based on the attainment of environmental goals, quantitative criteria, and standardized calculations (Dorst et al., 2022; Dumitru et al., 2020; Xie et al., 2022). Moreover, being characterized by sectoral divisions, societal challenges like sustainability have traditionally been dealt with in rather siloed ways (Warbroek et al., 2023). Sectoral path dependencies and fragmentation persistently stand in the way of dealing with sustainability issues for which an integrative approach is vital, also regarding their long-time horizons and impacts across several sectors (Nykvist & Nilsson, 2009; Warbroek et al., 2023; Wickenberg et al., 2022). Modern and neoliberal ideals also influence and allow a rather objective and economic measurement of nature's value, resulting in social and environmental aspects of an intervention being easily outweighed by more politically relevant economic concerns (Adelle & Weiland, 2012; Kotsila et al., 2021). Furthermore, policies that are assessed from a goal-attainment and economic perspective fail to address trade-offs, unintended consequences and the distributive effects of a policy intervention (Mickwitz, 2006).

2.3.3: From quantity to the quality of urban nature and the role of principles

Overall, the level of institutionalization of modernist ideals values quantity over quality of urban nature. Here, economic concerns and notions of nature are often, inherent to the rationalistic approach, weighted more while ignoring notions of inclusivity and justice and rarely addressing the underlying drivers of climate change and biodiversity loss (Bulkeley et al., 2023). Bulkeley et al. (2023) stipulate the necessary change in focus on what can be counted towards what should count, namely the quality of urban NBS, in terms of delivering multiple, just, and equal benefits. Indeed, it is mentioned by other studies as well that a shift should be made regarding the evaluation of NBS, to include those benefits, trade-offs and unintended consequences that are difficult to capture with only quantitative valuation methods (Dorst et al., 2022; Dumitru et al., 2020; Frantzeskaki et al., 2019; Kronenberg et al., 2021; Langemeyer & Connolly, 2020; Raymond et al., 2017; Seddon et al., 2021; Welden et al., 2021; Xie et al., 2022). Moreover, transforming evaluations in ways that value the multiple benefits provided by NBS can prove the full potential of NBS and increase the engagement of multiple stakeholders (Welden et al., 2021; Xie et al., 2022). This supports the embedment of NBS to foster the transformative change of current urban infrastructure regimes along more sustainable pathways (Welden et al., 2021; Xie et al., 2022).

As studies increasingly indicate the need to shift away from the quantity towards the quality of NBS, efforts have been made to design standards, principles or guidelines for the design and implementation of NBS (Bulkeley et al., 2023; Dumitru et al., 2020; IUCN, 2020; Seddon et al., 2021; Cohen-Shacham et al., 2019). Figure 1 summarizes some of the recently developed and used standards for NBS. This figure also shows similarities in the aspects of the design and implementation process of NBS that are considered important by multiple developed standards.

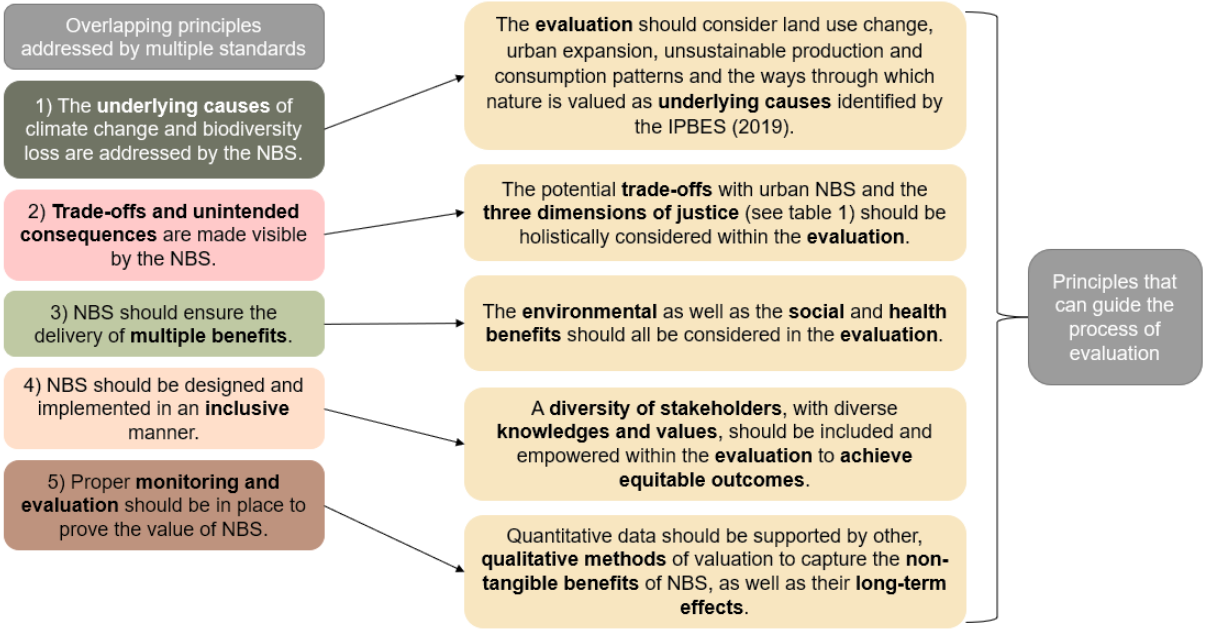
Figure 1
Overview of principles developed for NBS



Standards are regulatory tools that create a shared understanding of what is appropriate and below which levels it is not wise to go (Grubbauer & Dimitrova, 2022). Through this, standards can create common frames on what is needed to ensure NBS that are successful, sustainable, just, and equal (Flynn & Hacking, 2019). Moreover, Bulkeley et al. (2023) argue that standards can guide the process of measuring the performance of NBS and their mainstreaming. Standards rather inform and set a norm for what is considered an appropriate NBS, while policy evaluations asses, with the use of certain criteria, how the design and implementation of NBS played out in practice. However, such standards can be useful to guide the assessment of current evaluations of NBS, and to what extent the evaluations consider the principles argued to safeguard the effectiveness, sustainability, equality, and justice of NBS. Figure 2 displays the overlapping principles addressed by the standards from figure 1, which have been translated into principles that should be addressed by evaluations to contribute to its transformative potential.

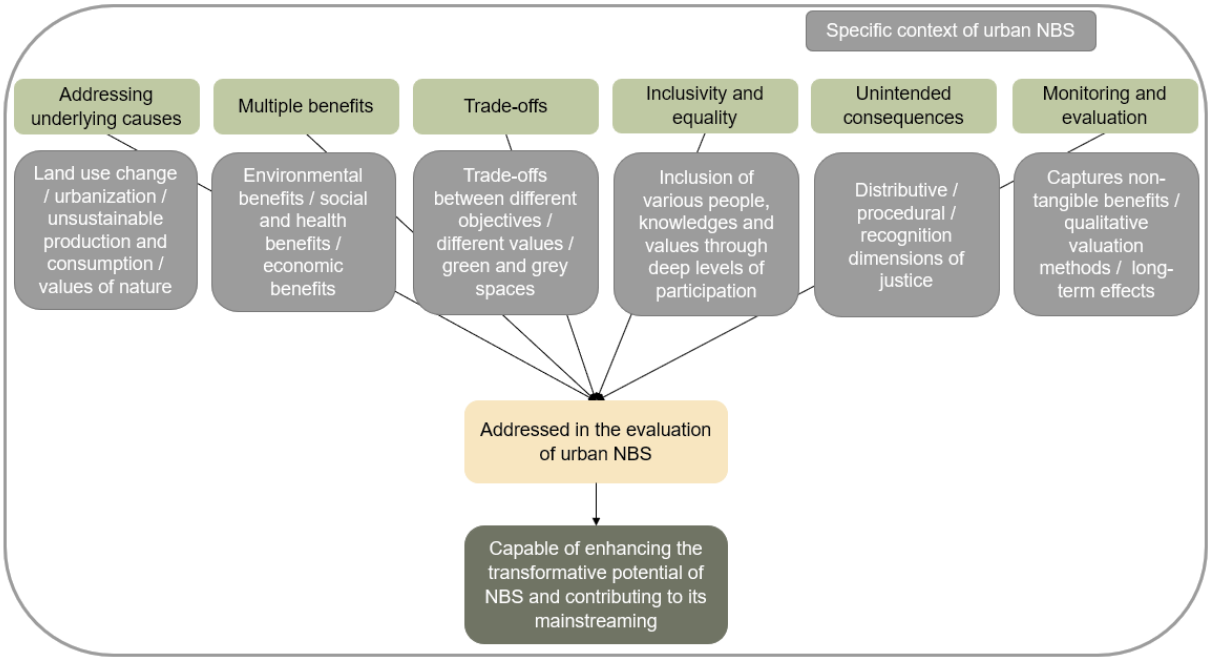
Figure 2

The overlapping principles and their translation to the context of evaluations



The first four principles, when not fully considered in the design and evaluation of NBS, can lead to pitfalls and challenges that constrain the mainstreaming of NBS and its transformative potential (Dorst et al., 2021, 2022; Frantzeskaki et al., 2019; van der Jagt et al., 2023; Xie et al., 2022). Moreover, monitoring and evaluation practices that can demonstrate the potential of NBS are identified as key stepping stones to achieving transformative change of NBS (Xie et al., 2022). Furthermore, incorporating the long-term stability of NBS through continued monitoring and maintenance systems is identified as necessary for the continued effectiveness of NBS while contributing to its mainstreaming (Cohen-Shacham et al., 2019). Therefore, it can be hypothesized that evaluation practices that address the principles on the right side of figure 2 can contribute to the mainstreaming of NBS and enhance its transformational potential. This relationship has been visualized in figure 3 and guides the empirical investigation of how urban NBS are currently evaluated, and to what extent those evaluations contribute to the transformative potential of NBS.

Figure 3
The analytical framework



3 - Methods

The methods chapter discusses the methodological steps taken in this research, based on the analytical framework that has been developed in the previous theory chapter. First, the research strategy is discussed, including the research framework. Second, the data collection methods and the data processing procedures are explained.

3.1: Research strategy

3.1.1: Comparative case study analysis

A comparative case study analysis was chosen as the research strategy as it helps to achieve the aim of this research, which is to explore how different urban NBS have been evaluated in the Netherlands, and to what extent those evaluations considered the transformative potential of NBS. A comparative case study analysis is defined by Gerring (2004) as the in-depth study of a group of cases, aiming to transfer lessons to a larger group of similar cases. Research on NBS has particularly focused on single case studies, which illuminates the possibility to investigate the effects of different contexts and processes on the outcome of NBS, which would be an important way forward in research on NBS (Frantzeskaki et al., 2019; Dumitru et al., 2020). Moreover, research on the mainstreaming of NBS underlines its context-specificity and the inability to copy an urban NBS from one city to the other (Dorst et al., 2022; A. van der Jagt et al., 2023; Xie et al., 2022). Therefore, exploring how urban NBS are evaluated in different urban environments is valuable and contributes to the current lack of comparative case study analysis regarding urban NBS.

3.1.2: Case study selection

The cases were initially selected from the Urban Nature Atlas database, created by the EU-funded project NATURVATION, which is currently the most comprehensive database of urban NBS implemented within Europe and beyond (NATURVATION, n.d.). In total, the Urban Nature Atlas contains 30 Dutch urban NBS, located in either Amsterdam, Utrecht or The Hague. However, as this research aims to explore the evaluation methods of various urban NBS across different contexts, it was deemed important that also cities of a smaller size and outside the Randstad (a densely populated urban area where the four major cities of the Netherlands are located) are included in the case study sample.

Therefore, cases were also selected from the project Green and Blue Networks for resilient cities (Atelier GroenBlauw, n.d.). This project aims to develop green and blue spaces within cities to help them adapt to climate change and contribute to biodiversity. Although not explicitly mentioning the term NBS, the projects can be identified as urban NBS as they implement green and/or blue spaces intending to deliver multiple benefits. This strategic case study selection procedure eventually yielded a case study sample of 52 urban NBS. The cases are located across 14 cities in the Netherlands, with sizes varying from 821.752 inhabitants (Amsterdam, North Holland) to 28.555 (Culemborg, Gelderland). Appendix 1 includes an overview of these urban NBS, including their location within the Netherlands, the size of the city, the type of NBS implemented and the status of implementation.

3.1.3: Steps guiding the investigation of current evaluation documents

The table displayed in Appendix 1 was further extended to analyse if and what kind of evaluations have been conducted on the selected NBS. Per NBS case, the key initiating actors of the project were identified, as well as the means of financing, to set the governance and financial context for each NBS, both identified as important enablers for high-quality urban NBS (Bulkeley et al., 2023). Also, the location, type and scale of the urban NBS will be identified to obtain the general characteristics of the NBS. These characteristics are described in section 3.1.4: Characteristics of the NBS case study sample.

Second, it was investigated if an evaluation has been of the urban NBS in question. If yes, various characteristics of that evaluation process were gathered where possible, including the actors responsible for the evaluation, the criteria and methods used, the type of data gathered, if this data was quantitative or qualitative and if any stakeholders participated in the evaluation. The general characteristics of the urban NBS and its evaluation (if performed) that were collected can be viewed in Appendix 2. The selection of these evaluation characteristics is mainly based on the study by Huitema et al. (2011), who for the first time conducted a meta-analysis of climate policy evaluations in six European countries. Huitema et al. (2011) used those characteristics of evaluations to gain more knowledge on how such climate policy evaluations were conducted, which is in line with the aim of this researchto increase the understanding of how urban NBS in the Netherlands are evaluated. Therefore, their characteristics were deemed useful for the purpose of this research as well. Moreover, to the knowledge of the author, a study similar to Huitema et al. (2011) but applied to the context of urban NBS has not been conducted yet from which evaluation characteristics could be adopted. Also, climate policy is closely related to and partly overlapping with the practice of NBS, both intervening within SESs, characterized by complexity, unpredictability and uncertainty, to tackle environmental problems.

Third, the evaluation, if present, was analysed to see how the six evaluation principles defined in figure 2 are addressed by the evaluation. The table in Appendix 3 displays how the evaluation principles have been operationalized in leading questions that were answered for each evaluation, as well as possible examples. The questions are based on and thus greatly overlap with the analytical framework displayed in figure 3 and the evaluation principles detailed in figure 2. To assess whether the evaluations match or adhered to the developed evaluation principles, a traffic-light system like the one used by the IUCN Global Standard for NBS was deployed. The IUCN traffic-light system consists of four levels, indicating whether an NBS intervention adhered to the IUCN Standard in an insufficient, partial, adequate or strong way (IUCN, 2020). The research by Châles et al. (2023), who applied the IUCN Standard to coastal NBS in Small Island States, further detailed the methodology of the IUCN Standard, which the current research adopted and altered to fit the current research aim. A score was thus attributed to each of the six evaluation principles for every evaluation of an urban NBS based on the answer to the leading question and the consequent level of alignment. The traffic-light system used can be viewed in table 3. For each of the evaluation principles, the traffic-light system is further detailed, allowing the assessment of each specific principle. Appendix 3 displays this specification, that guided the analysis of the evaluation documents that are part of this study. These steps of the research help to answer the first two sub-questions by providing insights into how urban NBS are currently being evaluated in the Netherlands, and how they address the six developed evaluation principles.

Table 3

The traffic-light system for the level of alignment to the evaluation principles

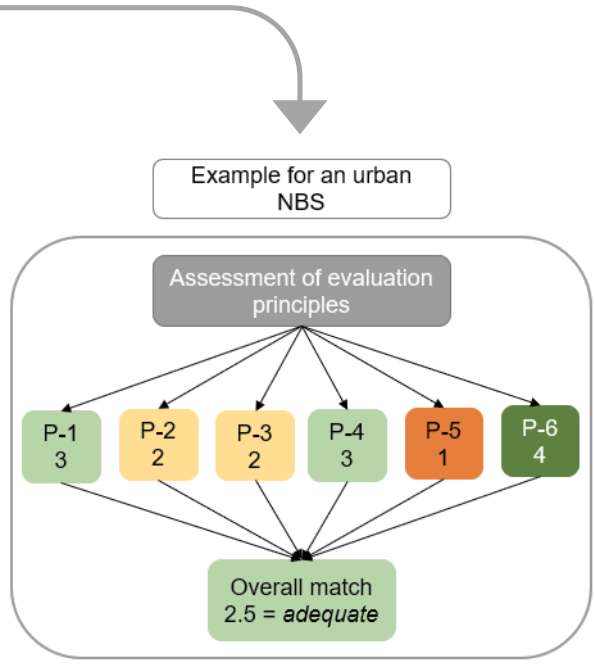
	Level of alignment	**Rationale for assessment**	**Assigned score**
	Strong	Assigned when the evaluation extensively addresses the leading questions, meaning that the evaluation strongly aligns with the given evaluation principle.	4
	Adequate	Assigned when the evaluation partially addresses the leading questions, meaning that the evaluation adequately aligns with the given evaluation principle	3
	Partial	Assigned when the evaluation does address the questions but not precisely enough to assign an adequate level, meaning that the evaluation only partially aligns with the given evaluation principle.	2
	Insufficient	Assigned when the evaluation does not or barely address the questions, meaning that the evaluation does not align with the given evaluation principle.	1

Note: Adopted from the IUCN (2020) and Châles et al. (2023)

To identify the transformative potential of the evaluation sample, an overall match score wasbe given to each evaluation of an urban NBS. This is again based on the methodology of the IUCN Standard, as it allows for the calculation of an overall match with the principles (IUCN, 2020). For the context of this research, it means that an overall match was calculated for the assessed evaluations and their alignment with the six evaluation principles. To do this, each principle was considered equally important and given equal weight. The overall match was then obtained by calculating the average score of the six assessed evaluation principles. Because these scores ranges from 1 to 4, the overall match also corresponds to a number between 1 and 4. Following the reasoning of Châles et al. (2023), a similar traffic-light system was developed to indicate the meaning of the overall match concerning the evaluations analysed and their alignment to the six principles, shown in table 4. The overall match is particularly useful in the current research to determine which evaluations most strongly align with the evaluation principles, and thus display the strongest potential to contribute to and enhance the transformative potential of NBS. Therefore, this step helps to answer the third sub-question of this research regarding the extent to which current evaluations capture the transformative potential of NBS.

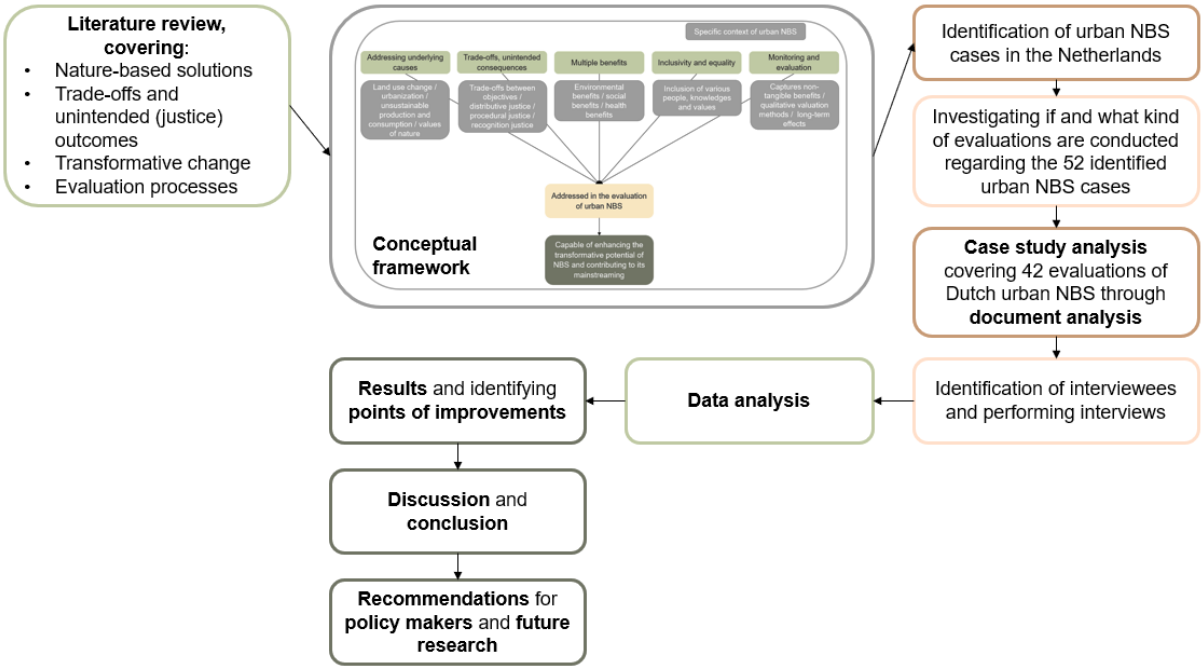
Table 4
The traffic-light system for the overall match and the relation to transformative change, illustrated by an example

	Overall match scoring	**Rationale for assessment**
	3.5 and above	The NBS evaluation is *strongly* in line with the evaluation principles and can thus considerably contribute to transformative change.
	Between 2.5 and 3.4	The NBS evaluation is *adequately* in line with the evaluation principles and can thus to some extent contribute to transformative change.
	Between 1.5 and 2.4	The NBS evaluation is *partially* in line with the evaluation principles and can thus make a limited contribution to transformative change.
	Lower than 1.4	The NBS evaluation is *not* in line with the evaluation principles and thus does not contribute to transformative change.



The steps of this research have been summarized in the research framework, displayed in figure 4.

Figure 4
The research framework



3.1.4: Characteristics of the NBS case study sample

In total, evaluations could be found for 42 of the 52 initial cases in this research sample. The same search strategy was applied to all 52 initial cases, investing a similar amount of time in each search. This search was conducted through Google, searching on the name of the NBS, together with its key initiating actors or/and the term evaluation, assessment, performance or effect. If all these searches did not result in a type of evaluation document, the search ended, and the conclusion was made that no evaluation could be found in the amount of time available. This eventually happened for 10 of the 52 cases, whilst for the other 42 cases evaluation documents were found with this search strategy.

For these 42 cases, characteristics were collected on the NBS that were being evaluated. The sample mainly includes sustainable neighbourhoods, followed by sustainable urban drainage systems (SUDS) and urban parks (see figure 6 below). Green squares, green roofs and pocket parks were to a lesser extent included in this sample. The one 'other' case refers to the Sand Engine project in The Hague which represents a form of coastal protection. Most of these NBS took place on the street or neighbourhood scale (64%) (figure 5), whilst green roofs and squares (both 100%), as well as forms of urban agriculture (83.3%), and some community gardens (40%), were mainly implemented on the micro-scale. Three NBS stretched more than one neighbourhood, taking place on a city-wide scale, which included the Ribbon as part of Maximapark in Utrecht, the City Island Tour in Utrecht, and the Sand Engine project.

Figure 5
The spatial scale of NBS

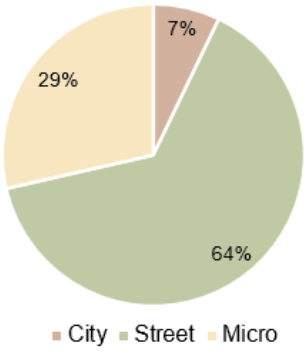
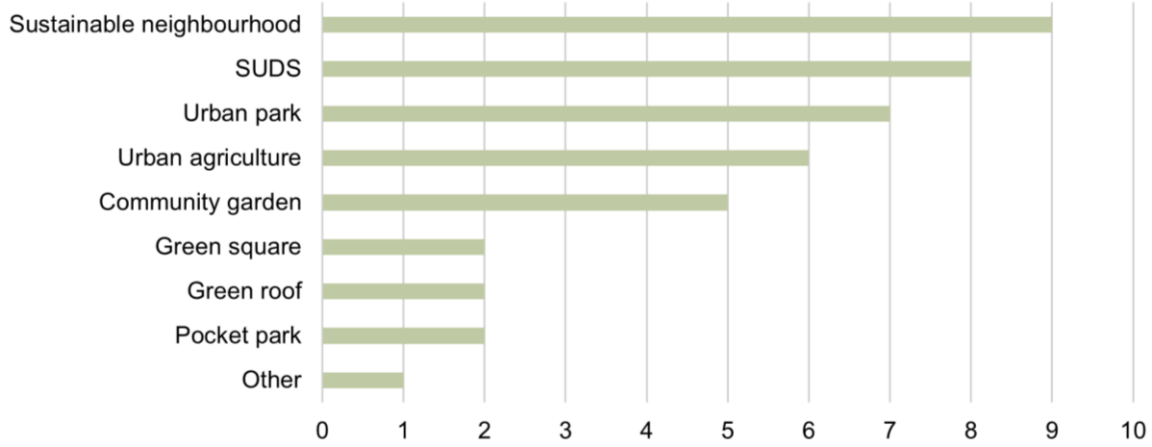


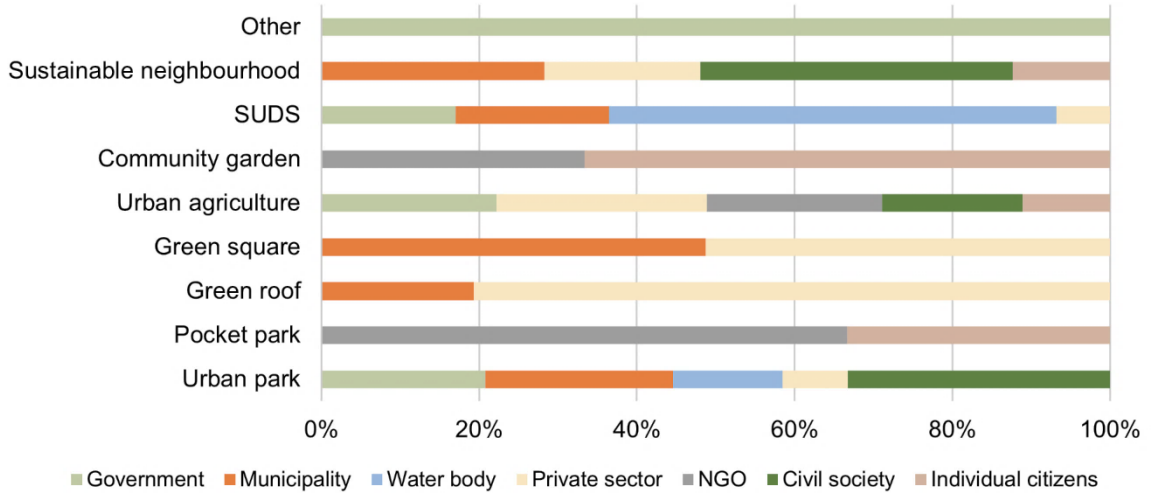
Figure 6
The type of NBS



Most of these initiatives are initiated by municipalities (35.7%), a similar finding to Bulkeley et al. (2023), who state that municipal actors are key initiating, implementing and financing actors regarding NBS. This can also be observed in figure 7, showing the key initiating actors per type of NBS. Municipalities are followed by the private sector (17,9%), which is mainly involved in initiatives regarding green roofs and squares, and urban agriculture. Individual citizens, initiating 14.3% of the cases, are mainly involved in community gardens, whilst the water bodies, initiating 10.7% of the NBS, are predominantly, but not surprisingly, involved in SUDS.

