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Co-benefits and conflicts in alternative stormwater planning: Blue versus green infrastructure?

Hanna Kvamsås

Department of Geography, University of Bergen, Bergen, Norway

Correspondence
Hanna Kvamsås, Department of Geography, University of Bergen, PO Box 7802, 5020 Bergen, Norway.
Email: hanna.kvamsas@uib.no

Funding information
NORCE Norwegian Research Centre; Universitetet i Bergen

Abstract

Blue–green infrastructure (BGI) is often promoted for its co-benefits and multifunctionality. However, this infrastructure is repeatedly planned, implemented and researched almost entirely based on the goals of stormwater management. Thus, more knowledge is required about how co-benefits are perceived and actioned by planning actors. By investigating co-benefits from a value perspective, this paper will contribute to the ongoing debate on how stormwater planning actors address the potential co-benefits and conflicts in the planning and implementation of BGI. The data are derived from policy document analyses and interviews with municipal and private planning actors in Bergen and Tromsø, Norway. The paper argues that municipal water actors are motivated to implement BGI beyond stormwater management goals and approach co-benefits and holistic stormwater management as an ideal in stormwater planning. However, the tensions and conflicts between the co-benefits become more evident in the actual implementation of BGI. The paper finds that when holistic BGI implementation is initiated by the municipal water actors, the stormwater management aspects dominate the BGI implementation. Finally, the paper concludes that even though blue and green values and interests are often conflicted in the implementation of BGI, urban stormwater planning is in the process of developing a blue–green value set based on the potential synergies of co-benefits. The paper therefore empirically illustrates how collective values and interests can develop and unfold across sectors and professional disciplines in BGI planning.

KEYWORDS

blue–green infrastructure, holistic planning, municipal planning, nature-based solutions, stormwater management, transformative adaptation, values

1 | INTRODUCTION

Across the world, human-induced climate change and extreme precipitation episodes have led to extensive stormwater problems and material damage in densely built urban areas (Bohman et al., 2020; Deely et al., 2020; Jiang et al., 2017; Kessler, 2011; Liu et al., 2019; Lund, 2018; O'Donnell et al., 2017). When conventional underground drainage systems are unable to handle stormwater, the response is to increasingly plan for blue–green infrastructure (BGI) to manage stormwater problems above ground (Alves et al., 2019; Brears, 2018; Dhakal & Chevalier, 2016; Flores et al., 2021; Ghofrani et al., 2020; Travaline et al., 2015; Wihlborg et al., 2019). BGI comprises interconnected natural elements such as rivers, streams, canals, ponds, wetlands, water reservoirs and designed landscape elements such as rain

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gardens, bioswales and green roofs (Liao, 2019; Oral et al., 2020). Such nature-based BGI implementation is currently regarded as vital under the EU strategy on climate change adaptation (Flores et al., 2021). Despite this increased focus on nature as a functional component of urban infrastructure, the implementation of nature-based solutions such as BGI is by no means mainstream (Matsler, 2019).

Based on arguments that adaptation strategies are more likely to be undertaken if compelling co-benefits can be demonstrated (Sharifi, 2021), we need to investigate and understand the role of co-benefits in urban adaptation planning. BGI development processes are suitable for such investigations as they are often based on co-benefits, multifunctionality and multiple benefits arguments (Alves et al., 2019; Hansen et al., 2019; Meerow, 2020; Meerow & Newell, 2017; Raymond et al., 2017). The opportunity to provide co-benefits for multiple actors could play a crucial role in transformative adaptation strategies (Alves et al., 2019; Frantzeskaki et al., 2019; Kvamsås, 2021; Raymond et al., 2017). Transformative adaptation strategies include actions that result in, or intend to result in, transformation (Lonsdale et al., 2015). The paper will investigate the transformative potential of BGI by exploring how local planning actors address the co-benefits and conflicts in the planning and implementation of BGI.

Co-benefits arguments provide holistic approaches to stormwater management and promote the simultaneous solving of multiple problems (Schuch et al., 2017). In this context, we define co-benefits as the additional positive effects and values achieved by a specific mitigation or adaptation measure (Sharifi, 2021). Examples of nature-based BGI co-benefits are water savings, energy savings, air quality improvement, carbon sequestration, biodiversity protection, nature conservation, recreational opportunities and public health benefits (Alves et al., 2019). These co-benefits can represent various actors, values, and interests in adaptation planning. The related concepts of multifunctionality and multiple benefits involve how green infrastructure (natural and designed green spaces) in urban areas provide ecological, social, and economic functions for different actors (Hansen et al., 2019; Matsler et al., 2021).