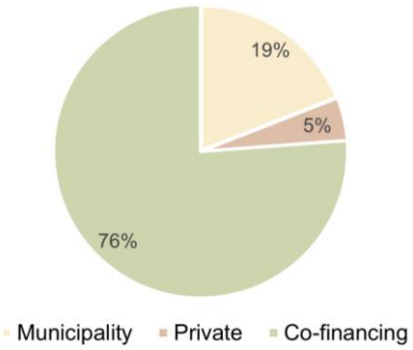
Moreover, community gardens as well as pocket parks are the type of NBS predominantly initiated by civil society actors. Civil society groups initiated 8.9% of the NBS in this sample, and NGOs 7.1%. As the findings of this research also indicate, NGOs and civil society groups are to a lesser extent involved in initiating NBS (Bulkeley et al., 2023). Additionally, NBS implemented on a city-wide scale are mainly initiated by governmental actors (50% of their NBS), while municipal (76.2%) and water bodies (83.3%) are mainly involved on the street scale. The private sector is predominantly initiating NBS on the micro-scale (60%).

Figure 7
The key initiating actors per type of NBS



Co-financing arrangements appeared to represent most forms of financing for the included NBS (76%), followed by municipal funding (figure 8). NBS that are funded solely by European, national or provincial governments were not found, reflected in the prevalence of co-financing partnerships. Such partnerships are recommended by Bulkeley et al. (2023), as diversifying sources of finance can assist in the implementation of NBS whilst contributing to the longevity of NBS.

Figure 8
The means of financing NBS



3.2: Data collection methods and data processing

Multiple data collection methods were used to gather the information needed to answer the main research question and its sub-questions. The use of multiple data sources enables a triangulation of the results which strengthens the internal validity of the research whilst allowing an in-depth analysis of the cases resulting from the use of various sources (Verschuren et al., 2010).

For the first step of this analysis, a document analysis is used to gather and analyse the evaluation documents regarding the urban NBS cases. As already mentioned, 42 evaluation documents of the 52 initial cases were found through a similarly applied search strategy. Scientific as well as non-scientific and grey forms of articles, reports and other documents were gathered through this process, as long as they involved an evaluation or assessment of one of the Dutch urban NBS part of the case study sample. These documents may have been created by actors involved in the process of designing, implementing, or evaluating the NBS (e.g., municipality) or external actors (e.g., scientists). Both the site of the Urban Nature Atlas and Atelier Green and Blue were used as starting points for this document analysis, as they already collected relevant information and sources. The program Microsoft Excel was used to store the characteristics of the evaluations collected during this process. Additionally, the program IBM SPSS Statistics was used to perform descriptive statistics to summarize and better understand the sample of evaluations and their characteristics (Braude & Low, 2010). Because SPSS uses certain types of variables, a transformation of the variables collected during this first analysis to either nominal (or categorical), ordinal or interval/ratio scales is necessary (Bryman & Cramer, 2012). How this is done for the variables conducted in this research can be viewed in Appendix 2.

The document analysis is supplemented by semi-structured interviews with actors involved in either commissioning or conducting evaluations on one of the urban NBS that are part of the case study sample. These interviews increased and deepened the knowledge about the practice of evaluating and conducting research on urban NBS in the Netherlands. The interview participants were thus selected based on their involvement as commissioning or conducting actors in one of the evaluation analysed, a characteristic that was captured in the Excel database for each of the evaluation documents. A total of ten participants were interviewed, and an overview of those participants can be viewed in table 5. The interviews were guided by an interview guide, consisting of general questions asked to each respondent, based on the analytical framework and thus covering the consideration of the evaluation principles by the interview participants. These general questions were supplemented in each case by more specific talking points based on the evaluation in which the participant in question was involved. The interview guide can be found in Appendix 4. The interviews provided the research with useful information from multiple and diverse perspectives on the practice of evaluating and/or researching NBS.

Table 5

Overview of the ten interview participants and their characteristics

Participant number	Time and place interviewed	Evaluation involved in	Type of work
1	28-04-23, online	Neighbourhood Stadswerven, Dordrecht	Researcher at a water knowledge organisation
2	02-05-23, online	The Ribbon Maximapark, Utrecht	Consultant at knowledge organisation
3	02-05-23, online	Neighbourhood Eva-Lanxmeer, Culemborg	Academic researcher
4	03-05-23, online	Erasmus Canal Filter, Amsterdam	Senior policy advisor at water organisation
5	03-05-23, online	Neighbourhood Cherry Garden, Utrecht	German NGO
6	03-05-23, online	Neighbourhood Groene Mient, The Hague	Knowledge and network organization
7	04-05-23, online	Green Strip Zuidas, Amsterdam	Researcher at a water organisation
8	04-05-23, online	Wadi Ruwenbos, Enschede	University lecturer
9	15-05-23, online	City Island Tour, Utrecht	Landscape architect for a municipality
10	24-05-23, online	Community garden Trompenburg, Amsterdam	University lecturer

All ten interviews were conducted online through Microsoft Teams and lasted for half an hour to an hour. With the permission of all ten respondents, the interviews were recorded through Teams and transcribed. As all participants, except one, were Dutch, the interviews were also translated into English during the transcription process. The transcripts have been coded in the program NVivo following a deductive and thematic coding process guided by the analytical framework (Braun & Clarke, 2012). The thematic analysis allows for the identification of patterns across a data set, offering insights into meaningful, shared and collective themes. From a deductive perspective, this allows the identification of themes that are particularly meaningful to the concepts and topics displayed in the analytical framework and therefore relevant and useful to enrich the answers to the research questions. Moreover, a thematic analysis is described as an accessible qualitative research method that suits itself well for studies using multiple methods (Braun & Clarke, 2012).

Since data from people, namely the participating interviewees, were collected during this part of the research, some ethical issues need to be considered. First, the interviews were only recorded with the consent of the interviewees. The informed consent of the participating interviewees was assured by extensively informing them about the research. Moreover, the participants were informed beforehand that their participation in the research is voluntary, and that they could withdraw from the research at any time. Transcripts from the recorded interviews were anonymously analysed for the scientific purposes of this research only. Therefore, the personal information of the interviewees were replaced through data pseudonymization to safeguard the privacy of the interviewees.

4 – Results

The results chapter discusses the most important findings from the methodology applied to the evaluation case study sample, to explore how current evaluations of Dutch urban NBS take the six evaluation principles into account and what this implies for the transformative potential of NBS. Section 4.1 describes the characteristics of the evaluation sample based on descriptive statistics performed in SPSS, which provides insights relevant to the first sub-research question on how Dutch urban NBS are currently being evaluated. Section 4.2 describes the observations from the descriptive statistics performed on the level of alignment of the evaluation sample to the six evaluation principles. This section sheds light on the overall match between the evaluation sample and the six evaluation principles, representing the potential of current evaluations to contribute to the transformative potential of NBS. To clarify, figure 9 once more shows the six evaluation principles, together with their leading question that guided the empirical investigation of the evaluations. Afterwards, sections are devoted to each of the six evaluation principles, diving deeper into how the evaluation sample aligned with each individual principle. Each section describes how the principles are addressed in the analysed evaluation documents, reflecting the consideration of the principles from a policy document perspective. This is supplemented by data from the ten interviews, reflecting a perspective from practitioners in the field of researching or/and evaluating NBS. These six sections provide insights relevant to the second and third sub-questions on how current evaluations of Dutch urban NBS consider the evaluation principles and what this means for their potential to contribute to the transformative change of NBS. But first, the characteristics of the evaluations of these NBS are discussed to understand the type of evaluations to which the principles were applied.

Figure 9

Overview of the six evaluation principles and their leading questions

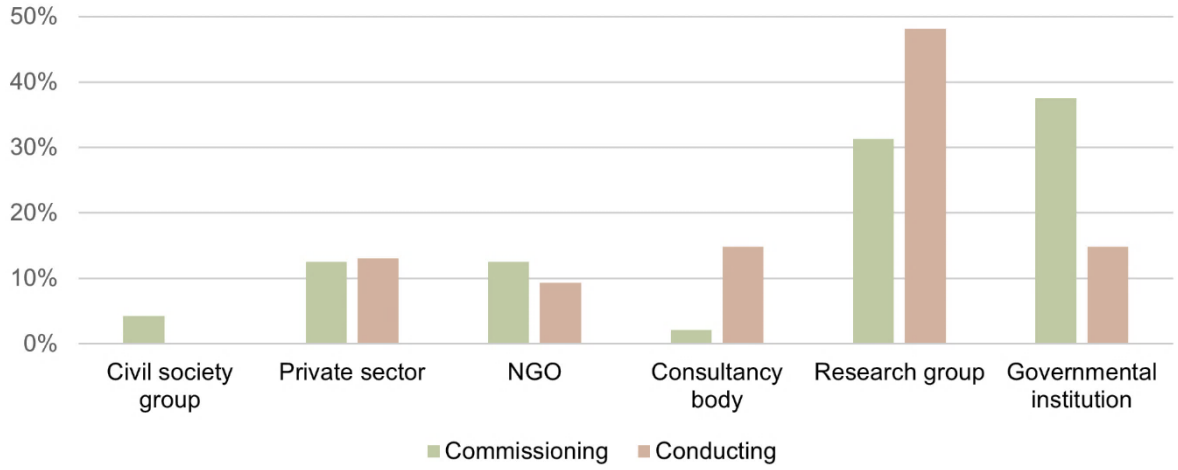
Evaluation principles	Leading questions
Principle 1 Addressing underlying causes	Does the evaluation consider one or more of the underlying causes as identified by IPBES (2019) and discussed in Bulkeley et al. (2023)?
Principle 2 Multiple benefits	Does the evaluation address both environmental, as well as social and economic benefits?
Principle 3 Trade-offs	Does the evaluation address possible trade-offs between objectives or values of the NBS?
Principle 4 Inclusivity and equality	Which stakeholders, if any, are involved and at what level of participation are these stakeholders involved?
Principle 5 Unintended consequences	Does the evaluation address the dimensions of distributive, procedural and recognition justice?
Principle 6 Monitoring and evaluation	Does the evaluation capture non-tangible benefits, as well as long-term effects, by means of qualitative methods besides a sole focus on quantitative ones?

4.1: Describing the characteristics of the urban NBS evaluations in the Netherlands

Several characteristics of the evaluation documents on the NBS were collected. Most of the evaluations are conducted ex-post (76.2%), whilst 10 evaluations are conducted ex-ante. Both evaluations take place in different phases of the policy cycle, where ex-post evaluations take place after the implementation of an intervention to assess its outcomes (Mickwitz, 2006). Ex-ante evaluations are pre-assessments of an intervention, taking place before a policy or plan is implemented, which is required in many countries, as well as in the Netherlands, in the form of an environmental impact assessment (EIA, or in Dutch: MER) (Mickwitz, 2006). The ex-ante evaluations are mainly commissioned by governmental actors (70%), and indeed often entail an EIA by an consultancy to consider the environmental impacts of a new development plan (examples include Molenvlietpark in The Hague or City Island IJburg in Amsterdam). Other ex-ante evaluations involve the assessment of different planning options before a plan is implemented (examples include City Island Park Tour in Utrecht or Water System Leidsche Rijn, also in Utrecht).

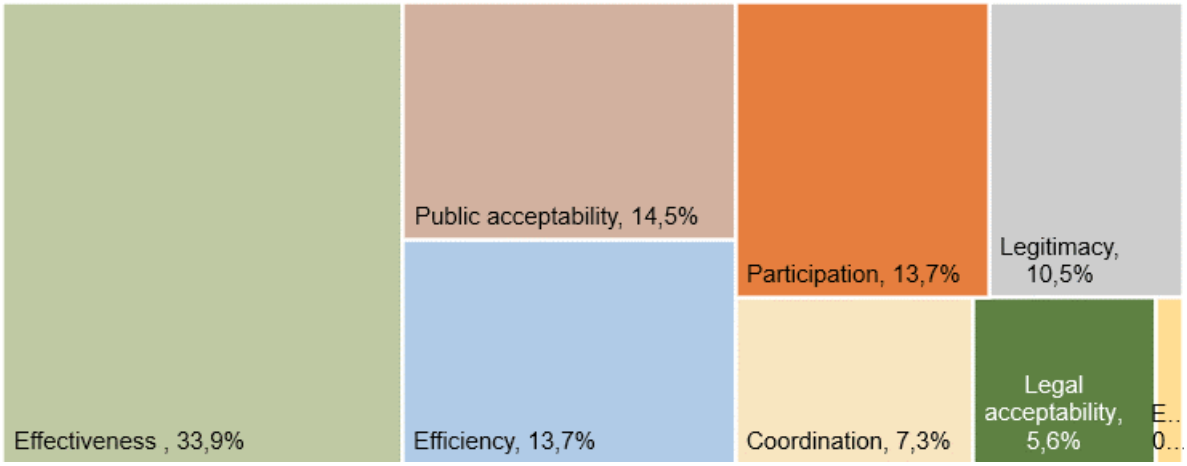
Governmental institutions (37.5%), as well as research groups (31.3%), are the main commissioning actors, whilst research groups also predominantly conduct evaluations (48.1%) compared to the other actor groups (figure 10). The research groups of the current sample consist of various Dutch independent knowledge institutions regarding the topics of (urban) water management, soil or sustainability. Additionally, universities from different cities in the Netherlands have been identified as conducting actors within the category of research groups. The analysis demonstrates that all evaluations conducted by such research groups are assigned with a learning purpose, whilst those evaluations conducted with an accountability purpose are mainly done by governmental actors (50%). Moreover, such evaluations with an accountability purpose are mainly commissioned by governmental actors (87.5%), for example related to the Dutch legal requirement of conducting an EIA when a new zoning plan is developed. NGOs, civil society groups and the private sector are to a lesser extent involved in the process of commissioning and conducting evaluations as compared to governmental and research institutions. This is in line with the findings of Bulkeley et al. (2023), who indicate that NGOs and civil society groups might not have the resources to conduct evaluations, whilst the private sector might be concerned about negative publicity.

Figure 10
The commissioning and conducting actors of the evaluations



All evaluations included in this sample evaluated the effectiveness of the NBS in question, which reflects the general definition of evaluations in the environmental policy domain, as well as the rational perspective on evaluations, to assess the performance of policies (Crabb & Leroy, 2012; Kunseler & Vasileiadou, 2016). Effectiveness is in this case related to the attainment of the goal of the NBS, which can be environmental, as is mostly the case for SUDS or green roofs, or social, which is often the case for community gardens or pocket parks. Although this rational perspective is also associated with efficiency as an indicator, for example related to cost-effectiveness, only 13.7% of the evaluations used efficiency as an indicator. Here, the criteria of legitimacy (10.5%), public acceptability (14.5%) and participation (13.7%), reflecting the reflexive approach to evaluations, are used to a similar extent as the indicator of efficiency (figure 11). The fact that only one evaluation considered equity as indicator, understood by Mickwitz (2006) as the distribution of costs and benefits of an environmental policy, underlines the statement that these aspects of NBS are often not captured in the evaluation of urban NBS (Baró et al., 2021; Dumitru et al., 2020; Frantzeskaki et al., 2019). The evaluation of the sustainable neighbourhood the Cherry Garden in Utrecht captures equity through the criteria of ‘values’, finding for example that residents valued the mixed tenure within the neighbourhood that created a feeling of equality and equal treatment of both owners and renters.

Figure 11
Overview of the criteria used in the evaluations



The main method used to evaluate the cases is a document analysis (figure 12), whilst no evaluation made use of social experiments, described by Huitema et al. (2011) as a participatory methodology that can for example include games. The study by Huitema et al. (2011) was the first to conduct a meta-analysis of evaluations on climate policies in European countries, where social experiments, questionnaires and interviews were characterized as participatory. Of the cases examined in the current research, nearly 27% made use of questionnaires or interviews and can thus, according to Huitema et al. (2011), be regarded as participatory. This mirrors the finding of Huitema et al. (2011), where only 25% of the 259 evaluations were categorized as participatory. Besides, according to the levels of participation deployed in the current research, questionnaires and interviews are still regarded as tokenistic forms of participation, operating on the level of consulting where the evaluation is merely presented to actors to register their inputs (Kiss et al., 2022). This differs from the deeper level of participation where actors can collaborate or co-decide on certain aspects of the evaluation, reflecting real agency and decision-making power to actors which is not provided when they are asked to fill out a questionnaire or conduct an interview. The relatively large category of 'other' mainly includes those evaluations that were conducted by actors involved in the NBS in question. These evaluations included no type of methodology, appearing to be based on their own experience with and expertise of the NBS. This was for example the case with Green Slachthuis Square, which was evaluated by a municipal officer that was involved in the Neighbourhood Improvement Plan that also concerned this square. Moreover, this category for example includes the sporadically used methods of field trips, spatial analysis or participant observation.

Figure 12
Overview of the methods used in the evaluations

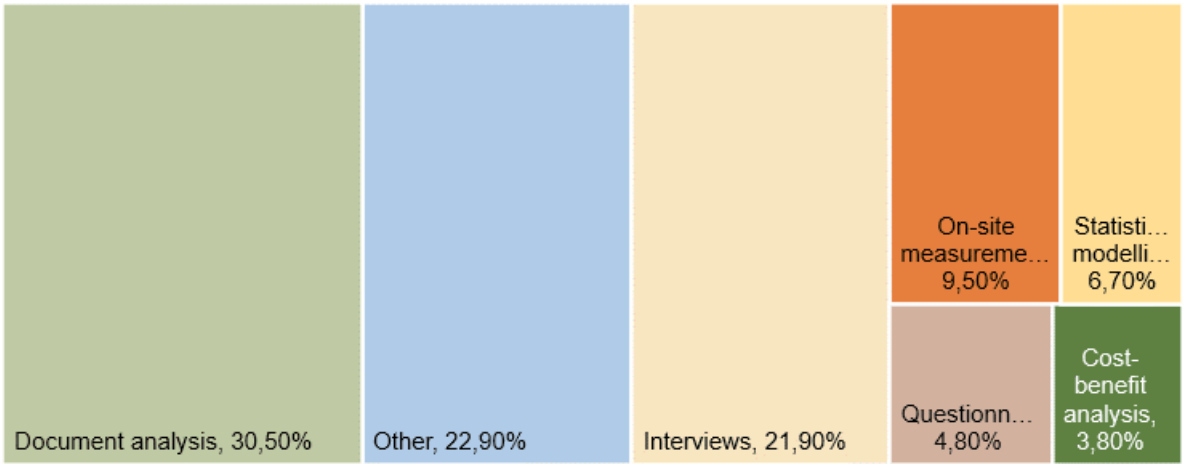
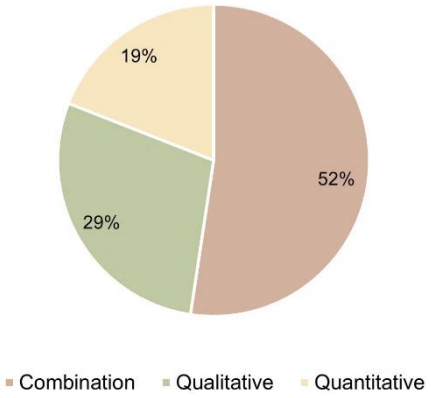


Figure 13 indicates that the sample mainly includes evaluations that used a combination of qualitative and quantitative methods (52%). Moreover, 81% of the evaluations made use of two or more methods, with the largest portion (40,5%) using two different methodologies. A document analysis combined with interviews, as well as a document analysis combined with on-site measurements, are the most prevailing combinations when two methods are used. 19% of the sample thus solely made use of one methodology, while it is argued that a triangulation of methods in policy evaluations is valuable to identify and bring attention towards the unintended consequences of policy interventions (Mickwitz, 2006; Huitema et al., 2011). Moreover, as figure 13 indicates, the same percentage (19%) of the evaluations is solely based on quantitative valuation methods. Green roofs are solely evaluated by quantitative methods (100%), followed by SUDS (75%). As the literature indicates, these evaluations may have difficulties with capturing the multiple benefits, trade-offs and unintended consequences of NBS, pointing towards a limited contribution of these evaluations to the transformative potential of NBS. The following chapter continues to analyse the evaluations by exploring their consideration of the six developed evaluation principles.

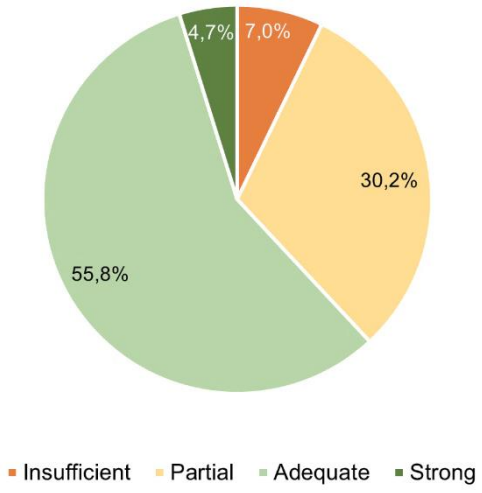
Figure 13
Type of methodologies used by the evaluations



4.2: Exploring the level of alignment to the evaluation principles

All evaluations obtained an overall match based on the level of alignment of each evaluation to the six principles. As described in the methodology, the evaluations are given a level of alignment for each individual principle, ranging from insufficient (1) to strong (4), and the overall match can be obtained by calculating the average of these six scores given to each of the evaluation principles. Overall, the evaluations in this sample obtained an overall match of 2.6 on average. This value correspond to an adequate level of alignment, revealing that most evaluations (55.8%) are adequately in line with the evaluation principles (figure 14), which further means that a majority of the evaluations to some extent contributes to the transformative potential of NBS. The evaluation of the Polder Roof Zuidas in Amsterdam obtained the lowest overall match of 1.2, meaning that this evaluation is insufficiently in line with the evaluation principles and does not contributes to transformative change. The evaluation of neighbourhood the Cherry Garden in Utrecht obtained the highest overall match of 3.8, strongly aligning to the evaluation principles and considerably contributing to the transformative potential of NBS. No evaluations thus completely adhered to all six evaluation principles, which would correspond to a score of 4.

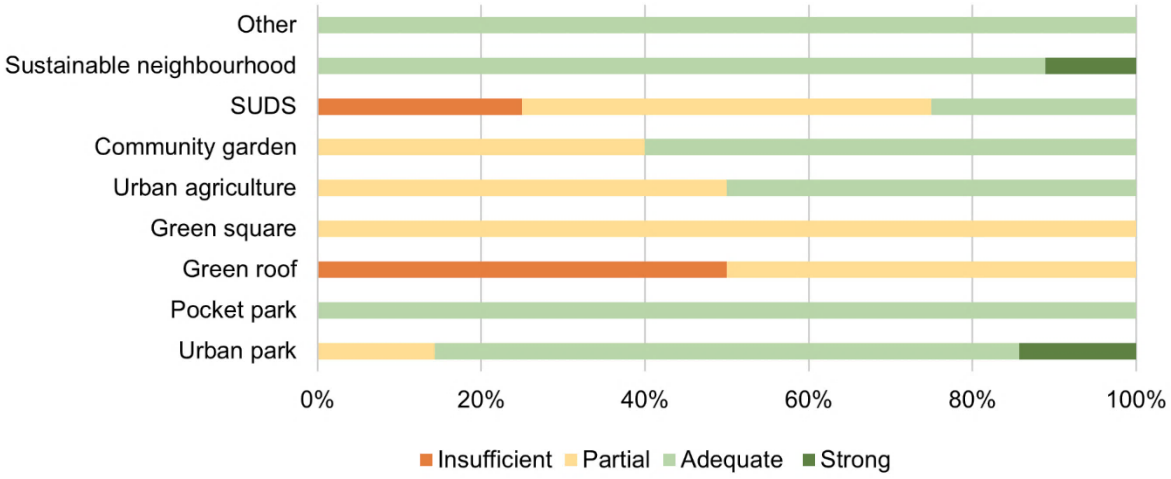
Figure 14
Overview of the obtained overall match by the evaluations



Furthermore, 30.2% of the sample partially aligned with the evaluation principles. Also, a larger share of evaluations (7%) insufficiently aligned with the principles compared to those that strongly aligned with the principles (4.7%). Regarding the different types of NBS in this sample, it can be observed that mainly SUDS and green roofs obtain an insufficient score, whilst pocket parks, urban parks and sustainable neighbourhoods overall obtained a higher level of alignment with the evaluation principles (figure 15). As SUDS and green roofs are predominantly evaluated using quantitative valuation methods, this might provide an

explanation. Indeed, the evaluations scoring insufficient are all solely based on quantitative methodologies, while those using qualitative (75%) or a combination of methods (68.2%) mainly obtained an adequate overall match.

Figure 15
Overview of the level of alignment per type of NBS



Besides, it is checked whether the amount of information in the evaluation documents influenced the overall match obtained by the evaluation. One could argue that an evaluation of a larger size has more space and resources to address each of the six evaluation principles. The amount of information is categorized along three levels, visible in table 6. A Pearson correlation indicates that the relationship between the amount of information present in an evaluation and the overall match obtained with the six evaluation principles is not significant $r([40]) = 0.239$, $p = [0.128]$. This means that a higher amount of information present in the evaluations does not correspond to a higher obtained overall match. Also, only a slight percentage of the evaluations (16.7%) display a small amount of information.

Table 6
Categorization of the amount of information present in the evaluations

Amount of information	Description	Presence in sample
Small	A maximum of 5 pages	16.7%
Medium	More than 5 but less than 10 pages	33.3%
Large	More than 10 pages	50%

Table 7 summarizes the statistical variables of the six evaluation principles, as well as the overall match. Principle 6 of monitoring and evaluation scores on average the highest, whilst the principles of unintended consequences and inclusivity and equality score considerably lower on average. This is also reflected in the most frequent level of alignment for these principles, which is partial for inclusivity and insufficient for unintended consequences. Principle 3 of trade-offs also reflects a most frequent level of insufficient whilst scoring on average higher, which is explained by the level of insufficient and adequate having the same frequency of occurrence in the sample.

Table 7
The statistical variables for the six evaluation principles and the overall match

	P1: Drivers	P2: Multiple benefits	P3: Trade-offs	P4: Inclusivity and equality	P5: Unintended consequences	P6: Monitoring and evaluation	Overall match
Mean	3.02	3.02	2.52	1.71	1.76	3.29	2.55
Median	3	3	3	2	2	4	2.67
Mode	4	3	1	2	1	4	2.70
Standard deviation	1.179	0.897	1.174	0.742	0.850	0.918	0.646

Figure 16
Overview of the level of alignment for the six evaluation principles

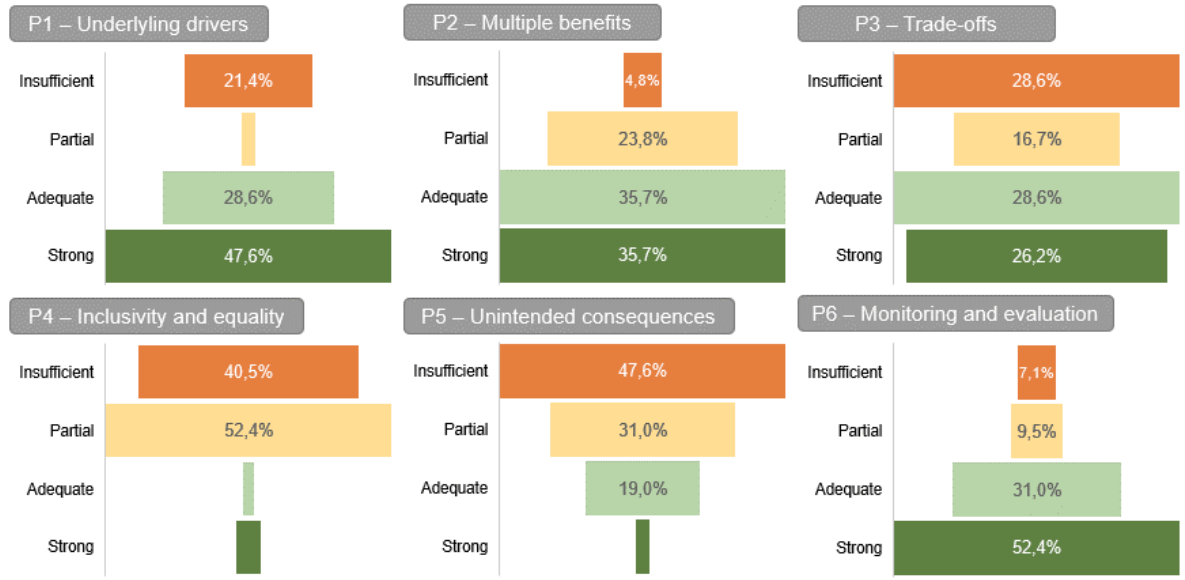
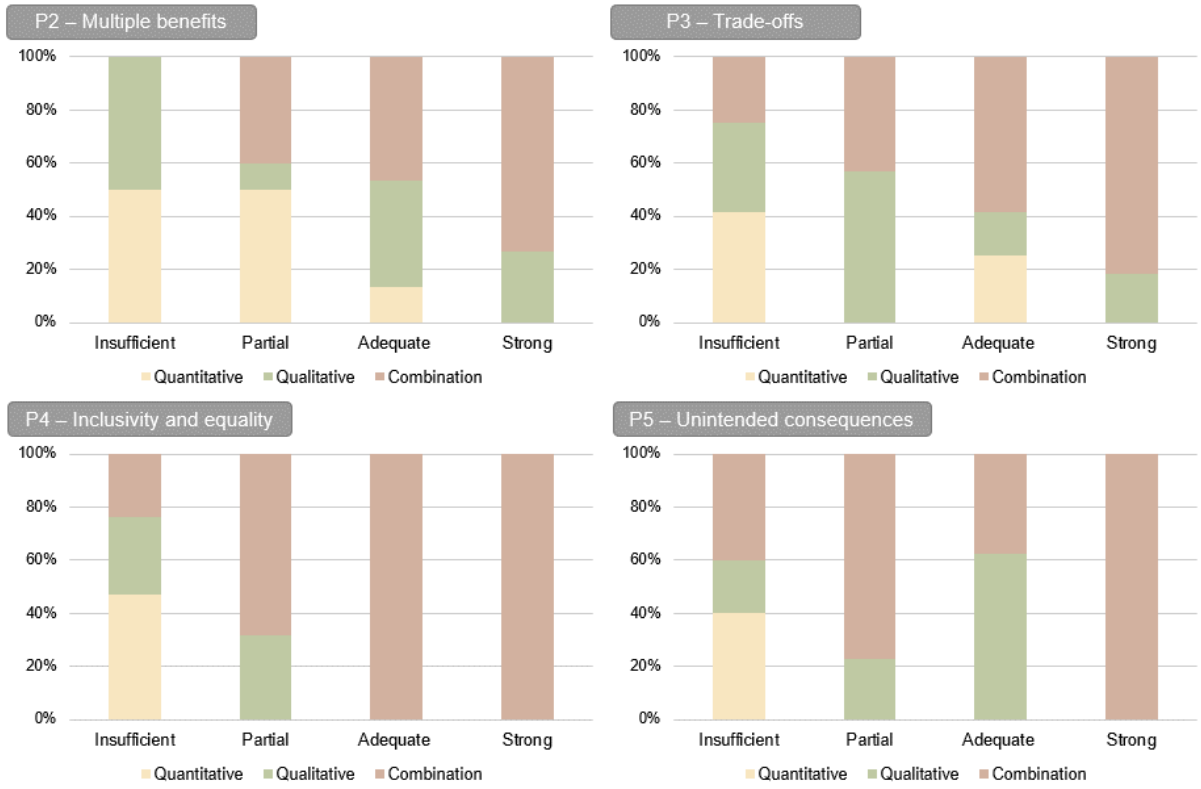


Figure 16 further visualizes the differences in alignment across the six principles, showing that the principles of inclusivity and unintended consequences scored considerably lower when compared to the principles of underlying drivers or multiple benefits. Furthermore, as has been stated before, evaluations solely using quantitative methods fail to properly capture the multiple benefits, trade-offs and unintended consequences of NBS. Indeed, for the principles of multiple benefits, trade-offs, inclusivity, and unintended consequences, quantitative methods are mainly represented in the level of insufficient alignment, barely on the level of adequate alignment and not on the level of strong alignment (figure 17). In contrast, the levels of adequate and strong alignment are predominantly characterised by the use of a combination of methods and qualitative methods. Especially regarding inclusivity and unintended consequences, quantitative methods are solely used for those evaluations that obtained an insufficient level of alignment, underlining the statements in literature that evaluations based on quantitative valuation methods can not properly capture the unintended consequences and inclusivity aspects of urban NBS. To further unravel how the sample of evaluations did or did not sufficiently address the evaluation principles, and what this indicates about the contribution to the transformative potential of NBS, the following sections discuss the level of alignment between the evaluations and each of the six principles individually.

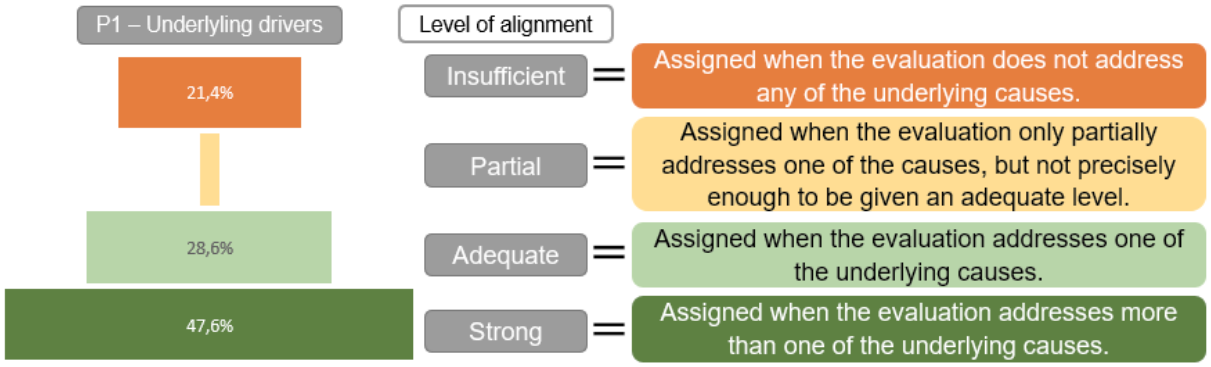
Figure 17
Distribution of the type of data method used over different principles



4.3: Analysing Principle 1 – Underlying drivers

This section provides insights on the performance of the evaluations regarding principle 1 – underlying drivers, based on the question if the evaluation considered any of these drivers. Three underlying drivers, derived from the IPBES (2019), were examined in this research, namely land use change and urbanization, unsustainable production and consumption and values of nature, related to the relationship between humans and nature. To clarify its meaning, figure 18 visualizes the level of alignment obtained by the evaluations and when this level of alignment was given.

Figure 18
The level of alignment for principle 1 – Underlying drivers

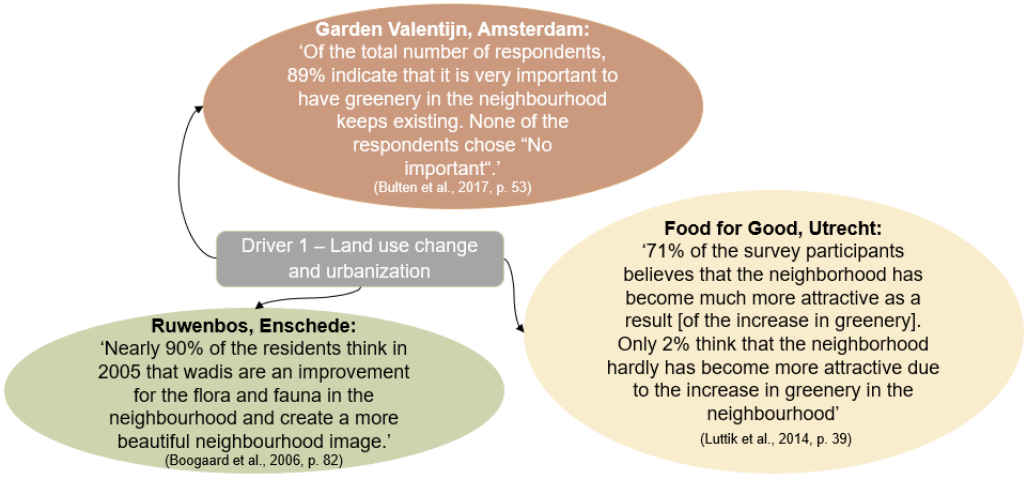


As figure 18 shows, almost half of the evaluations (47.6%) obtained a strong level of alignment, indicating that these evaluations addressed more than one underlying driver. However, still 21.4% of the evaluations insufficiently addressed this driver, indicating that no underlying drivers were considered. Of those evaluations that did address one of the underlying drivers, driver 1 of land use change and urbanization is addressed the most (45.5%), followed by driver 2 of sustainable production and consumption (32.7%) and driver 3 regarding values of nature (21.8%). The following three sections discuss how the three underlying drivers are addressed in the evaluation documents and the interviews. Driver 2 of sustainable production and consumption has in this regard not been extensively discussed in the interviews, as they were largely not addressed in the evaluations that were discussed during those interviews. However, the interviews did provide some useful insights into the experience of driver 1 of land use change and driver 3 of values of nature from a practical perspective, which the following two paragraphs will discuss.

4.3.1: Driver 1 – Land use change and urbanization

The evaluation documents addressing the driver of land use change mainly did so by stating the desirability for green spaces within growing cities and very paved neighbourhoods. This is for reasons ranging from improving and accommodating a healthy, attractive urban living environment, increasing habitat quality and biodiversity within cities, providing spaces of tranquillity to escape the hectic urban setting to creating places where one can move and sport in a car-free and safe environment. Most of the evaluations (11 out of 20) based these statements on results from interviews conducted with residents, users of the NBS, the relevant municipality, experts from for example universities and other stakeholders involved in the implementation of the NBS, such as a landscape architect, or a combination thereof. With residents or users of the NBS, the use, or wished use in the case of not yet implemented NBS, is discussed, as well as the importance of and appreciation for the added green in the neighbourhood. Often, when interviews are conducted with experts or municipal actors, the factors of success, but also possible or experienced obstacles, are discussed. Two of these evaluations additionally made use of questionnaires to involve the perspective of residents and users, in this case the community gardens. Four evaluations in total made use of questionnaires regarding conclusions on land use change, resulting from questions asked on the usage, importance of and value given to the NBS. Figure 19 exemplifies the kind of statements made in the evaluations by questionnaire respondents that reflect the appreciation for green spaces.

Figure 19
Illustrating statements from questionnaires used in evaluations regarding the appreciation of green space



The other seven evaluations that did not make use of interviews or questionnaires to involve the opinion of stakeholders came to the above-mentioned conclusions on land use change by making use of document analysis (8 out of 20) or field research (2 out of 20). The document analysis often used multiple types of sources, retrieving information from academic literature as well as policy documents, technical reports or other grey sources like newsletters or magazines. Moreover, 5 out of the 25 evaluation documents that addressed this driver merely did so by stating the aspiration of addressing biodiversity loss or climate change, instead of actually evaluating this aspect. This is for example seen in the evaluations of Rooftop Park B.Bylon and Water Buffer Spangen, which both indicate the enhancement of biodiversity and liveability in grey urban environments through urban nature but focus solely on evaluating the types of greenery on the roof respectively the functioning of the water buffer, not including the contribution of these NBS to the underlying driver of land use change.

The sample also included cases of sustainable neighbourhoods, which mainly consider this driver by addressing the transformation of previously grey areas, formerly having for example an industrial function, into a green neighbourhood within the city. Most of the evaluations of sustainable neighbourhoods (4 out of 6) based their statements regarding land use change on conducted interviews. Residents for example state a better urban living environment through the increase in green space, whilst often municipal officers or other implementing actors stress the ecological connections that can be provided through sustainable neighbourhoods.

Lastly, evaluations on urban agriculture address the driver of land use change by emphasizing the possibilities of food production within the city, for example on otherwise grey roofs or on neglected or unexpected places within cities that are, through its new function of food growing, being given new meaning. In the case of the Neighbourhood Garden Trompenburg in Amsterdam, the respondents from the interviews and questionnaires indicated the meaning given to the ability to practice food growing within the urban environment. The evaluation of Urban Farm ‘t Geertje touches upon the increased claims being made on land by urban citizens, threatening the spaces left for agriculture, where cities are seen as ‘competitors for the battle of land use’ (Caron-Flinterman et al., 2010, p. 1). However, this aspect is not incorporated in the actual evaluation but merely serves as an introduction for the concept of multifunctional agriculture. Here, it is observed again that evaluations exist that do not include the driver of land use change in the actual evaluation, but only state the desirability of urban nature in dense urban environments in the introduction.

But, this ‘battle of land use’ in urban environments is recognized by interview participants as well, in the context of growing urban populations and the consequent pressure to densify cities. However, a different perspective is also observed in the interviews, where the value of nature within the development of cities is being increasingly acknowledged. Both perspectives are supported by illustrative statements and presented in table 8.

Table 8
Two perspectives of interview participants on land use change, illustrated by interview statements

Perspectives on land use change	Illustrative statements
The battle between grey and green over space in cities	‘There is a **lot of pressure** on the urban area and the population is growing which **generally means more grey**. It is an enormous field of tension.’ *University lecturer – Wadi Ruwenbos, Enschede*
	‘I also know there is this **pressure to build** houses and to densify the city. There is this **tremendous tension** between greenery and building.’ *Consultant – The Ribbon, Utrecht*

	‘And it is really **tough to safe the space** because housing is really, really hard to get in Berlin at the moment and it is not getting easier.’ *NGO – The Cherry Garden, Utrecht*
	‘We have had **a tendency** in the Netherlands for years, regarding that there are so many homes that need to be added. Well, that **puts enormous pressure on the public space**.’ *Municipal landscape designer – City Island Tour, Utrecht*
The rise of green in predominantly grey cities	‘I also see in recent years, when it comes to housing, that there is **more attention for taking nature into account in the city**. And how to let that **go together** properly, there is more attention for that.’ *Knowledge organisation – Groene Mient, The Hague*
	‘I do have the idea that a lot of municipalities are **busy with greening**, and that does not apply only to green but also water. Previously filled-in canals are **now being dug open again**, to ensure more water storage.’ *Water researcher – Stadswerven, Dordrecht*
	‘On the other hand, there is this **really nice trend that is going against it**. We are banning more cars, and then I am talking about the larger cities, but that trend makes me very happy.’ *University lecturer – Wadi Ruwenbos, Enschede*
	‘And as a municipality, we have had the policy for a long time to densify within the existing city. But we now also have a spatial strategy that says; **we do not only want to build homes but also include greenery** and sports.’ *Municipal landscape designer – City Island Tour, Utrecht*

The municipal landscape designer, who recognizes the ‘enormous pressure on public space’ due to growing cities, also indicates that, when greenery is not included, ‘nobody will live here comfortably and that is also the assignment, that you can healthily live in the city’. This statement underlines the benefits nature can especially provide to the health and well-being of residents in dense urban environments. However, urban nature may still cause friction in dense urban areas, as pictured by a university researcher as follows:

> So actually, you have to design a neighbourhood in such a way that the tree can not cause any nuisance to the neighbourhood and to make it a part of the structure. A green structure that can grow old and mature has a lot of qualities that we need to deal with, for example, climate change (*Academic researcher, online, 02-05-23*).

This statement does, however, also underline the benefits urban nature can provide to tackle the negative impacts resulting from land use change and urbanization, and the climate crisis.

4.3.2: Driver 2 – Unsustainable production and consumption

The driver of unsustainable production and consumption is mainly addressed in the evaluations by either indicating the provision of alternative food networks or by enhancing the use of alternative modes of travel. The first is mentioned regarding community gardens, forms of urban agriculture, or the presence of communal gardens in sustainable neighbourhoods. The evaluations of these NBS often emphasize the provision of local and healthy foods to residents through short food chains which lower the distance between food production and consumption, indicated by the questionnaire respondents of both the evaluation of community gardens Food for Good and Trompenburg. The participants from the interviews at Urban Farm ‘t Geertje value this as well about the farm and indicate it as one of the reasons for visiting.

Such urban food growing practices are also said to increase the understanding of the production of food, which is something that traditionally takes place outside of the city boundaries.

The second point is mainly mentioned concerning sustainable neighbourhoods, where the aim is often to promote slow forms of mobility by creating an environment that stimulates walking and cycling and discourages the use of cars. In the evaluation of the neighbourhood Boszoom in Pijnacker-Notendorp, this point is addressed in the interviews as the creation of *living streets*, where green spaces instead of paved areas and parking spots are predominant, minimizing the visibility of cars whilst creating streets that are child-friendly and inviting to catch up with neighbours, indicated to be appreciated by the residents. Furthermore, some evaluations of sustainable neighbourhoods indicate low energy consumption, stemming from the often environmentally conscious residents living in such neighbourhoods. The evaluations of the Cherry Garden, Groene Mient and Erasmusveld all underscore this observation based on interviews conducted with residents, and in the last case expert meetings, including a province, a university and an architectural firm. The evaluation of Schoemaker Plantation takes a different approach, as the neighbourhood is at that time not built yet, where the ambition to create a slow traffic network is evaluated according to its fitting in already existing policies and plans of the municipality of Delft.

However, evaluations also exist, for example regarding the evaluation of Eva-Lanxmeer, where it is stated in the introduction that the way of living in this neighbourhood is characterized by environmentally conscious residents, but this is an aspect not carried through in the actual evaluation. Lastly, some evaluations briefly mention the (re-)use of sustainable, circular, or natural materials. However, this point is often not critically examined, as it remains unclear what is exactly defined as sustainable materials, how it will be applied in practice or how it can contribute to the underlying driver of unsustainable production and consumption.

4.3.3: Driver 3 – Values of nature within cities

The driver values of nature is first addressed by evaluations of mainly community gardens which state that involving people in the design, implementation and management of NBS fosters the engagement and ownership experienced by residents regarding their living environment. Interviews conducted in Eva-Lanxmeer as well as in the Cherry Garden indicate similar findings, where residents become more connected with nature and their living environment through the self-management of public space and communal gardening activities. An interview participant as well confirms the benefits of having NBS visible within cities, to increase awareness and understanding among urban residents, which may also lead to a change in people's behaviour. Moreover, a participant involved in a gardening project in Berlin indicates the importance of its educational purposes regarding the value of nature, 'especially for cities like Berlin or Amsterdam, where the closeness of nature is not a given'. The evaluators of neighbourhood Stadswerven also mention this positive relation between the visibility of nature and the experience residents have of nature. However, while the neighbourhood is at the time of the evaluation not built yet, they do stress the importance of investigating the values of future residents regarding the naturalness of Stadswerven, and whether this is actually being appreciated by its residents and aligns with the aspiration of the municipality of Dordrecht to contribute to a sense of place.

Such an investigation of the appreciation of urban nature can indeed be beneficial because tensions are also observed in the evaluation documents stemming from the different values and images urban residents have of nature in the city. The naturalness of the tidal park addressed in the evaluation of Stadswerven may, when residents and visitors are not properly informed about this, be considered as laxity in maintenance, as indicated by the evaluators. A similar tension is observed in the interviews conducted for the evaluation of the neighbourhood Boszoom, indicating that the project team first received emails from residents complaining about the neglect of maintenance resulting in a messy green environment covered with weeds.

Here, however, after explaining to the residents that such a lush environment is very beneficial for biodiversity, their appreciation for the green living environment increased. Both the evaluation of Stadswerven and Boszoom underline the importance of educating residents about the added value of such ecological nature for urban biodiversity. Indeed, an interview participant involved in the wadis in Ruwenbos, Enschede states that residents were often unaware of the functioning and benefits of the wadis for climate adaptation, whilst providing such knowledge to residents is said to increase their appreciation for such systems over a 'normal, more tight street'. However, whilst another participant working for a knowledge organisation agrees with the statement that re-naturing cities can foster new connections between humans and nature, this participant also underscores the complexity of the different images of nature that exist within cities. He describes this with the following example:

> For example, my father-in-law believes that a good garden and beautiful garden is grey with a tree or a bush here or there and where things like weeds need to be removed. And it is really impossible to get that out of his head, but it is better for nature to plant some wildflowers as well. It does strike me, that in various places the enormous raked and orderly gardens mean that there still exist completely different images about what nature is and what the value of nature is (*Knowledge organisation member, online, 03-05-2023*).

Most of the participants (7 out of the 10), including water and academic researchers, a university lecturer, a senior policy adviser and a landscape designer, describe the often negative values people have regarding biodiverse and more wildly organized nature spaces. This includes the fear of insects and other animals being attracted to these spaces and the perception that these wild areas are not pleasant to look at and are thus often seen as a sign of laxity in municipal maintenance. This is also observed by a municipal landscape designer, exemplified in the following statement:

> You just need thorn bushes or nettles for butterflies sometimes, but where are you going to put them? Because indeed, residents do not want them, their children can not play in them, or it does look messy too. It is not neat enough or not colourful enough. That is a dilemma because we also want to make a city together and collaborate with residents. So, it is a puzzle and yes, often a difficult balance. What do you do when residents say; nice those critters, but we do not care, and we just want our car in front of the door (*Municipal landscape designer, online, 15-05-23*).