Daylighting stormwater infrastructure often challenges conventional stormwater management and makes the values, politics, and priorities of stormwater governance more visible as the infrastructure moves above ground (Kati & Jari, 2016). Such visibility could also highlight the conflicts in interests and values in stormwater governance (Finewood et al., 2019; Meerow, 2020). For example, BGI is repeatedly planned, implemented, and researched almost entirely based on the sole benefit of stormwater management goals, showing the potential tensions in the holistic blue–green concept (Meerow, 2020). Current literature describes significant conflicts and barriers in BGI implementation regarding uncertainty, lack of space and knowledge, lack of funding, professional traditions, and fixed mindsets (Dhakal & Chevalier, 2017; Jiang et al., 2017; Matthews et al., 2015; O'Donnell et al., 2017; Qiao et al., 2018; Thorne et al., 2018; Wihlborg et al., 2019). Notably, the interests and values associated with BGI conflicts and co-benefits often relate to specific professionals involved in BGI development, such as water engineers, landscapers, and planners (Meilvang, 2019).

The holistic BGI focus has parallels with transformative adaptation approaches which assert that solving the global climate crisis involves solving intertwined global crises in health, poverty, and nature (Wamsler et al., 2021). The implementation of transformative adaptation also requires human action that demands changes in the mindsets, beliefs, values, norms, and practices of people and organizations (Heifetz et al., 2009; O'Brien & Selboe, 2015). Thus, understanding and addressing the conflicts, co-benefits, and the potential holistic approaches to BGI planning and implementation could be crucial to developing holistic strategies for climate adaptation, which is deemed critical for further societal transformation (O'Brien & Selboe, 2015).

In this context, stormwater governance and planning literature requires more research. While there is much ongoing research into green infrastructure performance, there has been less research on the politics, priorities, conflicts, and trade-offs in BGI planning and implementation (Finewood et al., 2019; Meerow, 2020). Co-benefits and multifunctionality are also elusive concepts, and little information is available on how they are perceived and actioned by planning actors (Hansen et al., 2019). Also, it is unclear why stormwater management goals prevail and why co-benefits and multifunctionality appear to be missing during implementation (Meerow, 2020). Specifically, Meerow (2020) has asked for research on how decision-makers choose what type of green infrastructure is to be installed, and where.

This paper aims to contribute to these knowledge gaps. Drawing on theories on value perspectives and transformative adaptation (O'Brien & Selboe, 2015; Raymond et al., 2017; Rosenberg, 2021), the paper will analyze how BGI is planned and implemented in two Norwegian municipalities: rainy Bergen and freezing Tromsø. In short, the paper will (1) contribute to the ongoing debate on how stormwater planning actors address the potential co-benefits and conflicts in BGI planning and implementation and (2) conclude on how these insights could advance research and knowledge on holistic BGI planning as transformative adaptation strategies.

2 | THEORY: UNDERSTANDING BGI AS TRANSFORMATIVE ADAPTATION

This section will first provide an overview of current blue–green co-benefits and conflicts. It will then elaborate on transformative adaptation strategies and reflect on how to understand the values in holistic BGI planning.

2.1 | The blue–green co-benefit context

Urban drainage is an ancient field with a primary focus on conveying water away from urban areas, dating back to at least 3000 BC. In recent decades, urban drainage and related literature have evolved towards a holistic approach focusing on BGI multifunctionality and co-benefits (Fletcher et al., 2015). BGI comprises interconnected

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natural and designed landscape elements, including water bodies and green and open spaces. It is closely related to the concept of green infrastructure, which includes regional, peri-urban, and urban green bodies (Ghofrani et al., 2017). BGI comprises aquatic green spaces such as rivers, streams, canals, ponds, wetlands, and water reservoirs. In addition, terrestrial green spaces designed for stormwater management such as rain gardens, bioswales, and green roofs are key elements (Liao, 2019).

Recently, multiple studies have been conducted on blue–green co-benefits and multifunctionality (Alves et al., 2019; Hansen et al., 2019; Matsler, 2019; Meerow, 2020; Raymond et al., 2017). Several studies assessed the value of co-benefits and explored the differences in costs, performance, and societal perception between BGI solutions and the gray and combined infrastructure solutions. Alves et al. (2019) presented a method to include a cost–benefit analysis of flood risk mitigation measures. They concluded that assessing relevant co-benefits when identifying the best adaptation strategies to improve urban flood risk management is crucial to show the efficiency of green infrastructure compared to traditional gray infrastructure. Matsler (2019) highlighted the institutional tensions that emerge from attempting to fit nature into existing asset management practices by valuing and "bookkeeping" natural components of green infrastructure such as trees, soil and vegetation.