Not only residents, but also different political departments, especially those that are not concerned with the topic of urban nature, have different wishes, ideas, and images of green within the urban environment, as indicated by a consultant, who was involved in an initiative from the Dutch government on nature inclusivity. He explains it as people from different ministries speaking different languages, where more biodiverse urban nature is seen as not being possible due to the attraction of insects and other animals, which complicates the cooperation between departments. A university researcher describes the observed preference for order in urban living environments, whilst indicating that such spaces, where biodiversity is low, also create more vulnerabilities to the consequences of climate change:

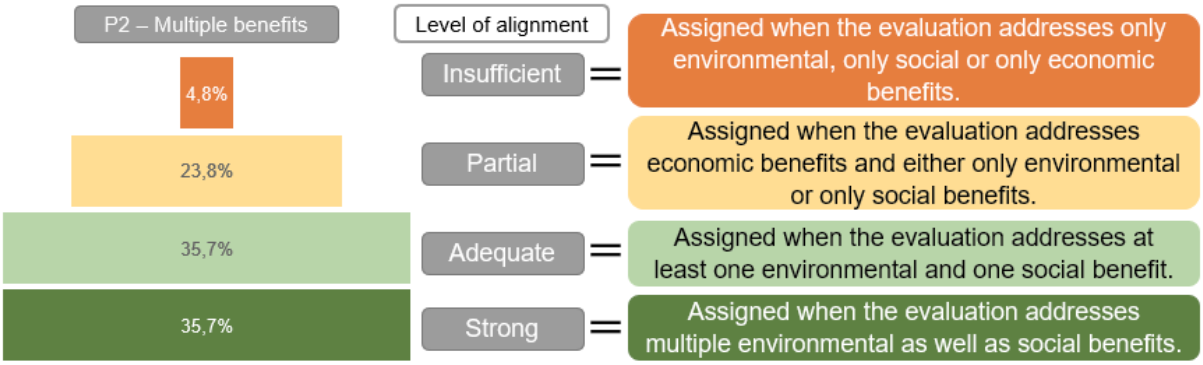
> The control and the fear of nature, which is also reflected in the discussion about the wolf, make it difficult to accept and underline the preference for order and neatness. But also, that order comes with negative effects and vulnerabilities (*Academic researcher, Online, 02-05-23*).

Such perceptions of nature are also indicated to be one of the reasons why certain green projects fail, underlying the importance of the opinion of residents on such interventions as they often take place in their front or back yard.

4.4: Analysing Principle 2 – Multiple benefits

This section provides insights into the performance of the evaluations regarding principle 2 – multiple benefits, based on the question if the evaluation addressed both environmental as well as social and economic benefits. To clarify, figure 20 visualizes the level of alignment obtained by the evaluations regarding this principle and when this level of alignment was given.

Figure 20
The level of alignment for principle 2 – Multiple benefits

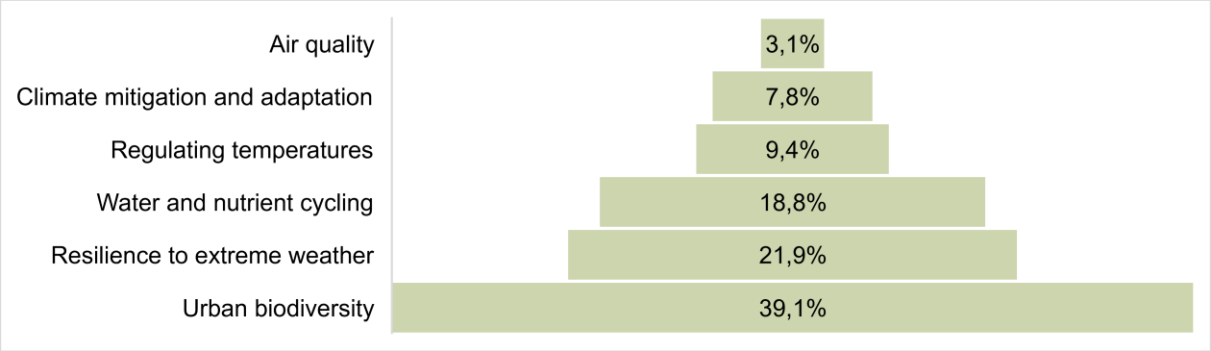


As figure 20 shows, 35,7% of the evaluations scored a strong level of alignment, thus complying with the principle of addressing multiple benefits for nature as well as humans at once. A similar percentage obtained an adequate score, indicating that these evaluations addressed at least one environmental and at least one social benefit. In total, three categories of benefits were examined. 37 out of the 42 evaluations addressed at least one environmental benefit, 35 of the 42 evaluations addressed at least one social benefit and 22 evaluations also addressed an economic benefit of the NBS. First, each of the categorized benefits is discussed separately, followed by a discussion of the provision of multiple benefits at once by urban NBS.

4.4.1: Environmental benefits

Most of the evaluations (39,1%) that addressed environmental benefits did so by addressing urban biodiversity, followed by resilience to extreme weather events (21,9%) and water and nutrient cycling (18,8%) (figure 21). Strikingly, climate mitigation and adaptation are only explicitly addressed by 7,8% of the evaluations, whilst urban nature is often praised as a contributor to climate mitigation and adaptation. However, four out of the five evaluations that addressed climate mitigation and adaptation also addressed urban biodiversity, so simultaneously considering the crises of climate change and biodiversity loss. All four regard sustainable neighbourhoods, indicating that these might be fruitful locations to implement NBS that address both climate change and biodiversity loss.

Figure 21
Distribution of the type of environmental benefits addressed by the evaluations



When addressing the benefit of climate mitigation and adaptation, this was mainly done by indicating the reduction in GHG emissions from a lower consumption of energy, something said to be important for residents in an interview about the neighbourhood Groene Mient. Also, the neighbourhoods of the Cherry Garden and Eva-Lanxmeer evaluated the environmentally conscious community living there, who are willing and wanting to contribute to climate mitigation and adaptation. In both neighbourhoods of Erasmusveld and Stadswerven, which still had to be built at the time of the evaluation, climate mitigation and adaptation are solely addressed as an aspiration of the municipality of The Hague, respectively Dordrecht, to realise a climate-adaptive neighbourhood.

Most evaluations who reflected upon the regulation of temperatures did so by discussing the contribution of the NBS to the urban heat island effect, consequently lowering temperatures and relieving heat stress. However, it is striking that the green and/or blue roofs that are included in this sample all stated the benefits of such roofs to lower the urban heat island effect, but none of them actually evaluated this stated benefit. Only one evaluation addressing the benefit of regulating temperatures evaluated this aspect through an interview, indicating that such benefits of sustainable neighbourhoods are being increasingly noticed and appreciated by residents.

Preventing flooding in the case of excessive rainfall is mentioned when addressing the increased resilience to extreme weather events, mainly addressed in evaluations of SUDS. These evaluations are often based on water infiltration measurements through which statements are made on the water storage function of the NBS in question, which is for example the case for the evaluations of the Green Strip Zuidas, the Water Buffer Spangen or the wadis in Ruwenbos. The last environmental benefit of water and nutrient cycling is often mentioned in the case of SUDS and green roofs, providing water storage functions, while purifying rainwater and reducing levels of phosphate and nitrogen, also largely based on measurement programs.

Urban biodiversity is more broadly addressed, indicating the environmental benefits to aquatic ecosystems as well as the increased ecological connections and habitats for birds, insects, and bees within fragmented urban environments. Whilst the evaluation of Food for Good explains the contribution green spaces can offer to the urban ecological structure in their chapter on the meaning of nature, partly based on scientific literature, this aspect is not evaluated in the rest of the document. This is in contrast to the evaluation of the Ribbon in Utrecht, where interviews with implementing actors state the added value of the ecological connections the park provides. However, the users interviewed in the same evaluation did not specifically mention this concerning their reasons for visiting the Ribbon, rather indicating their appreciation for its openness and variety in greenery. This may indicate that residents are often not aware of this broader intention of urban nature, as their contribution to the ecological structure of a city is often based on the ambition of a municipality, reflected in multiple evaluations of sustainable neighbourhoods that still have to be created. In those evaluations, urban biodiversity is often mentioned as one of the pillars of the neighbourhood concerning its wider contribution to the city's ecological structure and how this fits already existing municipal visions or other policy documents.

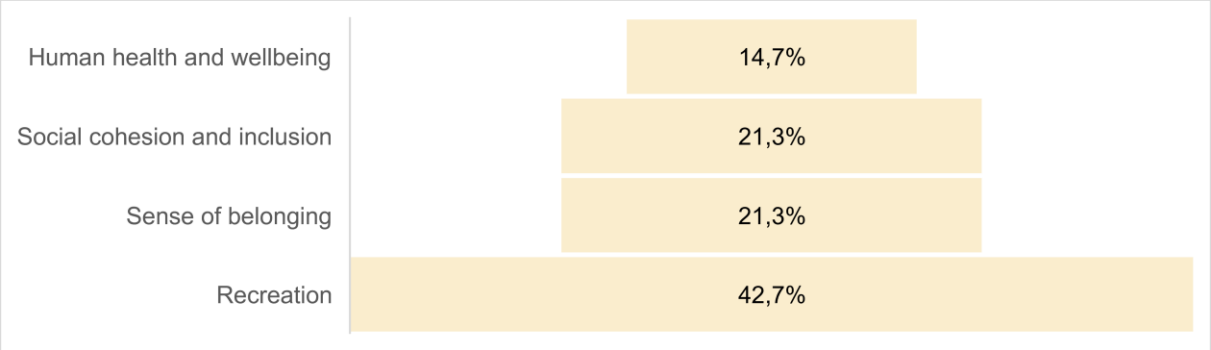
Often, urban biodiversity is not concretely measured but merely stated to be benefitted by the increase in green space, based on own expertise or experience with the NBS, but sometimes also corroborated by interviews or questionnaires that reflect the added value of the greenery in the eyes of residents or users. Strikingly, the evaluation of Rooftop Park B.Bylon in Amsterdam is the only evaluation in this sample that concretely measured the diversity of flora and fauna present on the roof. The evaluation of Eva-Lanxmeer attempted to also measure biodiversity, but critically states that the data collected proved to be insufficient and unstructured which hindered their ability to make substantiated statements about the development of biodiversity in the neighbourhood. The evaluators, therefore, propose a

monitoring system to systematically collect data on the development of biodiversity to be able to contribute to the discussion on the ecological benefits of sustainable neighbourhoods like Eva-Lanxmeer. Indeed, regarding the limited measurements of biodiversity reflected in the current sample, improving the monitoring of biodiversity can provide more meaningful inputs for debates on the benefits of NBS to biodiversity.

4.4.2: Social benefits

Those evaluations addressing the social benefits of NBS mostly did so by indicating the increased recreation opportunities for urban residents (figure 22). Human health and well-being are being addressed the least, whilst interview participants have indicated that creating a healthy living urban environment is often mentioned as a reason for municipalities to implement urban nature.

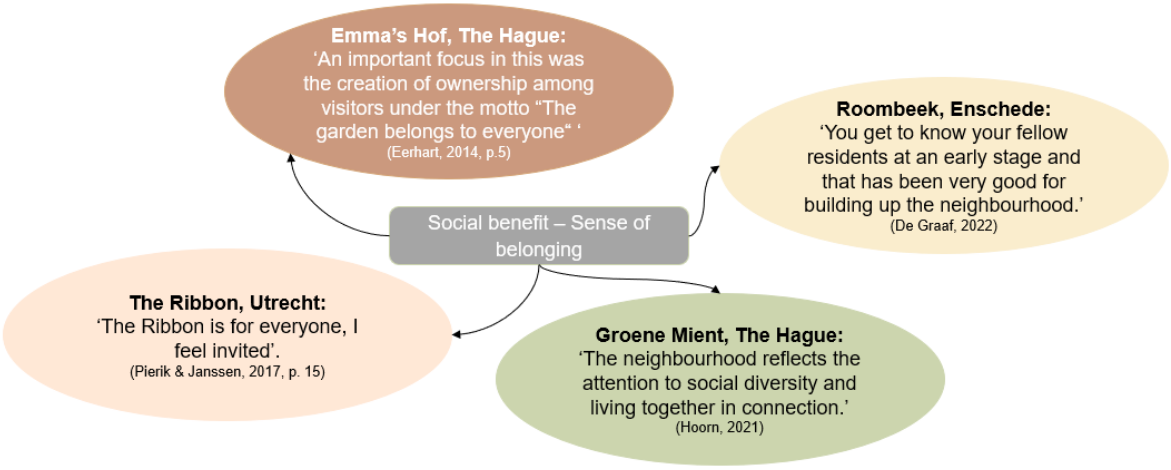
Figure 22
Distribution of the type of social benefits addressed by the evaluations



When health and wellbeing are addressed, this is indeed often in relation to improving the quality of the urban environment to create healthy living urban areas. Besides, the creation of a car-free environment where moving is stimulated to benefit one's health is also mentioned by interviews with users and implementing actors of the Ribbon. The EIA for the City Island IJburg underscore the benefits of the intended high-quality green spaces for the wellbeing of its residents, whilst the evaluator of the Cherry Garden also reflects on the wellbeing of the community to be high. However, other NBS solely state the stimulation of movement or the contribution to a healthy living environment as an aspiration, whilst not carrying this element through in the actual evaluation. Similarly, social cohesion is often said to be improved as NBS provide spaces for urban residents to meet and develop social contacts, however, such statements are rarely based on interviews with those intended beneficiaries but often stem from the own expertise of the evaluator(s) of the NBS, or on interviews with implementing stakeholders. All five community gardens of this sample did evaluate the aspect of social cohesion, and three of them did so with a combination of interviews and questionnaires among users of the garden that revealed the positive impact of community gardens on social cohesion as experienced by the participating users.

A sense of belonging is quite broadly addressed, for example related to a strong sense of community in the Cherry Garden resulting from the shared values of residents, based on conducted interviews. Figure 23 further shows comments made in the interviews of different NBS, reflecting the kind of statements on this social benefit of NBS. All statements stem from interviews conducted with either initiators (Emma's Hof), residents (Groene Mient and Roombeek) or users (The Ribbon) of the NBS.

Figure 23
Illustrating statements made in interviews from the evaluations on 'sense of belonging'



Note: De Graaf, 2022; Eerhart, 2014; Hoorn, 2021; Pierik & Janssen, 2017

Recreation is addressed by indicating the provision of green spaces to play, garden, relax, meet or organize parties. The evaluators of the Ribbon of Pocket Parks in Amsterdam indicate that such spaces 'correspond to the necessity to enable cheap recreation in the daily living environment' (Tolman & Witsenburg, 2013, p. 33). Providing such spaces is often stated in the design principles of to-be-developed urban parks or sustainable neighbourhoods, reflecting on the different recreational activities that will be provided by these NBS employing different green spaces. Furthermore, recreation is often mentioned in the evaluations as added benefit besides the primary function of the NBS in question, often based on statements from users or other stakeholders involved in initiating or implementing the NBS. The evaluation of the Bellamy Water Square in Rotterdam exemplifies this, where the designer mentions that, whilst the water square is primarily intended as a practical measurement to store water, he together with the residents also added qualitative additions to the square, providing residents with different recreational functions under which a garden and a playground for children.

4.4.3: Economic benefits

The economic benefits were not categorized like the environmental or social benefits. When the economic benefits from NBS were addressed in the evaluations, this mostly related to the economic opportunities provided by the urban green space, for example by providing room for catering or by selling the harvest from urban farms to residents or local restaurants or canteens. Evaluations of sustainable neighbourhoods often mentioned the economic benefit of the self-management by residents in those neighbourhoods, as it results in less cost for the municipality. Lastly, it is also often mentioned that the (re-)development of sustainable neighbourhoods increases the attractiveness of the neighbourhood, where the value of living near green and blue spaces is reflected in the housing prices. Whilst this may indeed provide economic benefits to some actors, like housing developers, it may also induce a process of green gentrification, which does not benefit those who can not afford to live in or near these attractive green and blue neighbourhoods.

4.4.4: NBS and the provision of multiple benefits at once

More than two-thirds of the evaluations considered the multiple benefits NBS can provide for both the environment as well as for humans. Also, multiple interview respondents (6 out of 10) stated the value of the multiple benefits provided by NBS and additionally indicated the value of capturing these benefits when researching and evaluating NBS. This is because showcasing these multiple benefits is said to strengthen the support for NBS, underlined by a participant from a water organization, stating that capturing the multiple benefits of NBS is only valuable when these are all proven and backed up by research. A water researcher notices that

nowadays ‘mostly opinions or things that logically make sense are going around’ about NBS. A different water researcher similarly states that NBS ‘are being praised as something that is going to fix it all, but that is very disappointing in practice’, when looking at certain research results. When NBS are easily praised for their multiple benefits that logically make sense, this may lead to many false claims, ‘nullifying the credibility of many positive stories’, as indicated by the first mentioned water researcher. These statements underline the importance of conducting proper evaluations of NBS to solidify their delivery of possible multiple benefits at once and to strengthen the evidence base of NBS based on proven instead of false claims.

However, not all interview participants holistically evaluate NBS. A water researcher states that ‘evaluation can be very broad regarding all the aspects of NBS, but that is something that I do not do very often’, indicating the sole focus of a current project on water quality. Another water researcher similarly states that evaluations should primarily focus on the compliance of the NBS to its assigned function. The following statement exemplifies this:

> You have to look at what is the intended goal, does the intervention meet this goal and what management and maintenance are necessary. In addition, at the very end, you can also consider a piece of amenity value. If you have two interventions that function exactly the same and have the same costs over their entire life cycle and are both sustainable, then you could look at what the residents think, who might like this more than the grey or vice versa. But that comes all the way at the end as far as I am concerned. I think you should keep yourself far away from that because that is different for each person (*Water researcher, online, 04-05-23).*

The correct functioning of the NBS should be the primary focus of evaluations according to this perspective, whilst other, more intangible benefits that may be provided by the same NBS come ‘all the way at the end’ of the evaluation process. Different kinds of benefits may also be more frequently assigned to certain types of NBS, exemplified by a university lecturer who researched community gardens, where social effects are the primary focus. This participant also mentions the example of urban agriculture, a field of research that attracts people from many different disciplines, where it is observed that the multiple benefits for both nature and humans are being addressed. Therefore, the focus on either environmental or social aspects of NBS, or a combination of them, may also stem from the discipline and background of the evaluator(s).

Furthermore, four participants, including a municipal landscape designer and a water and academic researcher, regard it as challenging to showcase and prove the multiple benefits of NBS. Two of the evaluation documents also reflect upon this. The evaluating organisation of the Green Strip in Amsterdam states that, whilst such a SUDS can achieve multiple climate-adaptive goals, trying to fit all these goals within one design may lead to conflicts and faults. Moreover, an interviewee comments the following on the Sand Engine in The Hague: ‘The multifunctional nature of the Sand Engine is part of the Building with Nature philosophy, but then you also have to accept the tension between goals’ (Gerdes et al., 2021, p. 30). A municipal landscape designer mentions something similar during the interview: ‘That is really a challenge and sometimes things go well and sometimes less, to get all expectations, goals stated in policy frameworks but also wishes of residents, to get that together properly’. The following statement from a participant from a knowledge organisation further elaborates on the challenging task of showcasing the multiple benefits of NBS:

> It would be good, but I wonder if it is always feasible. Often with very small adjustments they can serve multiple purposes. But often it is also practically not feasible. Sometimes it cost just a little more money, which is not available. It is sometimes also complicated to get the right people at the table that have the right expertise for that. It is a beautiful thing to strive for, but whether it is always achievable is another matter (*Knowledge organisation member, online, 04-05-23*).

Indeed, an academic researcher agrees that the multiple benefits that can be offered by NBS are often not given the right attention, especially in dense cities where limited space is available and where the cost weighs heavily in a decision. A consultant exemplifies that 'a housing block will gain more in the short term, but in the long term, you wish to see all costs and benefits to be considered', illustrating the value of properly reflecting upon the multiple benefits that NBS can especially provide to predominantly grey urban areas. An academic researcher also observes this limited attention given to the multiple benefits of NBS in academia:

> But we have the tendency, also in research, to focus on those ecosystem services which also generate money and that are not a lot yet. That very broad pallet of services such a system could offer makes such a system valuable. That is very often unexposed and difficult to explain because it is not easy to make it hard (*Academic researcher, online, 02-05-23*).

Therefore, some participants indicate that it can be useful to express the multiple benefits of NBS in monetary or other numerical terms, 'so that it also has a weight on the board table', as expressed by a consultant. However, the participants also stress that it can be difficult and complex to express the non-tangible benefits of NBS in numerical terms. Another perspective on the economic considerations of NBS is also observed, where the importance of a strong will and determination of the people with decision-making power in the process of implementing NBS is underscored, who stress the social and environmental values of urban nature. Table 9 substantiates these three perspectives regarding the economic considerations of urban nature with illustrative statements by the interview participants.

Table 9
Three perspectives of interview participants on the economic considerations of urban nature, illustrated by interview statements

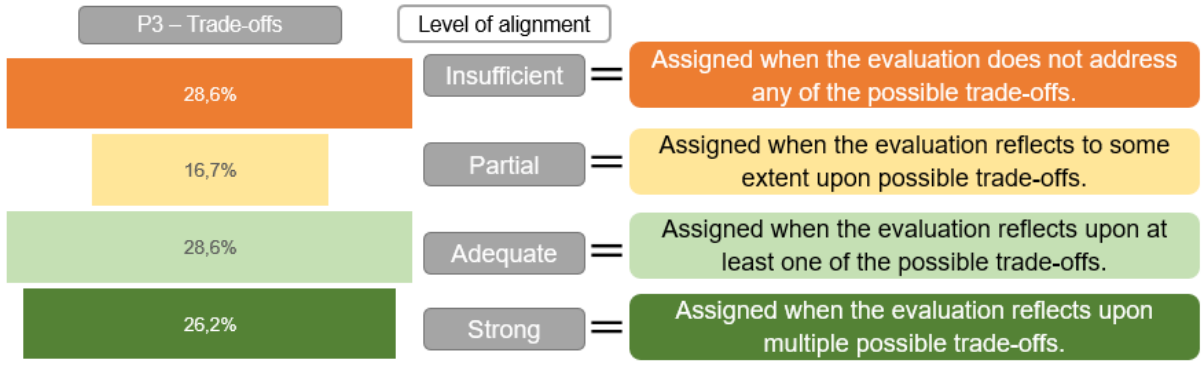
Perspectives on the economic considerations of urban nature	Illustrative statements
The value in quantifying urban nature	'You may try to monetise it or to express the quality of life in something else so that it also has **a weigh on the board table**. There is **a need** for that.' *Consultant – The Ribbon, Utrecht*
	'It **can help the decision-making** process to provide this sort of information.' *Water researcher – Stadswerven, Dordrecht*
	'Yet those are for a very blue officer, who has to decide if a project will receive money or not, more difficult as **they want to see those numbers**.' *Academic researcher – Eva-Lanxmeer, Culemborg*
	'Yes those kinds of things do help, I think that is a **great way to make those things more transparent**.' *Knowledge organisation – Groene Mient, The Hague*
	'You have to make it **visible**.' *Water researcher – Green Strip, Amsterdam*
	'I am sure it is **helpful** to quantify the benefits, the things that people see and to have a better look and **create an overview** of those benefits.' *NGO – The Cherry Garden, Utrecht*

The difficulty of quantifying urban nature	‘Also, regarding greenery providing health and wellbeing for residents, so that is more about that healthy urban life. But **how do you express that economically?** Yes, that remains **unclear**.’ *Municipal landscape designer – City Island Tour, Utrecht*
	‘But I think when it comes done to these interventions, often a lot of things **can not be specifically measured** and that applies to those qualitative aspects.’ *Knowledge organisation – Groene Mient, The Hague*
	‘Yes well if you look at the social side, I think that it is very complicated to quantify that. **How do you express if something like that has value or not?** I think it is a difficult question.’ *Senior policy adviser – Erasmus Filter, Amsterdam*
	‘It is **not as easy as making a sum** showing how much ecosystem services are worth to make it easier to choose for the green intervention.’ *Water researcher – Stadswerven, Dordrecht*
	‘Because there is also a lot of discussion about what the benefits of those services exactly are. What weighting factor do you attach to it? What is it worth to us that the air quality is better? Has proper research been done? Which parameter are we looking at? **It is a complex subject**.’ *University lecturer – Wadi Ruwenbos, Enschede*
	‘But I can imagine that it is **difficult to express** such things in numbers. I also sometimes wonder, **why we would want that, expressing things like a playground or sports park in such values**.’ *University lecturer – Garden Trompenburg, Amsterdam*
The importance of stressing the added, non-economic value of NBS	‘On the other hand, sometimes you just have to say: yes this is going to cost more, but we are going to do it anyway because **it delivers more social benefits**.’ *Water researcher – Stadswerven, Dordrecht*
	‘In the end, it is also **a will** whether you want to spend it on something or not. Some mayors or city councils rely on the fact that you can calculate exactly well, this yields so much, so that is a good investment. Others rely more on the fact that **nature values are being strengthened**.’ *Knowledge organisation – Groene Mient, The Hague*
	‘We do research on the values of green, and then the economic value is one, but **it is precisely more about the value of the social aspect** and health. And the biodiversity, those are very different but perhaps more important. So, we are actually more concerned with that than with; how can we express this in money?’ *Municipal landscape designer – City Island Tour, Utrecht*

4.5: Analysing Principle 3 – Trade-offs

This section provides insights into the performance of the evaluations regarding principle 3 – trade-offs, based on the question if the evaluation addressed any of the possible trade-offs related to urban NBS. To clarify again, figure 24 visualizes the level of alignment obtained by the evaluations regarding this principle and when this level of alignment was given.

Figure 24
The level of alignment for principle 3 – Trade-offs



A similar number of evaluations addressed trade-offs to an insufficient (28.6%) or an adequate (28.6%) extent, meaning that either trade-offs were not addressed or reflected upon at all, or the evaluation did reflect upon at least one of the trade-offs. A distinction between three types of trade-offs was made, and most of the evaluations that addressed a trade-off addressed the one between different values given to urban nature (39.5%), followed by the trade-off between grey and green spaces within urban environments (32.6%) and the trade-off between different goals of the NBS (27.5%). The following three sub-sections discuss each of the trade-offs based on observations from the evaluation documents as well as the conducted interviews.

4.5.1: Trade-off between grey and green spaces

The trade-off between grey and green spaces within urban environments is similarly addressed as the driver of land use change in the evaluations, referring to growing urban populations and the consequent need for grey spaces putting pressure on urban green spaces. This can for example result in a trade-off as experienced in the development of the City Island Park Tour in Utrecht, where it is acknowledged that it might be impossible to avoid a shared car route within the park to accommodate accessibility to surrounding businesses, compromising on the 'green, unless' principle. The interviews conducted in the Ribbon for example reflect a fear of overbuilding, threatening its appreciated openness and landscape quality. Three other evaluations also discuss the trade-off between grey and green in interviews with involved stakeholders and users, whilst this trade-off is reflected in the SWOT analysis performed for the Knowledge Mile Park Bridge, revealing the threats of increasing heat stress and heavy rainfall and the opportunity to increase space for biodiversity. Moreover, two evaluations consider this trade-off through self-developed indicators, namely the use of space as part of a broader Sustainability Profile measuring the sustainability of neighbourhoods under which Erasmusveld in The Hague, and closeness to nature as one of the quality criteria for playing nature in the evaluation of Speeldernis. However, evaluations also exist where, for example in the case of Food for Good, the trade-off between grey and green spaces is discussed in their chapter on the meaning of nature, but not reflected in the questionnaire used to evaluate the community gardens, where the focus is primarily on the smaller neighbourhood scale and the aspect of social cohesion.

Besides, the trade-off between grey and green spaces is often addressed within the evaluations by adopting a landscape approach, considering the urban landscape as a whole.

The evaluators of Molenvlietpark in The Hague for example stress the importance of compensating lost green spaces due to the growing need for houses and infrastructure resulting from the densification task of the municipality of The Hague. Furthermore, evaluations adopting a landscape approach often indicate that implementing similar NBS throughout the city can contribute to a larger and connected structure of urban nature stretching the urban area, creating larger habitats for species which benefit urban biodiversity. The evaluators of Stadswerven in Dordrecht refer to such green spaces as stepping stones in the creation of an urban ecological network, where they also advise making use of the flora and fauna already present in a national park located close by. This underlines the importance of, besides solely providing more green, stimulating connections between these green spaces across the urban landscape to be a significant contributor to urban biodiversity (Kabisch et al., 2022). The interview with a municipal landscape architect also reflects the importance of considering the urban landscape in its totality, stressing the contributions of the City Island Park Tour in Utrecht to the ecological network of the city.

4.5.2: Trade-off between different goals of NBS

Section 4.4.4: NBS and the provision of multiple benefits at once already discussed possible tensions between the multiple goals of NBS, and the current section further elaborates on the trade-offs between different environmental, social, and economic goals of the investigated NBS. First, evaluations indicate the trade-offs that may happen between the ecological and recreation goals of urban green spaces. For example, the actors conducting the EIA for City Island IJburg indicate the trade-off between the desired increase in water recreation as envisioned by the municipality of Amsterdam and the consequent increase in emissions in the harbour. Moreover, the evaluators of the Sand Engine in the Hague reflect on the disturbance caused by walkers and kite surfers in the breeding environment of birds, stating that providing space for both nature development as well as recreation is difficult to reconcile. Second, evaluations address trade-offs between different environmental goals, consisting of NBS that are either identified as SUDS or provide a water storage function alongside its function as a park, where the environmental aspects of the NBS have a strong focus in the evaluation. The evaluation of Park Luna in Heerhugowaard for example stresses the benefits of the high amounts of vegetation provided, but also states that the decomposition of plant materials may lead to blue-algae bloom. Lastly, evaluations also address trade-offs between environmental or social goals and economic goals of the NBS. This is for example reflected in the evaluation of neighbourhood Boszoom in Pijnacker-Notendorp, where an interview with the landscape designer revealed a trade-off between the appreciated environmental and social value of the green spaces in front of the door by residents, but the economic loss of not having a parking spot in front of the house in the eyes of housing developers.

4.5.3: Trade-off between different values of NBS

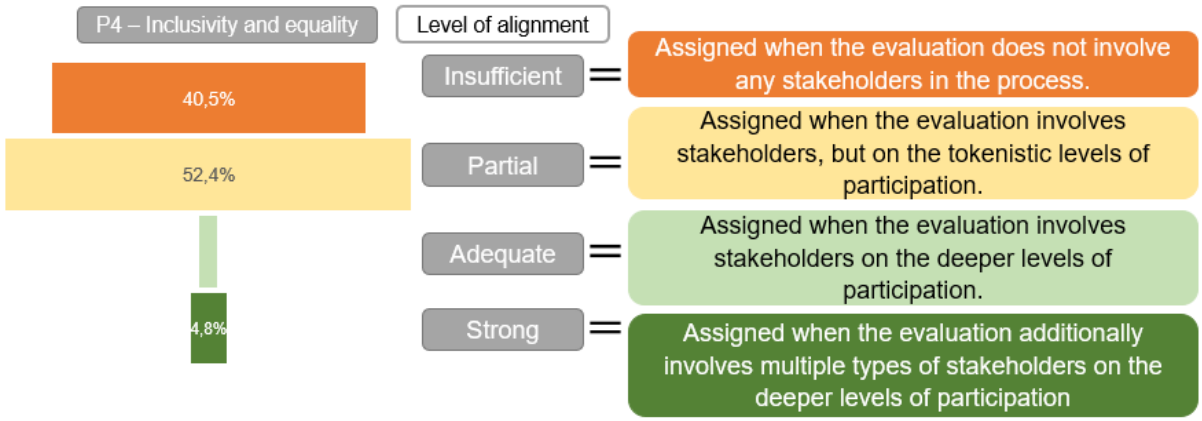
Regarding this third and last category of trade-offs, evaluations often indicate the different values and uses of urban nature, which is reflected upon by stipulating the different functions the NBS provides to accommodate these different values and uses of urban nature. As the evaluators of the Ribbon conclude, based on the interviews conducted with users and implementing stakeholders, one of its success factors is the good match between the design of the park and the wishes of the users. Similar conclusions are made for other NBS as well, often based on questionnaires considering questions regarding the involvement in or the nature values of community gardens, or on interviews with initiating or implementing stakeholders. For City Island Park Tour in Utrecht, one of its design principles is to provide a balance of activities for different users groups, and as stated by a municipal landscape architect involved in this project, the park is eventually made for the residents of Utrecht, so it is therefore deemed important to provide space for all the different user interests. Indeed, as already discussed in section 4.3.3: Driver 3 – Values of nature within cities, different values and images of urban nature exist which may lead to conflicts and trade-offs. In this regard, multiple interview participants perceive it as important to include the wishes of different

residents in the process of designing and implementing urban nature. The next chapter on inclusivity and equality further sheds light on this aspect of including urban residents in the process of NBS.

4.6: Analysing Principle 4 – Inclusivity and equality

This section provides insights into the performance of the evaluations regarding principle 4 – Inclusivity and equality, based on the question if the evaluation included any stakeholders and at what level of participation. To clarify, figure 25 visualizes the level of alignment obtained by the evaluations regarding this principle and when this level of alignment was given.

Figure 25
The level of alignment for principle 4 – Inclusivity and equality



The principle of inclusivity and equality scored considerably lower compared to previously discussed principles of underlying drivers or multiple benefits. A large share of the evaluations (40.5%) scored insufficiently on principle 4, meaning that these evaluations did not involve any stakeholders in their process. More than half of the evaluations (52.4%) scored partially, indicating that these evaluations did involve stakeholders but on tokenistic levels of participation. These evaluations either used interviews or questionnaires to involve stakeholders, which corresponds to the level of consulting and is thus still regarded as a form of non-participation as participants are not given real decision-making power over the evaluation (Kiss et al., 2022). Moreover, the number of interview participants involved is often rather low, and sometimes this is also reflected upon by the evaluations, stating the limited extent to which the evaluation is representative of the neighbourhood or the group of users. Figure 26 visualizes the number of interviewees involved in the interviews conducted. It becomes clear that more than half of the evaluations only included a maximum of four participants, of which 20% solely interviewed one participant. However, 20% of the evaluations in total included more than 10 interviewees, with a maximum of 50 participants included in the evaluation of Urban Farm ‘t Geertje who were visitors of the farm interviewed during one busy Saturday. These evaluations also belong to those with a large amount of information, consisting of at least 10 pages (however, the evaluations in this category all have a minimum of 25 pages), for which perhaps also more time and resources were available to conduct evaluations with more than 10 interviewees. The type of actors interviewed is visualized in figure 27, revealing that municipalities are most often involved in the interviews conducted within the evaluations of this sample. Also, landscape designers appeared to be a type of actor often involved in interviews about NBS, similar to the initiating actors of NBS, who are often the ones to be interviewed when only one interviewee is involved.

Figure 26
The number of interviewees involved in the interviews conducted as part of the evaluations

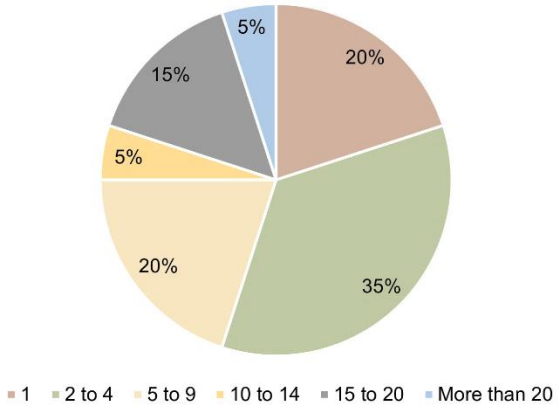
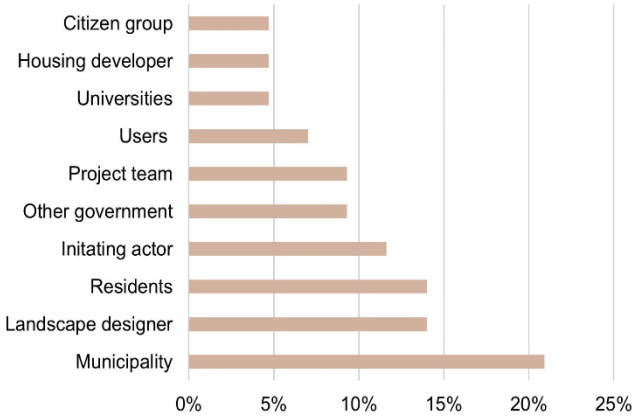


Figure 27
Type of actors involved in the interviews conducted as part of the evaluations



Such evaluations, especially those belonging to the category of containing small amounts of information, selectively selected their participant(s) based on suitability for the research. Regarding the small size of the evaluation, such a sampling technique is probably also the most feasible considering the limited available time and resources. Those evaluations that tried to include a group as diverse as possible often reflect on the limited representativeness of the eventual sample, and the limited extent to which conclusions could be made beyond the sample included in the evaluation. Moreover, whilst residents do appear quite often as the interviewed actor, users only comprise 7% of the type of actors interviewed. This may seem quite contractionary, as users are often the intended beneficiaries of NBS, and whose statements are often made in the evaluations, whilst they do appear to be not represented to such an extent in the interviews.

Four evaluations made use of questionnaires, three of them concerning community gardens. Two of them specifically targeted users of the community gardens, where 25 respondents were yielded in the case of Food for Good and 12 for the evaluation of Trompenburg. Both the evaluation of Ruwenbos and the one regarding the community garden Valentijn targeted residents of the neighbourhoods in question more broadly, whether they were actively involved or not with the NBS. These questionnaires yielded more respondents, 94 in the case of the garden Valentijn and 129 and 130 in 1999 respectively 2005 in the case of Ruwenbos. In contrast to the interviews, the focus of the questionnaires is largely on the intended beneficiaries of the implemented NBS, with a clear goal of investigating their opinion on the NBS in question. In the interviews, this representation of the intended beneficiaries is less clear, and the questions more often focus on a description of the implementation process of the NBS, any obstacles experienced and lessons that could be learned from that.

Besides those evaluations only including actors through interviews or questionnaires, only two evaluations involved multiple actors on the deeper levels of participation, therefore obtaining a strong level of alignment. One of these is the evaluation of the neighbourhood Cherry Garden in Utrecht, where the evaluator was involved in the community through daily visits and participation in activities for three months. The evaluator stressed the importance of speaking to and involving a variety of residents. Moreover, through the interview conducted with him, he indicated that his involvement was appreciated by the community, allowing him to become familiar with the community which resulted in a higher level of trust and more information being shared, also about difficult topics. He underscores the worth of investing more time and energy into this aspect of research, although this might result in a more time- and money-consuming activity. However, the community was not involved in designing the evaluation, giving no real decision-making power to the community members over the set-up of the evaluation. Therefore, this way of involving residents corresponds to a level of co-designing. The other evaluation regards Food for Good in Utrecht, which attained a level of collaboration. Here,

stakeholders were consulted beforehand about the design of the study and the questionnaire. Their comments were considered which led to the creation of a questionnaire that was compact, understandable, and not too complicated, to be able to be accessible to those vulnerable groups involved in the NBS and those with less proficiency in Dutch, which benefited the study as well.

4.6.1: Inclusivity and equality as experienced in practice

This section supplements the observations from the evaluation documents with the main points from the interviews with practitioners in the field of researching and/or evaluating NBS. First, different reasons were mentioned for including actors in evaluations of NBS. Four categories of benefits have been identified, and these are substantiated with illustrative statements from the interview participants in table 10.

Table 10
Four categories of benefits from the inclusion of actors as illustrated by statements of interview participants

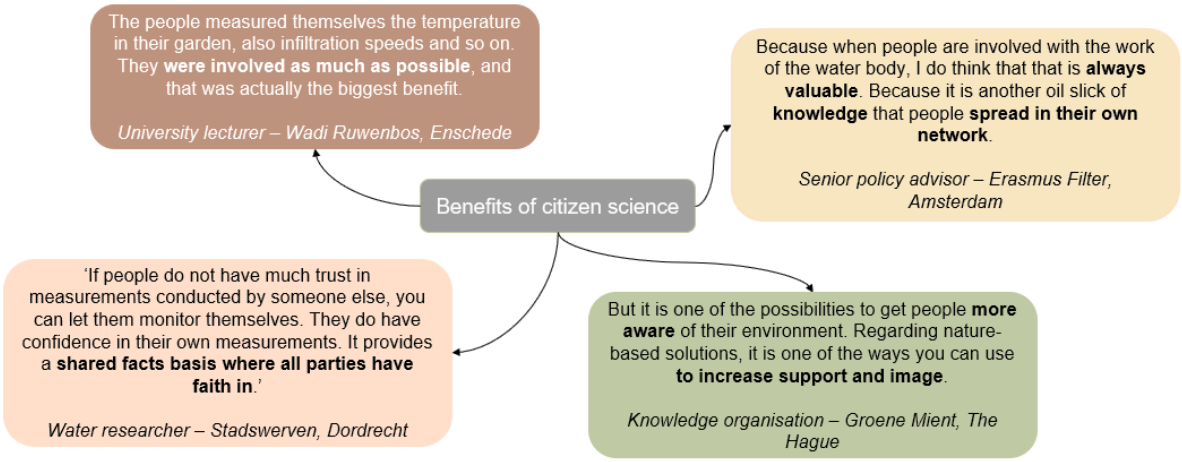
Benefits of including actors	Illustrative statements
Involving actors in the evaluation of NBS is important as NBS are implemented in the direct living environment of urban residents.	'It is good that you are **involved in your own living environment**. That is always the aim of participation, to take people along. But it does help if people **feel ownership**.' *Municipal landscape designer – City Island Tour, Utrecht*
	'The most important thing is that **you intervene in their front or back yard**, so they have to be **happy** about that. Some residents will cause a lot of hassle when they are not happy. That could be **easily prevented when they are heard**.' *University lecturer – Wadi Ruwenbos, Enschede*
	'You can make the most beautiful design, but it has **to match the target group**. Get parties involved and continue to do that.' *Consultant – The Ribbon, Utrecht*
Including various actors supplements the evaluation with valuable information stemming from the inclusion of different perspectives on and knowledge of the NBS.	'Interviews were held with a lot of different people from that area, who all distinctly knew that area; someone that owned a camping, a farmer, someone from the water body. And **all those people together knew enough of the whole socio-ecological system to be able to understand it properly**. And everyone gained more **trust**.' *Water researcher – Stadswerven, Dordrecht*
	'**Residents themselves know best** what happens in their own environment and are also able to think along to make projects better, regarding what is needed in those specific neighbourhoods.' *Knowledge organisation – Groene Mient, The Hague*
	'It also provides **a much better picture**, by involving the different perspectives.' *Consultant – The Ribbon, Utrecht*
	'We as researchers already had ideas about this, but we mainly wanted to get ideas also from the stakeholders involved. **To also be able to say: there is a need for this**, so these things we want to do and these things we are not going to do.'

	Academic researcher – Eva-Lanxmeer, Culemborg
	'I really would recommend getting to know the people and investing more time and energy into that to start building the trust, so they **start also talking about the critical points**. Because that is not always easy.' *NGO – The Cherry Garden, Utrecht*
Including the intended beneficiaries of NBS can support the verification of the aspired benefits of NBS in practice.	'We came quickly to the discovery that because we had to evaluate the success factors, you have to know **if it is a success and if yes, to whom** and what are those factors contributing to its success? So, you want to know if it is being **experienced as a success** by its users.' *Consultant – The Ribbon, Utrecht*
	'It is easy to say when you chose a natural solution to indicate it delivers certain ecosystem services for party X or Y. Then it is **good to check with party X or Y if this is actually the case**. I think you must be very careful with attributing all kinds of benefits of NBS without checking if those **intended beneficiaries experience** that in the same manner.' *Water researcher – Stadswerven, Dordrecht*
The understanding and knowledge of the NBS by people can increase by involving actors.	'The advantages are in particular that you get an easier implementation and that **people also understand what is in front of their door**.' *University lecturer – Wadi Ruwenbos, Enschede*
	'People tend to also **change their behaviour** because they now have received information on it where they used to not have this before. That is very important because **many things happen out of ignorance**.' *Senior policy advisor – Erasmus Filter, Amsterdam*

One approach to include actors in evaluations of NBS that stemmed from the interviews is participant observation. A university lecturer underscores the valuable information she was able to obtain from the participative observation conducted in community gardens. By spending much time in the gardens, she could 'fathom them much better'. Additionally, as the quote above from the evaluator of the Cherry Garden indicates, the increased connection with participants led to increased levels of trust, to discuss difficult points as well. However, both interview participants state that such extensive research is something that can not be conducted regularly due to the time and money it requires. The sample of this research reflects this statement, as only the two evaluations of the Cherry Garden and the community garden Trompenburg discussed here made use of participatory observation.

Another approach to facilitate the inclusion of actors is the use of citizen science, which can strengthen the monitoring process of NBS whilst enabling public education (Bulkeley et al., 2023). Four of the interview participants also mention the value of citizen science, which statements on citizen science have been visualized in figure 28.

Figure 28
Statements from interview participants on the benefits of citizen science



However, whilst these participants indicate that citizen science is being used in practice, it is still applied on a small scale, partly because it is acknowledged to be a very labour- and resource-intensive method. Indeed, the evaluations in the current sample did not use any form of citizen science. Moreover, it is mentioned that people often drop out or only a certain group of people are reached that are willing to participate. Also, a water researcher states that the results of citizen science must be reliable and that its usage also depends on the type of research you are conducting. Participants, therefore, indicate the value of citizen science, but question its applicability on a large scale, as exemplified in the following statement:

> It is not something you can roll out all over the country. Regarding nature-based solutions, I would not consider it the holy grail but one of the ways you can use to increase support and image (*Knowledge organisation, online, 03-05-23*).

The interviews more broadly reflect that participation does not always properly happen in practice. A participant working on the City Island Tour in Utrecht for example states that plans on participation still had to be made, although the development framework with the design principles for the Island Tour had already been established. The following statement reflects this participant's thoughts on participation within a municipal context:

> I think there is a long way to go, we do our best, but it does not always work out well. it is a municipality of a very large size, with all kinds of departments where sometimes officials change, so then as a citizen, you have to talk to another person. We have all kinds of policy frameworks, and you can not expect that every resident is aware of this. So that is really a challenge and sometimes things go well and sometimes less, to get all the expectations and goals stated in policy frameworks, but also the wishes of residents, to get that together properly. Sometimes things are just not possible because you have other interests. I think we all need to keep improving on that (*Municipal landscape designer, online, 15-05-23*).

The low awareness and willingness of residents to participate in different policies are also mentioned by a senior policy adviser:

> Because you want to involve people, but a lot of people are also not interested or are only interested when they are negatively affected by a measure. People have completely different things on their minds and that is what it is (*Senior policy adviser, online, 03-05-23*).

According to this participant, low awareness and willingness to participate are especially true for abstract plans, and she stresses the importance of determining the right scale of involvement. For example, policies that happen in the immediate living environment of residents make a policy less abstract, increasing the interests and willingness of people to participate. However, this participant reflects on the difficulty of finding this right level of involvement, finding it complex to involve people and this something she finds difficult to implement in research, also due to the often low awareness and willingness of actors to participate. A university lecturer points towards the difficulty of involving vulnerable groups, for example, those with a migration background, who are often already more distanced from an official organisation like a municipality. The following statement exemplifies this difficulty:

> Almere is a very multicultural city but reaching those groups with a migration background for example. How do you involve them in research? We do not even know those people, so the only thing you can do and what works is to have someone in your organisation who knows people with such a background. And that is hardly the case. It is really hard to reach those groups because you just do not know them yourself, as you also live in a bubble (*University lecturer, online, 24-05-23).*

According to this participant, the difficulty of involving vulnerable groups is complicated by the lack of diversity she observes in the members of her research organisation and network. To foster inclusion, the diversification of the people who conduct research, going outside more and trying to reach and start conversations to integrate with those vulnerable groups are mentioned as important steps.

Overall, three participants indicate that whilst, in practice, there exist very good examples of participation, there also exist many contradicting examples where residents are only shown the plan after it has been made, and a university lecturer further states that 'most plans are still made without the residents'. To stimulate participation, three participants mention the supporting role of regulations. A university lecturer describes it as a way to 'impose those various ambitions on yourself as a municipality', putting pressure on such institutions to implement measures to meet the regulated goals. A senior policy advisor describes the role of regulations as follows:

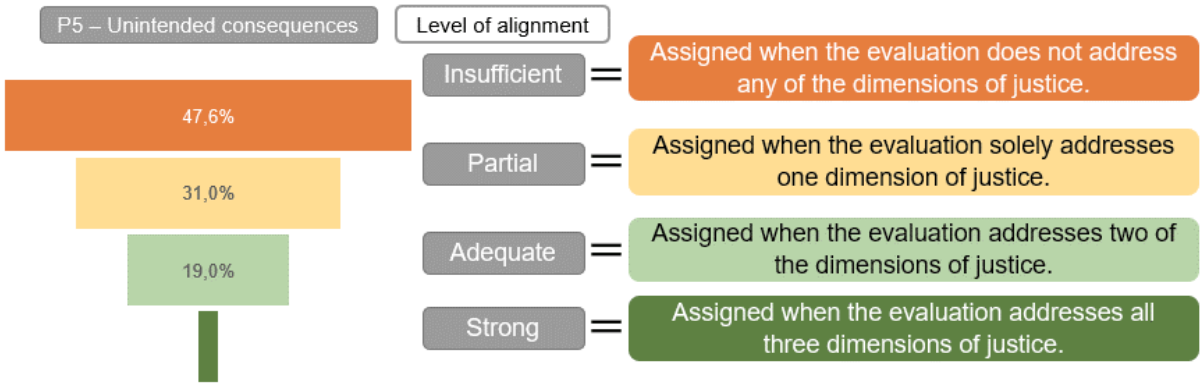
> For us, it is very convenient when things just have to be done. We have certain objectives that we have to meet so that puts pressure on us to take certain measures that just have to be implemented. It will have to, be that mentality, and then the finance and the support just come along easier (*Senior policy adviser, online, 03-05-23*).

Supportive regulations can thus foster the proper implementation of participation, whilst making the financial support for such ambitions more easily accessible.

4.7: Analysing Principle 5 – Unintended consequences

This section provides insights into the performance of the evaluations regarding principle 5 – unintended consequences, based on the question if the evaluation addressed any of the dimensions of justice, namely distributive, procedural and recognition justice. To clarify, figure 29 visualizes the level of alignment obtained by the evaluations regarding principle 5 and when this level of alignment was given.

Figure 29
The level of alignment for principle 5 – Unintended consequences



The unintended consequences in the form of environmental injustices that may result from NBS have been categorised in three dimensions, and most of the evaluations that addressed one of these dimensions addressed procedural justice (41,7%), followed by recognition justice (38,9%), whilst distributive justice has been addressed the least (19,4%). As figure 29 shows, almost half of the evaluations addressed principle 5 insufficiently (47,6%), meaning that these evaluations did not address any of the dimensions of justice. 31% of the evaluations addressed this principle partially and 19% adequately, meaning that either one dimension of justice is addressed, or two dimensions are addressed. The following three sections provide observations from the evaluation documents as well as from the interviews regarding the consideration of these three dimensions of justice in policy documents as well as in practice.

4.7.1: Distributive justice

The distributive implications of NBS are differently addressed in the evaluations. Often, it relates to the actual cost of participating in the NBS in question. For example, interviews with the co-founders of the urban farm De Schilde revealed that its intended beneficiaries were not reached, as the farm offered high-priced products while being in one of the poorest neighbourhoods of The Hague. Its residents were not able to purchase such products, and the modern and affluent customers envisioned by the urban farm were not present in the surroundings, so neither could benefit from the products offered by the farm.

Similarly, the re-development of the neighbourhood Poptahof in Delft meant that 40% of the housing stock became expensive owner-occupied houses to create financial support for the housing cooperation. However, this increase in housing prices was not regarded as desirable by the municipality as the housing stock had to stay affordable for already existing residents as well. Whilst processes of exclusion and gentrification were not discussed in this evaluation, such observations do point towards that direction, where the benefits of the redevelopment of a former deprived neighbourhood can not be felt by those who are not able to afford to live there anymore. The evaluation of the Knowledge Mile Park Bridge in Amsterdam also reflects processes of green gentrification, where more trendy businesses are said to be attracted to the neighbourhood due to the green bridge. However, the evaluators themselves do not critically reflect on such processes and the unintended, negative consequences of such processes in an urban neighbourhood. It is observed in other evaluation documents as well that the increased economic worth of green spaces around houses is merely portrayed as being beneficial, not reflecting upon the distributive implications of this correlation between the implementation of green and the consequent rise in housing prices. This may also relate to the methods used to evaluate the above-mentioned cases, where none of the three evaluations included users of the NBS or residents of the neighbourhood being able to voice their opinion or experience with the NBS.

The uneven distribution of costs and benefits of NBS is also reflected in three interviews. A water researcher and a member of a knowledge organisation both state that often the benefits of NBS are felt by other actors than those bearing the extra cost of implementing the urban nature. In the words of the water researcher, 'the person making the investments might not feel the benefits in his wallet because the benefits end up with someone else'. This may also hinder the implementation of NBS in the first place, as exemplified by the following statement:

> What also makes it difficult, is that the benefits of greenery lie with other parties than the costs of greenery. And that makes it complicated, because a municipality or an investor may invest 10% more to make climate adaptive measures, but he does not benefit from it. So why would he do that? And I think that is the complicated thing that can play here (*Knowledge organisation, online, 03-05-23)*.

When explained that the greening of neighbourhoods can increase housing prices which may lead to an uneven distribution of benefits, a water researcher answered that some may indeed experience that as a disadvantage, but for others, namely those retrieving money from the NBS, it represents an advantage. In this regard, an NGO member states that it can be a challenge to make such NBS affordable and accessible to all. However, as Moe's Garden in Delft exemplifies, sometimes a restricted accessibility of an NBS is needed to, in this case, allow the participation of non-western women in a for them safe environment, excluding for example men from other cultures. The evaluation of the Cherry Garden, on the other hand, stipulates the desired accessibility of the neighbourhood to residents with different socio-economic and cultural backgrounds by facilitating a mixed tenure that created equality among renters and home-owners, evaluated based on the participative observation and the interviews conducted with the residents themselves.

Lastly, it is observed that the beneficiaries of NBS are often portrayed as rather homogenous groups, merely stating that 'the users' or 'the residents' benefit from the NBS, or that they were heard in the design or implementation process. However, as the section before on inclusivity and equality revealed, many evaluations do not involve any stakeholders, and when involving them, users and residents together only make up 21% of the interviewed actors. However, differences may exist in their socio-economic and cultural backgrounds, especially in multi-cultural cities like Amsterdam, The Hague or Rotterdam, and therefore differences may also exist in the benefits and costs from NBS they experienced, as exemplified before by the neighbourhood Poptahof in Delft. Moreover, often statements within evaluations are based on interviews or questionnaires of a limited size, and some evaluations also reflect upon the consequently limited representativeness of their results. The limited sample size also narrows the level of diversity within the sample, where marginalized voices, which are already harder to reach, may be easily excluded. The evaluation of community garden Valentijn for example states that most of their respondents were highly educated white females, which does not reflect the high diversity of residents within the multi-cultural Indian Neighbourhood in Amsterdam. They partially attribute this to the questionnaire being only available in Dutch, making it less accessible to those residents who are not very familiar with the Dutch language. However, the evaluators did for example deployed iPads to complete the questionnaire on the spot and to include those residents who do not have access to an electronic device. The questionnaire developed for the evaluation of Food for Good for example made use of linguistic support to be able to include a group of Turkish women. Such steps can increase the accessibility of the data-gathering method to include a wider range of actors to increase levels of diversity.

4.7.2: Procedural justice

The evaluations addressing the dimension of procedural justice mainly did so by reflecting upon the inclusiveness of the decision-making process, where the participation of residents is often indicated as a factor contributing to the success of an NBS. It is observed that especially evaluations of sustainable neighbourhoods through interviews, including residents, reflect on

the importance of placing agency and responsibility with residents to create and design their own living environment through forms of collective private commissioning, often formulated as one of the lessons to be learned from such neighbourhoods. Other evaluations conclude on participation by discussing the different steps taken to include residents or other stakeholders, exemplified in the evaluation of the Ribbon of Pocket Parks where meetings, focus groups, social media and flyers were deployed to give the neighbourhood the chance to let their voice hear, formulating this communication as one of its success factors. However, some evaluations merely state the importance of the participation of various stakeholders from the beginning but do not substantiate this with examples or supplement this conclusion with other sources. The evaluation of the Ribbon for example concludes that participation is one of its success factors, but the users were not asked the question to reflect upon these procedural aspects of the realisation of the Ribbon. Similarly, the evaluation of the Speeldernis reflects on the steps taken by the municipality to involve users and their children but does not concretely indicate how and which values have been incorporated in the design of Speeldernis, solely based on document analysis.

Some evaluations more critically reflect on the procedural aspects of NBS. The evaluators of Food for Good in Utrecht for example reflect on the existence of power imbalances, where one group or individual may dominate over others which can lead to the forming of cliques which can negatively affect the success of an initiative. Furthermore, the evaluators of Green Square Slachthuis in The Hague reflect upon the difficulty to reach certain vulnerable groups, for example stemming from an anti-government attitude, which limits their agency within the decision-making process. Moreover, sometimes the decision-making powers over an NBS may lie with parties that are mainly interested in the economic benefits of an NBS. This is exemplified by the neighbourhood Poptahof, where the housing cooperation, which invested twice as much money compared to the municipality, experienced more decision-making powers, reflected in the economic pillar of the housing project being considered more at the expense of its social and environmental aspects.

4.7.3: Recognition justice

The dimension of recognition justice is mainly addressed in the evaluations by reflecting on the different needs and uses that are facilitated by the NBS in question. This can for example be observed in Emma's Hof, where the interview with one initiating actor revealed that the development of the garden was based on an intensive sampling of the wishes of the residents by ringing the doorbell of each house in the neighbourhood. However, the initiator also states that it was difficult to involve residents with various cultural backgrounds, while the goal was to reflect the multi-cultural character of the neighbourhood. Similarly, whilst Moe's Garden in Delft explicitly considered the wishes and values of non-western women to create a safe space for them, they also aimed to foster an increased understanding and recognition of the values of all different cultural groups present in the neighbourhood, which eventually also happened.

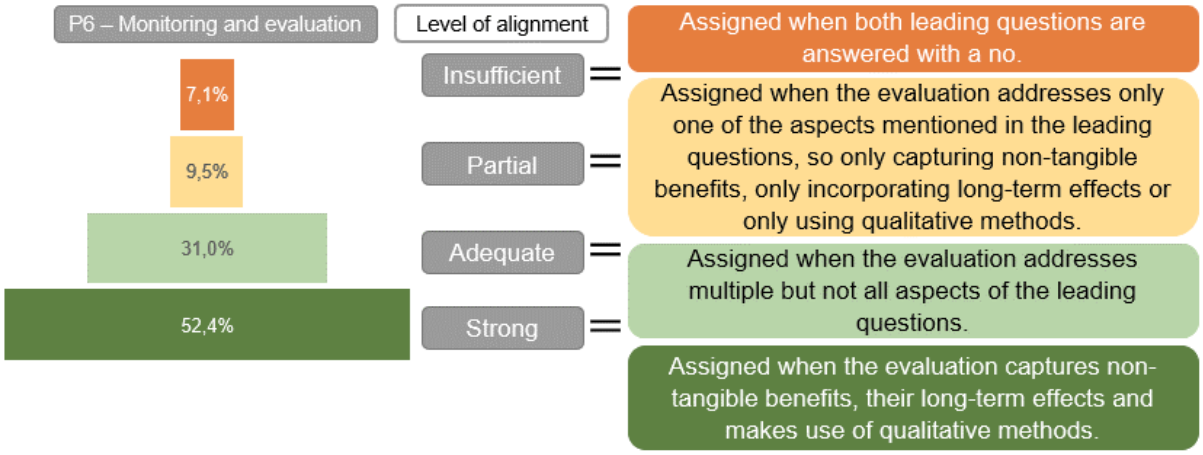
Other evaluations addressed this dimension of justice by elaborating on the benefits a participatory process can yield in terms of reflecting the different wishes and values of residents. The Cherry Garden mentions the created sense of community among its residents where everyone felt heard, which is similarly stated for the sustainable neighbourhoods of Eva-Lanxmeer and Roombeek, corroborated by interviews with residents. Moreover, an interview participant involved in the evaluation of Eva-Lanxmeer states that while the starting phase of the project requires more energy due to the extensive involvement of future residents, it does result in the long-term in a stable neighbourhood where the urge to move is very low. In this regard, most of the participants stress the importance of involving residents and other stakeholders upfront, to avoid resistance during the project and to overall result in a more successful implementation of NBS. Conflicting values can exist as well, as observed in the Ribbon, where some interview participants appreciated the safety of the park, whilst others disagreed due to the little lighting which made them feel unsafe at night. The inclusion of users of the NBS from the start ensures that their various wishes and interests are recognised from

the beginning and reflected in the design of NBS. A similar suggestion could be made about the upfront involvement of actors in the process of evaluating NBS, regarding the benefits it may similarly provide to more successful and valuable results of the evaluation. The next chapter on the last principle of monitoring and evaluation further discusses including actors through qualitative methods in the evaluation of NBS.

4.8: Analysing Principle 6 – Monitoring and evaluation

Finally, this last section provides insights into the performance of the evaluations regarding principle 6 – Monitoring and evaluation, based on the question if the evaluation captured non-tangible benefits of NBS, as well as their long-term implications by using qualitative research methods besides a sole focus on quantitative methods. To clarify, figure 30 visualizes the level of alignment obtained by the evaluations regarding this last principle, and when this level of alignment was given.

Figure 30
The level of alignment for principle 6 – Monitoring and evaluation



As figure 30 shows, most of the evaluations (52.4%) obtained a strong level of alignment with the principle of monitoring and evaluation, meaning that these evaluations captured the non-tangible benefits of NBS by making use of qualitative methods whilst not solely focusing on quantitative ones and who also included long-term implications of the evaluated NBS. The distribution of the types of methods used in the evaluation sample is already discussed in section 4.1: Describing the characteristics of the urban NBS evaluations in the Netherlands, as well as a discussion about the use of quantitative and qualitative methods. Section 4.8.1 provides further insights into the use of evaluation and monitoring methods in the evaluation documents, supplemented by observations from the conducted interviews.

4.8.1: Observations on the evaluation and monitoring of NBS from policy and practice

A majority of the sample (52%) of the evaluations used a combination of qualitative and quantitative methods, and seven out of the ten interview respondents state the benefit of using both types of methods, describing the distinct benefits provided by the different methods and how a combination of both can deliver valuable results. These benefits have been visualized in table 11, supported by illustrative statements from the interview participants.

Table 11
Benefits of the use of quantitative and qualitative research methods as perceived by the interview participants

Perspectives on the benefits of quantitative and qualitative methods	Illustrative statements
Benefits of the use of quantitative research methods	'Sometimes it is very important **to make things very sharp** and quantitative because you need **the basis** for something. We simply need at least that many square meters of a certain type of planting, otherwise those species will not come there. We know that, so then it helps that you have **a clear picture** of that.' *Municipal landscape designer – City Island Tour, Utrecht*
	'We are dealing with a reckoning world in which we **want to see numbers**. That we do facilitate with research, and I do also think that it can help to **deliver a message**.' *Academic researcher – Eva-Lanxmeer, Culemborg*
	'With quantitative you get **short, straight answers** in probably a **faster time** than qualitative things.' *NGO – The Cherry Garden, Utrecht*
	'For the research that I am involved in, **numbers are what matters**. Which measure is more beautiful or suitable is a trade-off that **does not belong to a researcher**. We can indicate, this option produces less noise than that one, but what eventually gets chosen, that is not up to us. But then you are still talking about numbers. *Water researcher – Green Strip Zuidas, Amsterdam*
Benefits of the use of qualitative research methods	'If you are not in conversation with people, you miss their **innovative ideas**. I like to be **surprised by stories**, and I think you do not get that by doing research quantitatively.' *University lecturer – Wadi Ruwenbos, Enschede*
	'Like amenity value or utility value, those kinds of terms **cannot be expressed in figures**, which automatically means that it is also good **to look at that more qualitatively**.' *Knowledge organisation – Groene Mient, The Hague*
	'With qualitative you get **more insights**; you get the **emotions**.' *NGO – The Cherry Garden, Utrecht*
	'For example, about people finding a natural park messy and think it is neglected. Then you **can investigate** through an interview if **this is really the case**.' *Water researcher – Stadswerven, Dordrecht*
	'We focus more on **storytelling**, making people who are involved tell and share their story and what it has done or **meant for them**. You eventually notice that those stories strike a much more **sensitive chord**. The beautiful stories are very important here as well to **convince people**.' *Academic researcher – Eva-Lanxmeer, Culemborg*
	I do not use them, but you do bring us ideas with your story. I think it can be **absolutely useful** to include the qualitative side as well. Even if it is just to **increase support** by involving people through qualitative

	methods. And, because you can then **better explain** why things are done the way they are being done.' *Senior policy adviser – Erasmus Filter, Amsterdam*

Overall, whilst quantitative methods can supply short, straight, and fast answers to deliver a clear message, the statements reflect that certain things can not be discovered by only using quantitative methods. The (additional) use of qualitative methods in that regard reveals the value and meaning people experience regarding NBS by allowing stories to be told and argued to deliver more convincing insights. Moreover, the last statement reflects the increased understanding of and support for the NBS through enhanced involvement of actors in the evaluation, something that is also not achieved by quantitatively assessing an NBS.

Furthermore, the interviews revealed two different trends in the use of quantitative versus qualitative methods. A university lecturer states that, while he finds it difficult to base his research on stories instead of exact numbers because of the way he was educated, he increasingly recognizes the value of including those stories in research of NBS. The following statement exemplifies this:

> Well, I am a fierce technician, so I lean towards numbers. The crazy thing is that the book you read from 2006, we are going to republish that and now it is just full of stories and very few numbers. These are stories of people who have been working with wadi's for over 20 years. So, I am more and more attached to the social part, while I am not trained for that (*University lecturer, online, 04-05-23*).

Another academic researcher, in contrast, mentions the increased use of quantitative methods to support qualitative research, as the following statement shows:

> I do a lot of qualitative research in my career, but where sometimes something more quantitative creeps in. Because we are dealing with a reckoning world in which we want to see numbers. We do facilitate that in research, and I do also think that it can help to deliver a message. This we also notice with our Food Forest project. We have to make hard that biodiversity increases, if the quality of the soil changes, how much carbon we expect to store, and so on. Those are still in numbers. But the beautiful stories are very important here as well to convince people (*Academic researcher, online, 02-05-23*).

The statement reflects the value of using a combination of both methods and especially that qualitative methods should not be disregarded because those are the methods capable of capturing the underlying meaning of a project which delivers valuable information in the evaluation of NBS. This relates to an observation made before, which revealed that those evaluations scoring insufficiently on all six principles are the ones evaluated by solely quantitative methodologies, whilst those using qualitative methods as well mainly score adequately on all six principles.

The long-term implications are addressed by 64% of the evaluations. The evaluations address the long-term of the NBS differently, but some overlap can be observed. SUDS mainly address the long-term by having long-term monitoring systems in place that provide knowledge for the maintenance and improvement of the NBS. Another group of evaluations, consisting mainly of sustainable neighbourhoods, address their long-term implications by discussing the lessons learns, which often leads to recommendations or guidelines on how similar initiatives could be implemented or improved. Already implemented and evaluated NBS thereby act as a source of inspiration for other initiatives. The evaluation of the Ribbon of Pocket Parks, for example, underlines the importance of creating a knowledge bank on a national scale to deliver knowledge and inspiration to other pocket park initiatives to strengthen their implementation on a larger scale. The importance of sharing lessons is also stressed in the evaluation of

community garden Valentijn, to increase the presence of green within growing cities that contributes to a better living environment. However, 36% of the evaluations are still based on a snapshot of the effectiveness of the NBS, not considering the implications of the NBS in the long-term.

5 – Discussion

The following chapter discusses the theoretical implications of the insights provided by the application of the analytical framework, consisting of the six evaluation principles that are hypothesized to contribute to the transformative potential of NBS, to the Dutch urban NBS evaluations. Here, future research recommendations are provided as well. The following section explores the policy implications of the results of the current research, providing recommendations on how evaluations can further contribute to transformative change. Lastly, the limitations of the current research are discussed.

5.1: Unpacking the empirical results

5.1.1: The alignment of the evaluations to the principles

This research aimed to investigate to what extent current evaluations of urban NBS in the Netherlands capture their multiple benefits, trade-offs, and unintended consequences, and what implications this brings to the transformative potential of NBS. The analysis demonstrates that, overall, more than 50% of the evaluations aligned with the six developed evaluation principles to an adequate extent. These findings indicate that these evaluations, on average, adequately considered the principles regarding the underlying drivers of the climate and biodiversity crises, the multiple benefits, trade-offs, inclusivity, and justice implications of NBS, for which it is argued that these evaluations can to some extent contribute to the transformative potential of NBS. However, only one evaluation strongly adhered to all six evaluation principles, indicating that more than 95% of the current sample does not fully support the transformative potential of NBS. The analysis also indicates that more than a third of the sample either made a limited or no contribution at all to this potential. These findings underline the need for improving the evaluation of NBS to foster their contribution to transformative change (Palomo et al., 2021). When evaluations are transformed in ways that can showcase the full potential and multiple benefits of NBS through an inclusive process, the mainstreaming of NBS in practice is strengthened and the transformation of current urban infrastructure regimes along more sustainable pathways is supported (Welden et al., 2021; Xie et al., 2022).

When zooming in on the individual principles, the analysis illustrates that especially the principles of inclusivity and unintended consequences are addressed to a considerably lower extent when compared to the underlying drivers or multiple benefits. This result corresponds to the troubling finding by Bulkeley et al. (2023), who show that those NBS focussing on delivering multiple benefits often pay limited attention to inclusive processes to ensure an equal provision of urban nature. Other literature as well stresses the lack of inclusivity in designing, implementing, and evaluating NBS, often leading to a (re-)production of injustices in urban environments (Baró et al., 2021; Langemeyer & Connolly, 2020; Toxopeus et al., 2020). Such findings raise questions on how urban NBS can simultaneously ensure the delivery of multiple benefits and address underlying drivers while ensuring inclusivity and safeguarding just and equal urban nature provision. Evaluation processes that capture all these different but crucial aspects to showcase the full potential of NBS can provide one answer to that question, as it contributes to further mainstreaming NBS in urban infrastructure regimes to transform those in the direction of sustainability to realize healthy, just, and sustainable cities for all. The following sections will therefore discuss the principal barriers to achieving a strong level of alignment with each of the evaluation principles, stemming from the main results of this research. These barriers lead to a set of recommendations to strengthen the practice of evaluating urban NBS to support its transformative potential, which is discussed in section 5.2.

5.1.2: Barriers to addressing the underlying drivers of biodiversity loss and climate change

Whilst almost 50% of the evaluation documents addressed more than one underlying driver, almost a quarter of the evaluations addressed none of the underlying drivers, therefore not

contributing to the transformative potential of NBS. Moreover, the analysis demonstrated that often evaluations merely addressed one of the drivers as an aspiration to be achieved by the NBS but did not include this aspect in the actual evaluation. The results further indicate that less than 10% of the evaluations considered the interconnected nature between climate change and biodiversity loss, corresponding to the finding these challenges keep being addressed separately, whilst supporting the call for more integrated research regarding these dual crises (Pettorelli et al., 2021). Moreover, addressing the contribution of NBS to the underlying drivers of the climate and biodiversity crises can further transcend the transformative potential of NBS beyond its local context (Bulkeley et al., 2023).

The evaluation documents and interviews also reveal tensions stemming from the different values and images assigned to nature in the urban environment, where residents often negatively perceive more widely and biodiverse urban nature. It reflects statements in literature about the observed distinction between humans and nature, and the value given to order, resulting in the misconception of cities as human-made environments separated from nature (Kabisch et al., 2022; West et al., 2020). Such misconceptions may underpin such observed tensions when residents with various values and images of biodiverse cities are involved. On the other hand, it underscores the importance of involving residents in evaluations to increase their knowledge and awareness of, and consequently the appreciation for, NBS (Mabon et al., 2022; Seddon et al., 2021; Toxopeus et al., 2020). Furthermore, the analysis of this principle illustrates that political departments may also have different images and values of urban nature, complicating an effective dialogue between different departments. This finding reflects the sectoral divisions as one of the embedded characteristics of European environmental policy, whilst literature argues for an integrative approach to sustainability topics like NBS, critical for ensuring long-term impacts stretching several sectors (Nykvist & Nilsson, 2009; Warbroek et al., 2023; Wickenberg et al., 2022). Adopting an integrative approach across sectors could not only strengthen the consideration of the underlying drivers of climate change and biodiversity loss in various urban planning plans, but it could also ensure the capturing of multiple benefits of NBS, which the following section considers.

5.1.3: Barriers to capturing the multiple benefits of urban NBS

The multiple benefits simultaneously provided for humans and nature are addressed by more than two-thirds of the evaluations, which is not in line with statements made on research barely addressing the multiple benefits of NBS (Dumitru et al., 2020; Seddon et al., 2021; Welden et al., 2021). Moreover, 35% of the evaluations addressed multiple environmental as well as social benefits, contradicting other observations stating that existing research predominantly addresses environmental over social benefits of NBS (Frantzeskaki et al., 2019; Welden et al., 2021). Whilst these results reflect the capability of evaluations to capture the multiple benefits of NBS, they are based on a limited case study sample in the specific context of the Netherlands. Moreover, this contrasting observation with existing literature opens interesting avenues for further empirical research in other contexts to confirm or challenge the ability of evaluations in particular to capture the multiple benefits of NBS at once.

However, as observed before with the principle of underlying drivers, some evaluation documents state the benefits NBS can provide to humans or/and nature but do not actually evaluate this aspired benefit. Also, whilst multiple interview participants underscore the value of capturing the multiple benefits of NBS in evaluations, not all do so in practice as it is perceived as a challenging task, finding themselves constrained by practical limitations. Besides, it is indicated to be difficult to get the right people with the needed expertise together, where a focus on either environmental or social aspects of the NBS may stem from the single background, discipline, or sector the evaluator(s) is/are affiliated with. Moreover, the analysis of the principle of multiple benefits often reflects a rationalistic approach being taken to evaluations. This approach allows a rather objective measurement of the quantitative value of nature, with a focus on the more politically relevant economic benefits, often resulting in ignorance of issues of justice and inclusivity (Adelle & Weiland, 2012; Bulkeley et al., 2023;

Kotsila et al., 2021). The considerably lower levels of alignment for the principles of inclusivity and justice resulting from the current study underline those observations. However, these barriers do stress the importance of properly showcasing the delivery of the aspired multiple, and the non-quantitative, benefits of NBS to solidify their value and make it worth their costs, resources, and space. Moreover, reflecting upon the aspired multifunctionality of NBS in evaluations ensures that trade-offs between different, and sometimes conflicting, goals of NBS are considered, with an emphasis on also showcasing the non-tangible benefits of NBS, to optimize the potential of NBS to deliver multiple goals for both nature and humans. This reflection can increase the understanding of and agreement on the multiple goals aimed to be delivered by the NBS to both nature and humans, ensuring that the right people are included to reflect both natural and social dimensions of the NBS, which can contribute to realizing the delivery of multiple benefits at once.

5.1.4: Barriers to addressing the trade-offs related to urban NBS

Almost 30% of the evaluations adequately reflected upon at least one of the possible trade-offs related to urban NBS, but in contrast, a similar amount of evaluations did not address any of the trade-offs, displaying opposing results. However, a quarter of the evaluations did reflect upon multiple possible trade-offs at once. Therefore, regarding the observation in the literature that trade-offs are barely captured in studies on NBS (Dumitru et al., 2020; Frantzeskaki et al., 2019), the results of the current study partly align but also contradict those observations. This warrants further research on the consideration of trade-offs in research and evaluations of NBS, whilst underlining the need to improve the capturing of trade-offs in such practices to strengthen the evidence base on the trade-offs of NBS (Bulkeley et al., 2023; Dumitru et al., 2020; Frantzeskaki et al., 2019). This is further supported by the observation that evaluation documents exist that merely mention trade-offs but does not capture these as criteria in the applied methodology to evaluate the NBS.

When trade-offs are addressed, it often concerns the trade-off between grey and green areas, addressed in various ways by the evaluation documents, for example through interviews with involved stakeholders and users, a SWOT analysis, or using self-developed indicators.
Moreover, the trade-off between grey and green spaces in urban areas is often addressed by adopting a landscape approach, where the contribution of the NBS to the wider ecological structure of a city is holistically reflected upon. Such connections between urban nature areas strengthen the net gain for urban biodiversity as a whole (Kabisch et al., 2022). Therefore, taking a landscape approach in evaluations can ensure that negative consequences of the trade-off between grey and green spaces, possibly disturbing these connections, are considered, which can contribute to the delivery of high-quality urban nature (Bulkeley et al., 2023). This is especially important in dense urban areas, characterized by the limited availability of land but also development pressures, hard decisions are often unavoidable, resulting in trade-offs (Hansen & Pauleit, 2014; Kronenberg et al., 2021; Turkelboom et al., 2018). Also interview participants observe the challenging task of providing space to NBS within urban environments that reflect the different values and uses of urban nature, whilst the latter is observed as an important aspect of the success of NBS. In this regard, the evaluators of the neighbourhood Stadswerven in Dordrecht stress the importance of evaluating if the NBS implemented is actually being appreciated by its intended beneficiaries, and if it aligns with the goals of the municipality. To better capture the trade-offs between various goals and different values of nature, evaluations could benefit from including such an inventory, where different values are recognised and where trade-offs, if deemed necessary to make, are acknowledged and made clear. Including such discussions in evaluations of NBS can lead to a broader understanding of such trade-offs, minimizing their possibly negative consequences which support the delivery of high-quality urban nature (Bulkeley et al., 2023).

5.1.5: Barriers to the inclusivity of evaluation processes

For the principle of inclusivity, the analysis demonstrates that more than 50% of the evaluations solely included stakeholders using interviews or questionnaires, regarded in this research as a form of non-participation due to the lack of decision-making power given to these participants (Kiss et al., 2022). This finding corresponds to both the studies of Kiss et al. (2022) and Puskás et al. (2021), revealing that a large share of participation regarding NBS takes place on the tokenistic levels of participation. The interview participants of the current study observe as well that in practice, participation often does not extend the provision of information to stakeholders on already established plans. This while participation on the deeper levels of participation can increase environmental stewardship and enhance the realization of just NBS whilst contributing to the mainstreaming of NBS (Kiss et al., 2022; Mabon et al., 2022; van der Jagt et al., 2023a).

Furthermore, 40% of the other half of the evaluations did not involve any actors at all. This reflects a lack of inclusivity, something that is observed in multiple other studies regarding NBS as well, which all stress that including the voices of different actors is crucial to enhance effective and just NBS (Bulkeley et al., 2023; Kabisch et al., 2022; Mabon et al., 2022; Seddon et al., 2021; Toxopeus et al., 2020; Tozer et al., 2020). Moreover, this result displays a lack of knowledge diversity, corresponding to the similar finding of Turner et al. (2022), while knowledge diversity is deemed important for the mainstreaming of NBS, especially in complex and culturally diverse urban environments inhabited by a heterogeneous population displaying various interests, needs and values (van der Jagt et al., 2023b). The lower number of evaluations in the current research involving more than 4 participants when conducting interviews, with 20% only involving one participant and where especially the users of NBS are frequently excluded, further exemplifies this lack of knowledge diversity. In that regard, the questionnaires conducted for the evaluation sample better represent the opinion and values of the intended beneficiaries of the NBS, whilst questionnaires still represent a form of tokenistic participation. However, multiple interview participants underline the importance of including the intended beneficiaries of NBS to verify the often easily made claims about the benefits provided to residents and users by NBS. Besides, the interviews revealed a range of benefits of including actors in research and evaluations of NBS, including the benefit of different perspectives and knowledge to be able to provide a holistic picture of the NBS, whilst the understanding of the NBS for the actors involved is enhanced, indicated to increase the acceptance of NBS in practice. While the inclusion of intended beneficiaries is not reflected in the current sample, it is indeed stated to be one of the crucial stepping stones towards mainstreaming NBS as it can prove the effectiveness of NBS and can provide evidence of the delivery of multiple benefits of NBS (Xie et al., 2022).

One approach to involve actors in the evaluation of NBS is through citizen science, stated to enhance inclusivity, provide public education, and strengthen the monitoring of NBS (Bulkeley et al., 2023), and indicated by interview participants to create a shared fact basis whilst increasing levels of trust and knowledge amongst the people involved. However, interview participants indicate that citizen science is rather applied on a small scale due to the labour and resources necessary for its implementation. Indeed, the current evaluation sample also did not include any form of citizen science. Moreover, the limited interest of citizens to participate is mentioned as a barrier, which is also mentioned as a barrier to the general participation of citizens in the process of NBS, especially regarding more abstract and complex projects and topics. It is also observed that currently, regulations do not require participation on the deeper levels of participation, in line with the identified barrier to participation found in the study of Wamsler et al. (2020). As stated by the same study, citizen involvement is often low on the priority list of municipalities, which have to deal with various problems and requirements in a context where they often lack the capacity to systemically involve citizens, a barrier also found by the study of Kiss et al. (2022). Moreover, the interviews revealed that barriers exist regarding the involvement of more vulnerable groups in research and evaluations of NBS, whilst these groups could especially benefit from the effective and just implementation

of urban nature (Bulkeley et al., 2023). Fostering inclusion and diversity within the group of actors evaluating an NBS is in this regard indicated by an interview participant to improve the integration of those vulnerable groups as well. Moreover, intermediaries, which are organisations that enable and facilitate dialogue between different actors, are said to mitigate power differences and be effective enablers of the inclusion of marginalised voices (Bulkeley et al., 2023; Kiss et al., 2022). The use of such intermediary organisations could thus be valuable in the context of evaluating NBS as well.

5.1.6: Barriers to incorporating dimensions of justice in evaluation processes

The results regarding the principle of unintended consequences reveal that almost 50% of the evaluations addressed none of the three dimensions of justice, covering distributive, procedural and recognition aspects of justice. Almost a third did address one of the dimensions of justice, but only one evaluation strongly aligned with the principle of unintended consequences and addressed all three dimensions of justice. The results largely support the observation that research and evaluations delivering evidence on aspects of justice are scarce (Cousins, 2021; Dumitru et al., 2020; Frantzeskaki et al., 2019; Langemeyer & Connolly, 2020; Toxopeus et al., 2020). It also supports the urge to strengthen aspects of justice in the planning process of NBS, including its evaluation, as the implementation of just NBS is deemed crucial for the delivery of equitable urban nature outcomes (Cousins, 2021; Langemeyer & Connolly, 2020; Toxopeus et al., 2020).

Moreover, it is observed that when the distributive implications of NBS are addressed in the evaluation documents, they are often not critically reflected upon. Evaluations merely reveal the economic benefits of the implementation of urban nature, in the case of the attraction of trendy businesses or the rise of housing prices, which are both characteristics of green gentrification (Bockarjova et al., 2020). Often, those neighbourhoods characterized by high housing prices and a high-income level benefit the most from the implementation of urban nature, at the expense of former or low-income residents (Toxopeus et al., 2020), but none of the evaluation documents considered these distributive implications of urban NBS. However, it is deemed important to consider such distributive implications as especially those vulnerable and marginalised groups would benefit from the implementation of urban nature (Baró et al., 2021; Bockarjova et al., 2020; Bulkeley et al., 2023; Cousins, 2021; Tozer et al., 2020). The intermediary organisations discussed before could, besides enabling the inclusion of marginalized voices, further, facilitate the explicit consideration of the distribution of costs and benefits in the evaluation of NBS and promote the equal provision of the benefits of urban nature (Bulkeley et al., 2023). Additionally, the evaluation of NBS should not be solely determined by market parties who predominantly prioritize the economic benefits of NBS (Bulkeley et al., 2023). Such neo-liberal approaches to evaluations diminish the non-tangible values of urban nature compared to its economic value, whilst ignoring inequalities and injustices by which current capitalist societies are characterized (Kotsila et al., 2021)[1].

Secondly, the procedural aspects of NBS are mainly addressed by reflecting upon their participatory processes which are often framed as one of the success factors of NBS and formulated as a lesson to be learned for similar NBS. Moreover, some evaluations include a critical notion of the procedural aspects related to NBS, for example, related to power imbalances or the exclusion of more vulnerable groups that are difficult to reach. Indeed, it is important to recognize that more participation does not automatically result in more just NBS when such procedural aspects are compromised (Mabon et al., 2022; Toxopeus et al., 2020). However, evaluations exist that merely mention the importance of the involvement of actors, but do not substantiate this statement with examples or other sources of information.

Lastly, the evaluation documents mainly address the dimension of recognition justice by reflecting upon the different uses that are facilitated by the NBS to represent the different

[1] See Kotsila et al. (2021) for a further discussion of NBS in neoliberal agendas.

values and needs regarding urban nature. This reflects the statement that NBS are no one-size-fits-all solution (van der Jagt et al., 2023b), whilst indicating that ensuring a diversity of types of NBS can deliver the multiple benefits of urban nature to different urban residents who value and need different types of urban nature (Bulkeley et al., 2023). Moreover, it is observed that especially community gardens seem to reflect upon aspects of recognition justice more critically, considering for example the difficulty of involving more vulnerable groups whilst they often aim to include various residents to reflect the multi-cultural character of the neighbourhood. This observation corresponds to the finding that NBS implemented on the community scale better allows for the embedment of urban nature in its cultural context, something that is also found to be crucial in the delivery of multiple benefits of urban NBS (Bulkeley et al., 2023). Moreover, a participatory process where the wishes of different users and residents are considered is in this regard emphasized by some evaluation documents, as well as in the interviews, stated to be important to ensure a successful implementation and use of NBS in the long term.

5.1.7: Barriers to capturing the non-tangible and long-term implications of urban NBS

More than 50% of the evaluations strongly aligned with the principle of monitoring and evaluation, meaning that these evaluations captured the non-tangible benefits of NBS by making use of qualitative research methods whilst including the long-term effects of the NBS. Moreover, the evaluation sample is predominantly characterized by the use of a combination of both quantitative and qualitative research methods. The interviews also reflect the use of a combination of both research methods in practice, as they each provide their benefits. Quantitative methods can create visibility of things and provide short answers which support the delivery of a clear message. Qualitative methods, on the other hand, shed light on the emotions and values of people and allows stories to be told, where interview participants stress how such insights can be very convincing. Besides, participants emphasize the ability of qualitative methods to capture those aspects of NBS that can not be easily quantified. Another perspective is also observed, where often quantitative methods are felt to be needed to express certain claims on and evidence of NBS in numbers. Here, the institutionalized role of the rationalist approach to evaluations is reflected, characterized by the use of quantitative methods and a rather objective assessment of urban nature's value (Adelle & Weiland, 2012; Dorst et al., 2021; Dumitru et al., 2020; Kotsila et al., 2021). However, studies stress the necessary shift from quantity to quality to be able to capture the multiple and often non-tangible benefits of NBS, as well as their trade-offs and unintended consequences (Dorst et al., 2022; Dumitru et al., 2020; Frantzeskaki et al., 2019; Kronenberg et al., 2021; Langemeyer & Connolly, 2020; Raymond et al., 2017; Seddon et al., 2021; Welden et al., 2021; Xie et al., 2022).

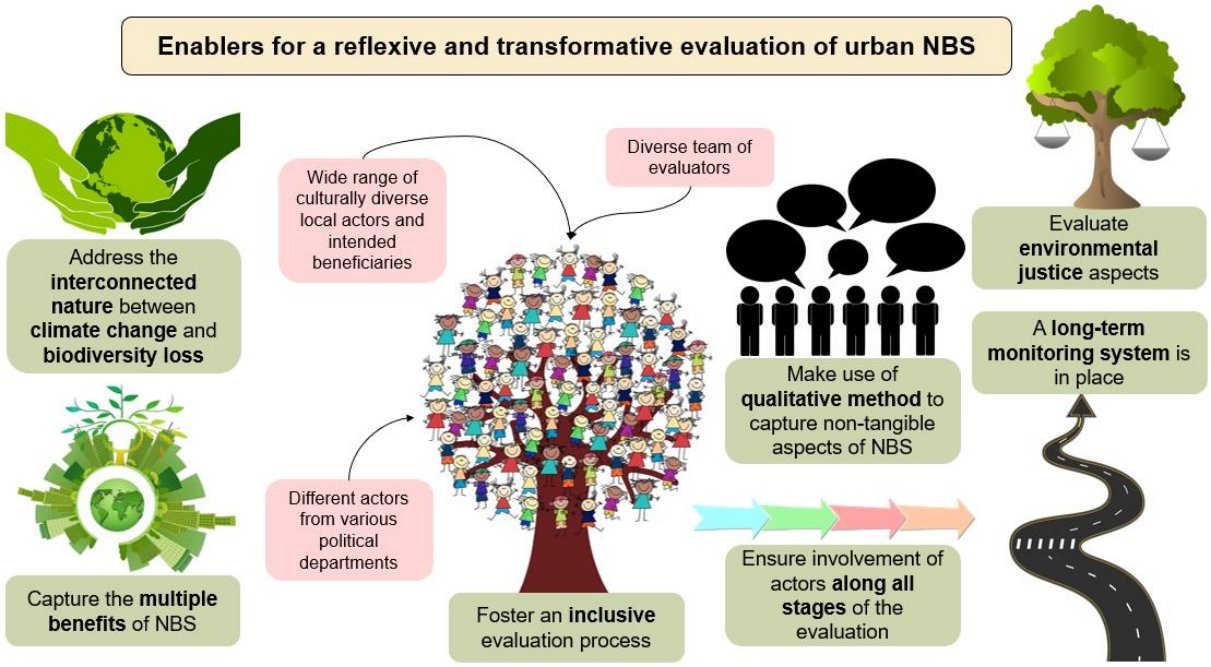
The results of the current analysis indeed underline the importance of using qualitative research methods, besides a sole focus on quantitative methods, to obtain higher levels of alignment with the evaluation principles. The results illustrate that those evaluations insufficiently addressing the principle of multiple benefits, trade-offs, inclusivity, and unintended consequences are all predominantly characterized by the use of quantitative methods, whilst the evaluations strongly addressing inclusivity and unintended consequences are only characterized by a combination of methods. These findings support the observation that evaluations relying on quantitative methods alone fail to capture those intangible benefits of NBS which are said, when proven and showcased properly through evaluations, can strengthen the transformative potential of NBS (Dorst et al., 2022; van der Jagt et al., 2023b; Xie et al., 2022). It also supports the call for a shift in focus from quantity to quality by means of including qualitative valuation methods in evaluations to capture the multiple benefits, trade-offs and unintended consequences related to NBS (Dorst et al., 2022; Dumitru et al., 2020; Frantzeskaki et al., 2019; Kronenberg et al., 2021; Langemeyer & Connolly, 2020; Raymond et al., 2017; Seddon et al., 2021; Welden et al., 2021; Xie et al., 2022).

Furthermore, the analysis shows that almost two-thirds of the evaluation documents address the long-term implications of NBS. This is for example done through the implementation of long-term monitoring systems to evaluate the functioning of NBS, but also by providing lessons, recommendations, or guidelines to support the successful implementation or improvement of similar NBS. Here, evaluations can inspire other NBS, showcasing the potential of NBS to create and contribute to healthy and sustainable urban living environments (Xie et al., 2022). Indeed, proving and showcasing the delivery of the full potential of NBS through evaluations is also deemed important to increase the awareness and mainstreaming of NBS in practice (Welden et al., 2021; Xie et al., 2022). Moreover, continued monitoring systems of NBS improve their long-term stability, supports the effectiveness of NBS in the long term and contribute to its mainstreaming (Cohen-Shacham et al., 2019).

5.2: Improving the contribution of urban NBS evaluations to transformative change

The previous sections have discussed the main results regarding the six evaluation principles, as well as the most important barriers observed to attaining these principles in evaluations of urban NBS in the Netherlands. The existence of these barriers points towards improvements that can be made regarding the evaluation of urban NBS, to better capture the potential of these solutions. Indeed, previous studies as well stipulate the improvement of the current evidence base of urban NBS (Dumitru et al., 2020; Frantzeskaki & McPhearson, 2022), whilst improving the evaluation of NBS is seen as crucial to support the mainstreaming of NBS in practice (Xie et al., 2022). The six principles developed in this research address current pitfalls and challenges related to urban NBS and are argued to contribute to the transformative potential of NBS. The principles can therefore serve as guidelines for the development of an evaluation framework that is capable of addressing the underlying drivers of climate change and biodiversity loss, captures the multiple benefits of NBS, and addresses their potential trade-offs and unintended consequences in an inclusive and equal manner. The recommendations provided below are therefore based on these six principles and their empirical results, as well as the barriers identified before, to form the basis for a transformative and reflexive evaluation framework. The different enablers for such an evaluation framework are visualized in figure 31 and are elaborated below.

Figure 31
Visualization of the enablers for a reflexive and transformative evaluation of urban NBS



First, such a transformative evaluation framework stresses the interconnected nature of the crises of climate change and biodiversity loss, to transcend the transformative change that can be realised through NBS beyond its local context. The current sample already contains seeds for this practice, as four out of the five evaluations addressing climate change also address urban biodiversity. It reflects the possibilities of urban NBS to contribute to the challenges of climate change and biodiversity loss simultaneously, underlining the differences NBS can make beyond their local contributions.

Second, a transformative evaluation framework supports the capturing of multiple benefits of urban NBS at once, to properly prove and showcase the full potential of NBS. Verifying the aspired multiple benefits of NBS in evaluations strengthens the evidence base of effective NBS which can lead to an increased acceptance of and appreciation for NBS, contributing to its mainstreaming in practice.

Third, a transformative evaluation framework emphasizes the involvement of various actors in the evaluation of NBS. An inclusive evaluation process fosters trust and acceptance of its outcomes, can contribute to the increased application and improvement of NBS in practice and can thus contribute to its mainstreaming. To ensure that increased levels of participation are not compromised by procedural injustices, safe spaces should be created where each voice is heard and considered equally, and where power imbalances are counteracted.

A) First, the involvement of residents and users of the NBS should be supported. When these local actors are included, their knowledge of and appreciation for the NBS is likely to increase. Moreover, their involvement can contribute to aligning their values and images of urban nature to the values of biodiverse and wild nature which are important to improve biodiversity in an urban environment. Here, it is important to ensure a diversity of actors involved, to contribute to the knowledge diversity of the evaluation and to properly represent the heterogeneous population living in often complex and culturally diverse cities. Furthermore, involving local actors can help to verify if the intended beneficiaries of urban NBS are actually benefitting from the implemented urban nature. Such evidence can further embed NBS in their local and cultural context whilst contributing to the uptake of NBS in urban infrastructure regimes. It also ensures that recognition aspects of justice are considered in the evaluation.
    a. The inclusion of local actors might for example be achieved by making use of citizen science, found in literature as well as in the current research as offering positive contributions to both the actors participating as well as the evaluation overall. However, it is important to consider if enough time and resources are available within the evaluation to realise citizen science. Here, the benefits of participant observation are also stressed by the results, or the use of interviews or questionnaires to investigate the opinion of the intended beneficiaries of urban NBS. However, to achieve deeper levels of participation, it is suggested to also empower local actors to collaborate and co-decide along the various stages of the evaluation process. This provides local actors with more responsibility over and trust in the evaluation, whilst the evaluation itself benefits from the inclusion of different perspectives and knowledge.
    b. Moreover, creating intermediary organisations can help to build trust between evaluating and participating actors, whilst supporting the inclusion of a diverse range of actors, including marginalized voices that are often easily excluded.

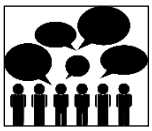
B) Second, it is recommended to include different actors from various political departments in the evaluation process to overcome a siloed approach often taken to sustainability issues in general, and NBS in particular. Such an integrative approach to NBS connects the perspectives and expertise of different departments and sectors,

which are said to be vital to properly tackle sustainability issues and to ensure long-term success.

C) Third, it is recommended to reflect inclusivity in the conducting actors of the evaluation as well. Creating a team of evaluators from different backgrounds and disciplines, with various forms of knowledge on both the environmental as well as social aspects of NBS, ensures that the multiple aspects of NBS are considered. Moreover, a diverse evaluation team may also stimulate and assist in the safeguarding of inclusivity in the actors participating in the evaluation.

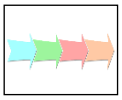
D) Lastly, to further stimulate participation on the deeper levels, policies that support open forms of collaboration, emphasize the involvement of marginalized voices and ensure the inclusion of a diverse set of actors beyond the ones usually involved, are deemed vital to foster inclusion and ensure equitable NBS outcomes (Bulkeley et al., 2023). The research indicates that such policy frameworks might benefit from the implementation of regulations that require inclusivity throughout the process of designing, implementing, and evaluating NBS, to speed up the process of increasing inclusivity and to make sure that inclusivity is high on the priority list of implementing and evaluating actors of NBS.

Fourth, a transformative evaluation framework assesses the environmental justice aspects of urban NBS, and preferably, when time and resources allow, considers all three interrelated dimensions of justice. This contributes to deepening our understanding of the justice aspects of NBS and to improving the realization of just NBS (Baró et al., 2021; Kronenberg et al., 2021; Langemeyer & Connolly, 2020).



Fifth, a transformative evaluation framework emphasizes the use of qualitative methods to be able to capture the non-tangible benefits and consequences of urban NBS. While the use of quantitative methods can supply the evaluation with often valuable and sometimes necessary short, clear, and numerical answers, this use should not deviate from the use of qualitative methods to be able to shed light on the non-quantifiable aspects of NBS.

A) It is important that the methods used in the evaluation are easily accessible to a wide range of actors, including the intended beneficiaries of NBS. Additionally, extra emphasis is placed on the inclusion of marginalized voices. While these groups are often harder to reach, they are crucial to include to achieve equitable outcomes of urban NBS (Bulkeley et al., 2023). It is therefore important that the qualitative methods used for an evaluation are also accessible to vulnerable and marginalised groups, which can for example be achieved by distributing a questionnaire in multiple languages, using iPads to record the opinion of local actors that do not own electronic devices, or deploying linguistic support during interviews. Here, intermediary organizations could assist the evaluation process, to support the inclusion of marginalized voices and facilitate the creation of safe and open spaces to debate (Bulkeley et al., 2023).



Sixth, a transformative evaluation framework fosters the involvement of actors along all stages of the evaluation process, from the definition of evaluation goals to the analysis of the data (van der Jagt et al., 2023). This strengthens the overall success of the evaluation and its long-term impacts, as it is underpinned by an increased knowledge diversity, delivering more usable and valuable data that can support the mainstreaming of NBS to contribute to its transformative change (Turner et al., 2022; van der Jagt et al., 2023; Welden et al., 2021; Xie et al., 2022). Moreover, the engagement of a diverse range of actors throughout the evaluation process empowers local actors because of increased levels of knowledge and skills, whilst increasing feelings of stewardship and strengthening the public support for urban NBS in the long term, which also contributes to the mainstreaming of NBS (van der Jagt et al., 2023).

Finally, a transformative evaluation framework is accompanied by a long-term monitoring system to ensure the long-term effectiveness of the NBS. Moreover, this supports the long-term contribution of NBS to healthy, equal, just, and sustainable urban environments, which strengthens the mainstreaming of NBS in practice (Cohen-Shacham et al., 2019; Welden et al., 2021; Xie et al., 2022).

While literature states the current dominance of the rational approach to evaluations in practice (Adelle & Weiland, 2012; Højlund, 2014; Kunseler & Vasileiadou, 2016; Nykvist & Nilsson, 2009), the proposed transformative evaluation framework is based on a reflexive approach, where the creation of more inclusive evaluation processes, where local actors feel empowered, are emphasized (Adelle & Weiland, 2012; Kunseler & Vasileiadou, 2016). Furthermore, it is important to notice that proposals like out-sourcing the improvement of inclusion to intermediary organisations should not direct attention away from changing institutionalized regimes and the way evaluations are conducted within such regimes, which currently hamper inclusive and just processes towards sustainability (Kiss et al., 2022). The transformative evaluation framework therefore supports the dismantling and reconfiguration of current regimes and established ways of evaluating NBS, to enable the mainstreaming of innovative practices like NBS and contribute to its transformative potential (Xie et al., 2022). The practices described above are hoped to serve as inspiration for those organisations involved in evaluating NBS, to improve their current practice of evaluating NBS. This would allow those organisations to extend their outcomes beyond local context by addressing climate change and biodiversity loss and to showcase the full potential of NBS by capturing its multiple benefits in an inclusive and just manner that yields multiple benefits for both the actors involved as well as the evaluation itself, to ensure the long-term success of NBS. Therefore, such an enhanced evaluation process safeguards the continued contribution of NBS to healthy and sustainable urban living environments that can be enjoyed and comfortably lived in by all urban residents.

5.3: Addressing the limitations of the current research

This last section of the discussion addresses the limitations of the current research. First, the case study sample was strategically selected instead of randomly, and the sample can therefore not be seen as representative of the Netherlands. This compromises the external validity of this research and limits the generalizability of the results (Verschuren et al., 2010). However, cases were selected from two different databases of urban NBS, which made it possible to select cases from different-sized cities located in various parts of the Netherlands to ensure an extent of diversity within the case study sample. Results may therefore apply to similar-sized cities in similar contexts. Besides to the best of the authors' knowledge, the current research is the first to be performed on the evaluation of NBS concerning transformative change in the Netherlands. Despite its non-representativeness, the research, therefore, developed an initial understanding of this under-researched topic, which provides insights for actors and institutions involved in the practice of evaluating NBS. Besides, the results may hold value for those actors concerned with designing and implementing NBS, for example, municipalities and other policymakers, on how they can initiate proper evaluations of NBS, or on how to improve their current evaluation procedures. At last, evaluation is part of the policy-making cycle after all, and by conducting this properly, evaluations can contribute to the improvement and mainstreaming of NBS in urban infrastructure regimes to strengthen the creation of sustainable, healthy, and just cities for all urban residents. In this regard, it would be valuable to conduct similar research in other cities and countries around the world, to see if patterns emerge from results found in other contexts. Moreover, future research, with the time and resources available, could conduct a larger case study to be able to test certain statements and observations on a broader and more diverse group of NBS evaluations. Performing research on a more representative case study sample further strengthens the external validity of the research (Verschuren et al., 2010).

Second, a certain amount of time was dedicated to searching evaluation documents for each of the NBS in the sample, which was limited by the time available for this research. Perhaps, if more time could have been dedicated to this process, more NBS and their evaluation could have been represented in this sample. Moreover, it should also be noted that more evaluations may exist for the same NBS, but only the one that was found first and deemed suitable for this research was included. However, despite these limitations, still, 42 evaluations from the initial 52 NBS cases were found from which interesting results were obtained. Third, some of the aspects of the analytical framework have been discussed in more depth extent in the interviews compared to other aspects. Driver 2 of sustainable production and consumption has in this regard not been discussed, as well as the dimensions of justice. This is because both aspects were not extensively addressed by the evaluations from which the interview participants were selected, and limited by the time available, it was decided that it would take too much time away from the available interview time to properly explain the meaning and relevance of these concepts to the participants. This does mean that while the dimensions of justice have been analysed in the evaluation documents, views from practice on justice implications of NBS are to a lesser extent represented in the current research. This does provide important avenues for future research to explore how organisations or individuals concerned with evaluating NBS in practice consider the dimensions of justice. Furthermore, future research could further extend the amount and diversity of the interview participants. The current research mainly involves participants from water bodies, universities, and other knowledge organizations. Whilst one participant from a municipality is included, it would be valuable to include more perspectives of these local authorities in future research, as they have been identified as key actors in the process of implementing NBS, and critical for the delivery of multiple benefits (Bulkeley et al., 2023). Future research would also benefit from conducting interviews with the intended beneficiaries of NBS, to verify observations about this group of actors and supplement the current research with their perspectives, something that is also argued to be valuable in the proposed evaluation framework. Through these ways, future research could extend the amount and diversity of interview participants to supplement the observations from practice with more diverse perspectives on the evaluation of NBS.

Also, research bias may be present due to the qualitative nature of this research, which can be reflected in some of the interpretations of the data made. However, the internal validity of this research was ensured first by explicitly explaining the choices made regarding the methodology, using well-established research methods (Gerring, 2004; Bryman & Cramer, 2011; Braun & Clark, 2012) and being transparent about the steps taken in this research. Second, a triangulation of methods was used to further strengthen the internal validity of this research (Verschuren et al., 2010).

6 – Conclusion

This research aimed to explore the evaluation of urban NBS in the Netherlands, to investigate if these evaluations capture the aspired multiple benefits, the possible trade-offs and unintended justice consequences of NBS, as well as their potential to contribute to transformative change. Therefore, the research aimed to answer the following research question:

To what extent do current evaluations of urban nature-based solutions in the Netherlands take their multiple benefits, trade-offs, and unintended consequences into account, and how can this be improved to support the transformative potential of urban nature-based solutions?

Based on a quantitative as well as qualitative comparative case study analysis of evaluations of urban NBS in the Netherlands, it can be concluded that, overall, most of the evaluations do adequately align with the six developed evaluation principles, meaning that these evaluations to some extent contribute to the transformative potential of NBS. However, the results also demonstrate that only one of the 42 evaluations showed the capability to strongly support the transformative potential of NBS. A limited or no contribution at all to this potential was made by more than a third of the evaluation sample. Additionally, the research illustrates that evaluations score especially low regarding the principles of inclusivity and justice. It reflects the under-represented character of these concepts in research and evaluations, while both are argued to be critical for both the provision of just and equal NBS as well as for the contribution of NBS to transformative change. Besides, the research points multiple times towards the mere consideration of, for example, the multiple benefits or trade-offs of NBS in evaluation documents, whilst not including this in the actual evaluation of the NBS. Finally, the research demonstrates that those evaluations solely using quantitative research methods insufficiently consider the multiple benefits, trade-offs, and justice consequences of NBS, whilst reflecting a lack of inclusivity.

These findings underline improvements that are necessary to make in the evaluation of NBS to further support its transformative potential and its mainstreaming in practice, to truly transform current urban infrastructure regimes along more sustainable, just, and equal pathways. One way to achieve this is by changing the currently dominant rationalistic approach to evaluations towards a reflexive and transformative approach. Such an approach moves away from a quantitative and objective assessment of context-specific NBS, that is characterised by economic considerations and the ignorance of inclusivity and justice issues. Instead, a reflexive and transformative approach to evaluations holistically considers the multiple benefits of NBS, adopts an integrative approach to the climate and biodiversity crises, and ensures the inclusion of actors from different political departments and a wide range of intended beneficiaries, whilst emphasizing the inclusion of marginalized voices in safe and open spaces where each actor feels heard and empowered. Especially within densely populated urban environments, whose culturally diverse populations are expected to grow, such inclusive evaluation processes are important to reflect the diversity of values and interests present in such environments and to overall improve the performance of NBS.

The enablers for a reflexive and transformative evaluation of urban NBS, which are based on the six evaluation principles and the empirical results of this study, can improve the current practice of evaluating NBS, and may therefore be valuable to those individuals and organisations concerned with the policy process around NBS. Whilst the study is based on a limited and non-representative case study sample, it does represent the first empirical study on this topic in the Netherlands, creating an initial understanding of the current process of evaluating Dutch urban NBS. This also opens interesting avenues for future research, especially regarding the context-specificity of urban NBS, to explore how different NBS are evaluated in other contexts, and how those may, potentially differently, contribute to its

transformative potential. Such research increases the current lack of comparative case study analysis of urban NBS, whilst strengthening the understanding of the relation between NBS and transformative change.

Enabling reflexive and transformative evaluations of urban NBS further strengthens the uptake of NBS in practice and enhances the transformative change that can be achieved by innovative interventions like NBS. This is especially urgent in a context where both the crises of climate change and biodiversity loss are worsening, making cities more vulnerable living places. Moreover, the range of international, European, and Dutch policy targets on sustainability, including the SDGs, the Kunming-Montreal GBF, the European Green Deal, and the Nature Network Netherlands, reflect the contribution innovative and effective NBS can make towards the fulfilment of these targets by creating resilient and sustainable cities. Such NBS and their improved evaluations can further contribute towards the necessary transformation of current urban infrastructure regimes to allow the creation of sustainable, healthy, equal, and just urban living environments for all its residents, now and into the future.

7 – References

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8 – Appendix

Appendix 1: Overview of the selected cases

City Number of inhabitants	**Name**	**Type of urban NBS**	**Start date**	**Implementation status**
Utrecht 361.924	Watersystem Leidsche Rijn[1]	Sustainable urban drainage system	1997	Completed
	The Garden Factory[1]	Rooftop urban agriculture	2013	Completed
	The Bio Washing Machine[1]	Aquifer Thermal Heat Storage (ATES) system	2009	Completed
	Roerplein Pocket Garden[1]	Green square	2015	Completed
	Sustainable Neighbourhood Cherry Garden[1]	Sustainable neighbourhood with public green spaces	2002	Completed
	Maximapark The Ribbon[1]	Urban park	2007	Completed
	Greening the Historical Canal[1]	Green riverbanks and corridors	2016	Completed
	Willem Alexander Park[1]	Roof park on a highway tunnel	2011	Completed
	Food for Good[1]	Community garden	2013	Ongoing
	City Island Park Tour[1]	Multiple green and blue spaces along two canals	2013	Ongoing
Amsterdam 821.752	Green Strip Zuidas[1]	Sustainable urban drainage system	2016	Completed
	Pocket Parks in Indian Neighbourhood[1]	Ribbon of multiple pocket parks	2011	Completed

	City Island Ijburg[1]	Sustainable neighbourhood	2018	Ongoing
	Polder Roof Zuidas[1]	Green roof with water storage and drainage system	2013	Completed
	Knowledge Mile Park[1]	Pocket parks, green walls and living labs along traffic-heavy street	2016	Ongoing
	Indoor PopinnPark[1]	Indoor park inside abandoned store	2016	Completed
	Community garden Valentijn[1]	Community garden	2013	Completed
	Laterna Magica Playground[1]	Green rainproof school playground	2016	Completed
	Trompenburg[1]	Community garden	2009	Completed
	B.Bylon Roof Park[1]	Green roof with garden and water storage	2014	Completed
	IJburg[2]	Sustainable neighbourhood nearby water	1997	Completed
	Erasmus canal[2]	Urban sustainable drainage system	1993	Completed
The Hague 514.861	De Schilde[1]	Vertical urban farm	2015	Completed
	The Sand Motor[1]	Coastal protection	2011	Ongoing
	Sport Campus Zuiderpark[1]	Combination of green roofs, permeable paving, and green spaces for water storage	2014	Completed
	Slachthuis square[1]	Green public square	2016	Completed

	Molenvlietpark[1]	Water storing green park	2017	Ongoing
	Groene Mient[1]	Sustainable neighbourhood with pocket parks, community garden and permeable paving	2016	Completed
	Experimental garden Erasmusveld[1]	Sustainable neighbourhood with sustainable water system and community garden	2018	Ongoing
	The Sea Heroes Garden[1]	Community garden	2015	Completed
	Mariahof[1]	Community garden	2012	Completed
	Emma's Garden[1]	Community garden	2007	Completed
Rotterdam 623.652	Urban Water Buffer Spangen[2]	Sustainable urban drainage system	2018	Completed
	The Roof Field Schieblok[2]	Rooftop garden	2012	Completed
	Garden of Today[2]	Sustainable neighbourhood with community gardens	2009	Completed
	Bellamy square[2]	Green and blue square for water storage	2012	Completed
	Speeldernis[2]	Nature play garden	2002	Completed
	Marconistrip[2]	Urban agriculture	2012	Completed
Dordrecht 119.576	Green Plan Stadswerven[2]	Sustainable neighbourhood	2015	Ongoing
Heerhugowaard 56.742	City of the Sun[2]	CO_2-neutral neighbourhood with water retention facilities	2004	Completed

Pijnacker-Nootdorp 56.652	Boszoom[2]	Sustainable neighbourhood	2014	Completed
Delft 106.184	The Shoemaker Plantation[2]	Sustainable neighbourhood	2016	Completed
	Poptahof[2]	Sustainable urban drainage system and park with water play garden	2006	Completed
	Moe'sTuin[2]	Community garden	2005	Completed
Enschede 158.553	Roombeek[2]	Sustainable urban drainage system	2002	Completed
	Ruwenbos[2]	Wadi system to manage rain water	1999	Completed
Hengelo 80.683	Kristalbad[2]	Combination of green and blue spaces for water storage	2013	Completed
Berkel en Rodenrijs 31.650	Floating Roses[2]	Floating greenhouse	2010	Ongoing
Emmen 56.640	Living Machine[2]	Sustainable drainage system with water pavilion	2002	Completed
Culemborg 28.555	EVA-Lanxmeer Living Lab[2]	Sustainable neighbourhood	1999	Completed
	Caetshage[2]	Urban farm	2006	Completed
Zoeterwoude 8.450	Farm t' Geertje[2]	Biological urban farm	1948	Completed

Note: Adopted from (NATURVATION, n.d.)[1] & (Atelier GroenBlauw, n.d.)[2]

Appendix 2: Overview of the general characteristics investigated for the urban NBS and their evaluation

General characteristics of the NBS	Leading questions and *examples*	Statistical application
1) Case number + name	*Case 1 – The Garden Factory*	ID = case number
2) City	In which city is the NBS implemented? *Utrecht, Amsterdam, The Hague, Rotterdam, Dordrecht, Heerhugowaard, Pijnacker-Nootdorp, Delft, Enschede, Hengelo, Naaldwijk, Emmen, Culemborg, Zoeterwoude.*	1 = Utrecht 2 = Amsterdam 3 = The Hague 4 = Rotterdam 5 = Dordrecht 6 = Heerhugowaard 7 = Pijnacker-Nootdorp 8 = Delft 9 = Enschede 10 = Hengelo 11 = Naaldwijk 12 = Emmen 13 = Culemborg 14 = Zoeterwoude
3) Type of urban NBS	What type of urban NBS has been implemented? *Urban park, community garden, sustainable urban drainage system (SUDS), sustainable neighbourhood, green roofs or squares, blue spaces, urban agriculture.*	1 = Urban park 2 = Pocket park 3 = Green roof 4 = Green square 5 = Urban agriculture 6 = Community garden 7 = SUDS 8 = Sustainable neighbourhood 9 = Indoor park 10 = Blue spaces 11 = Other
4) Scale of urban NBS	At which spatial scale is the urban NBS implemented? *1) Micro-scale on the level of individual buildings.* *2) Street or neighbourhood scale.* *3) Large city-scale across multiple urban settings (adopted from Bulkeley et al., 2023).*	1 = Micro-scale 2 = Street or neighbourhood scale 3 = City-scale
5) Key initiating actors	Who are the key initiating actors of the urban NBS? *National governmental bodies, local municipalities, industry actors, NGOs, civil society groups, individual citizens.*	*Multiple response answer* 1 = National or provincial government 2 = Municipality 3 = Water body (in NL: 'Waterschap')

		4 = Private sector 5 = NGO 6 = Civil society group 7 = Individual citizens
6) Means of financing	What is the main mean(s) of financing the urban NBS? *Public funding by European, national, or municipal funding schemes, private funding schemes, co-financing schemes (adopted from Bulkeley et al., 2023).*	1 = Public funding by EU 2 = Public funding by Dutch government 3 = Public funding by municipality 4 = Private funding 5 = Co-financing
General characteristics of the evaluation	**Leading questions and *examples (mostly adopted from Huitema et al. (2011), besides differently indicated)***	**Statistical application**
1) Type of evaluation	*Ex ante or ex post (Crabb & Leroy, 2012)*	1 = Ex ante 2 = Ex post
2) Commissioner of evaluation	Who initiated / commissioned the evaluation? *Governmental institutions, universities, independent research groups or advisory bodies, consultancy firms, NGOs, industry actors, civil society groups*	1 = Governmental institution 2 = Research group 3 = Consultancy or advisory body 4 = NGO 5 = Private sector 6 = Civil society group
3) Actor or organisation responsible for conducting evaluation	Who performed the evaluation? And is this actor or organisation external or internal to the NBS being evaluated? *Governmental institutions, universities, independent research groups or advisory bodies, consultancy firms, NGOs, industry actors, civil society groups*	1 = Governmental institution 2 = Research group 3 = Consultancy or advisory body 4 = NGO 5 = Private sector 6 = Civil society group
4) Purpose of the evaluation	Why and with what purpose has the evaluation been commissioned and conducted? *Accountability / learning and policy improvement (adopted from Schoenefeld & Jordan, 2019)*	1 = Accountability 2 = Learning
5) Criteria used	Which evaluation criteria have been used? *Effectiveness, efficiency (cost-effectiveness), legitimacy, coordination, public acceptability, legal acceptability, transparency, participatory rights, equity (adopted from Huitema et al. (2011) and Mickwitz (2006))*	*Multiple response answer* 1 = Effectiveness 2 = Efficiency 3 = Legitimacy 4 = Coordination 5 = Public acceptability

		6 = Legal acceptability 7 = Participation 8 = Equity
6) Methods used	Which methods have been used to evaluate the NBS? *Document analysis, statistical modelling, cost-benefit analysis, questionnaire or polls, stakeholder interviews, social experiments including games.*	*Multiple response answer* 1 = Document analysis 2 = Statistical modelling 3 = Cost-benefit analysis 4 = Questionnaire or poll 5 = Interviews 6 = Social experiments 7 = On-site measurements 8 = Other
7) Type of data gathered	What type of data has been gathered and/or used by the evaluation? *Quantitative, qualitative or a combination of both.*	1 = Quantitative 2 = Qualitative 3 = Combination

Appendix 3: Operationalization of the evaluation principles

Evaluation principles	Leading questions and *examples (based on analytical framework)*	Level of alignment	Rationale for assessment
1) Addressing underlying causes	Does the evaluation consider one or more of the underlying causes as identified by IPBES (2019) and discussed in Bulkeley et al. (2023)? *1) Land use change and urbanization -> creating space for nature within concrete urbanised structures (re-naturalizing grey spaces).* *2) Unsustainable production and consumption -> reducing GHG emissions, promoting alternative travel modes or enhancing alternative food production and consumption networks.* *3) Values of nature -> re-connecting people with nature to foster more positive human-nature relationships.*	Strong	Assigned when the evaluation addresses more than one of the underlying causes.
		Adequate	Assigned when the evaluation addresses one of the underlying causes.
		Partial	Assigned when the evaluation only partially addresses one of the causes, but not precisely enough to be given an adequate level.
		Insufficient	Assigned when the evaluation does not address any of the underlying causes.
2) Multiple benefits	Does the evaluation address both environmental, as well as social and economic benefits? *Environmental benefits:* *1) Climate mitigation and adaptation* *2) Air quality* *3) Regulating temperatures* *4) Resilience to extreme weather events* *5) Urban biodiversity* *6) Water and nutrient cycling* *Social and health benefits:* *1) Human health and wellbeing* *2) Social cohesion and inclusion* *3) Sense of belonging* *4) Recreation* *Economic benefits:* *1) Green jobs*	Strong	Assigned when the evaluation addresses multiple environmental as well as social benefits.
		Adequate	Assigned when the evaluation addresses at least one environmental and at least one social benefit.
		Partial	Assigned when the evaluation addresses economic benefits and either only environmental or only social benefits.
		Insufficient	Assigned when the evaluation addresses only environmental, only social, or only economic benefits.

	2) *Other economic returns or opportunities*		
3) Trade-offs	Does the evaluation address possible trade-offs between objectives of the NBS? Possible trade-offs: 1) *Trade-offs between green/blue and grey spaces.* 2) *Trade-offs between different goals of the NBS, in providing environmental as well as social and economic benefits.* 3) *Trade-offs between different values given to different aspects of nature by diverse groups (related to aesthetics, cultural heritage, or recreation).* Potential ways to address trade-offs: 1) *Multi-criteria frameworks.* 2) *Experimental approaches that provide room for debate and contestation.* 3) *Reflecting on the use of multiple forms of urban NBS.* 4) *Adopting a landscape approach considering trade-offs between urban NBS across the urban landscape.*	Strong	Assigned when the evaluation does reflect upon multiple possible trade-offs with urban NBS, whilst offering ways to address these trade-offs.
		Adequate	Assigned when the evaluation does reflect upon at least one of the trade-offs possible with urban NBS, whilst offering to some extent ways to address these trade-offs.
		Partial	Assigned when the evaluation does reflect to some extent upon possible trade-offs but does not offer ways to address these trade-offs.
		Insufficient	Assigned when the evaluation does not address or reflect upon any of the possible trade-offs related to urban NBS.
4) Inclusivity and equality	1) Which stakeholders, if any, are involved in the evaluation process? 2) At what level of participation are these stakeholders involved? *See table 2 for the levels of participation, ranging from informing and consulting (tokenistic participation) to collaborating, co-designing and*	Strong	Assigned when the evaluation additionally involves various and multiple types of stakeholders on the deeper levels of participation.
		Adequate	Assigned when the evaluation does involve stakeholders on the deeper levels of participation.

	empowering (desired, deeper levels of participation).	Partial	Assigned when the evaluation does involve stakeholders in the process, but only on the tokenistic levels of participation.
		Insufficient	Assigned when the evaluation does not involve any stakeholders in the process.
5) Unintended consequences	Does the evaluation address unintended consequences of the NBS? *See table 1:* *1) Distributive justice = who benefits and who loses? (Also see principle of trade-offs)* *2) Procedural justice = who was able to decide for who? (Also see principle of inclusivity)* 3) *Recognition justice = whose values and needs have been recognized? (Also see both principles of trade-offs and inclusivity)*	Strong	Assigned when the evaluation addresses all three dimensions of justice.
		Adequate	Assigned when the evaluation addresses only two of the dimensions of justice.
		Partial	Assigned when the evaluation solely addresses one dimension of justice.
		Insufficient	Assigned when the evaluation does not address any of the dimensions of justice.
6) Monitoring and evaluation	1) Does the evaluation capture non-tangible benefits, as well as their long-term effects? *See principle of multiple benefits as well as the evaluation characteristic of (5) methods used and (6) type of data gathered.* 2) Does the evaluation use qualitative valuation methods besides a sole focus on quantitative ones? *See evaluation characteristic (6) type of data gathered.*	Strong	Assigned when the evaluation captures non-tangible benefits, their long-term effects and makes use of qualitative evaluation methods besides quantitative methods.
		Adequate	Assigned when the evaluation addresses multiple but not all aspects of the leading questions.
		Partial	Assigned when the evaluation addresses only one of the aspects mentioned in the leading questions, so only capturing intangible benefits, only incorporating long-term effects, or only using qualitative methods.
		Insufficient	Assigned when both leading questions are fully answered with a no for the evaluation.

Appendix 4: Interview guide

General questions on background and experience with evaluations

- Can you tell me a bit about your current work position?
- What is your experience with doing research on and conducting evaluations of NBS?
    - (*Sometimes the term green measure or green intervention was used when nature-based solutions were not explicitly worded like that in the evaluation document*).
- Do you observe a rise, or not, in the implementation of NBS over grey, technological ones when dealing with the consequences of climate change?

The questions related to each of the principles were tailored to the evaluation where the interviewee was involved in. As different aspects of the principles were addressed to a different extent by each evaluation, this led to various questions being asked to the interviewees depending on these different characteristics of the evaluation. Therefore, some overlapping questions are displayed below, but may thus not be asked to all interviewees due to the different evaluations they were involved in.

Questions on the multifunctionality and common trade-offs related to urban NBS

- To what extent do you consider the multiple benefits of NBS, both environmental as well as social, when assessing such projects?
    - Do you think it is valuable to capture all these benefits in evaluations of NBS? Or do you also associate negative consequences with this?
    - To what extent do you think it is important, in today's society that is often driven by money, to also capture the economic benefits of NBS in their evaluations?
    - Sometimes, the benefits of NBS have to be captured in numbers, while this can be difficult for non-tangible benefits of NBS. How do you perceive this?
- Whilst NBS are often praised for their multifunctionality, this may also lead to certain trade-offs. For example, cities have to provide room to various functions, such as housing, infrastructure, or businesses, sometimes at the expense of green areas. How do you perceive this with the experience you have in practice?
    - Trade-offs can also emerge between different user interests of NBS. Do you have experience with such trade-offs in practice as well, where nature is valued differently by different groups of people?
    - Do you see the value of bringing back pieces of nature in dense urban areas to increase the connection between people and nature?
    - Have you experienced negative reactions to bringing nature back into the city, when this is for example implemented in a wild way to benefit biodiversity?

Questions on inclusivity

- *When actors were involved in the discussed evaluation*: what was the reason for you to involve actors in the evaluation?
- Do you often involve actors when researching and/or evaluating NBS?
- Do you see the added value of involving actors in evaluations of NBS?
    - *If yes*: what are in your perspective the main benefits of involving actors in evaluations of NBS?
    - *If no*: what are in your perspective the main disadvantages of involving actors in evaluations of NBS?
- Do you think improvements should be made regarding the engagement of actors in evaluation processes?
- Would it be valuable to also involve actors more actively in the design and execution of evaluations? For example, through citizen science = citizens are involved in monitoring and evaluating NBS.

Questions on monitoring and data methods used

- What is your view on and experience with the use of quantitative and qualitative data methods?
    - *Most interviewees were, but if an interviewee was not familiar with the distinction between quantitative and qualitative data methods, this was explained first.*
- To what extent do you make use of these methods yourself?

- Academic literature points out that evaluations would benefit from the use of qualitative methods to capture the non-tangible benefits of NBS. From your perspective, would the use of qualitative methods in this sense improve the evaluations of NBS? Do you perhaps also see disadvantages of the use of qualitative methods?