Raymond et al. (2017) developed a holistic framework for assessing the co-benefits and cost of nature-based solutions across socio-cultural and socio-economic systems, biodiversity, ecosystems, and climate. Ecosystem service frameworks are often used to examine the value of urban ecosystem-based approaches and examine the potential synergies and trade-offs. They also promote a broad framework of nature's contributions to people, recognizing various values associated with other worldviews on human–nature relations and knowledge systems in environmental decision-making (Raymond et al., 2017). As actors in urban areas increasingly turn to BGI and nature-based solutions to solve a range of urban challenges, the interest in green infrastructure's complexities, trade-offs, and politics also grows (Finewood et al., 2019).

Early consideration of the various social, ecological, and economic benefits in planning processes could foster synergies between the optimal provision of multiple green space functions (Hansen et al., 2019). New planning tools like the Green Area Factor tool are emerging in several cities to assess the sustainability of landscape designs and construction based on the proportion of green and built-up areas (Juhola, 2018). While such tools can be helpful in the BGI planning phase, they generally do not offer the capacity to monitor implementation and progress or evaluate the ongoing state of blue–green areas (Juhola, 2018).

In this context, we approach BGI development and the co-benefits focus as representing a holistic planning ideal that seems challenging to implement. While BGI can be a holistic and unifying term because of its multiple co-benefits, it also includes potential tensions, contrasts, and conflicts in alternative stormwater planning that might be blurred by a holistic BGI concept.

2.2 | Conflicts in BGI implementation

In examining the politics of green infrastructure planning in New York, Meerow (2020) argues that the main objective of BGI implementation is stormwater abatement. As stormwater management goals influence the localization of BGI, there is room to improve the strategic planning of multifunctional green infrastructure to benefit selected urban areas (Meerow, 2020). Alternative stormwater management includes solutions such as best management practices (BMP), low impact development (LID), sponge cities, sustainable urban drainage systems (SUDS), and water-sensitive urban design (WSUD) (Fletcher et al., 2015; Matsler et al., 2021). These are closely associated with green infrastructure but range from a greener to a bluer focus, some of them even excluding vegetation (Matsler et al., 2021; Wihlborg et al., 2019). Endorsing green infrastructure mainly as a combined sewer overflow solution narrows the definition of green stormwater infrastructure, fitting it into existing infrastructure politics and practice, while effectively de-emphasizing other co-benefits (Finewood et al., 2019).

Finewood et al. (2019) show how discourses on green and blue–green infrastructure can privilege some values at the expense of others in urban planning, potentially even preventing democratic planning processes. In this understanding, BGI falls under the purview of engineers who mainly promote technical, traditionally hidden and supposedly apolitical engineering solutions. In contrast, green infrastructure can challenge conventional engineering approaches as it is built right in the public eye, next to sidewalks, and on building exteriors, literally bringing the politics of stormwater governance into public view (Finewood et al., 2019).

The introduction of a new technology such as BGI can enlighten the way in which politics connects to infrastructure choices and creates openings for negotiation between contested systems and normative values. Examining green infrastructure and the discursive shift to BGI can provide insight into the politics and power that influence urban form (Finewood et al., 2019). Understanding the power, politics, and values embedded in such a discursive shift could help counter the depoliticization of urban environmental challenges (Finewood et al., 2019). While there is a general awareness of the multiple functions of urban green infrastructure, multifunctionality planning approaches vary considerably between cities (Hansen et al., 2019).

In sum, the current literature on stormwater planning explores selected conflicts and co-benefit-based synergies between the different objectives of blue–green planning. The potential co-benefits are essential arguments for daylighting stormwater infrastructure which, in turn, challenges multiple actors and interests who compete for limited urban space. Approaching BGI development as promoting a holistic planning ideal and acknowledging the tensions and conflicts within this ideal, the paper will continue exploring how a value perspective and transformative adaptation theory might contribute to providing a better understanding of how planning actors address the co-benefits and conflicts of BGI.

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2.3 | Transformative adaptation strategies

Much of the adaptation literature uses the transformation concept to describe adaptations beyond the limits of incremental adaptation that also provide (forced or chosen) opportunities for adaptation for organizations or individuals (Pelling et al., 2015). While a transformational adaptation concept can serve as an umbrella term for adaptations associated with societal transformation, a transformative adaptation strategy can refer to the actions leading, or intending to lead, to transformation (Lonsdale et al., 2015). In a world unable to avoid the severe consequences of climate change, adaptation efforts connected to societal transformation are crucial (O'Brien & Sygna, 2013). Furthermore, understanding adaptation as transformation can promote adaptation measures that challenge established values, organizations and power (Pelling, 2011). Thus, in this paper, understanding transformative adaptation as requiring human action that demands changes in the mindsets, beliefs, values, norms and practices of people and organizations (Heifetz et al., 2009; O'Brien & Selboe, 2015) is essential to our understanding of transformative adaptation strategies.

The need to understand transformative climate adaptation stems from an urgency to minimize the risks of maladaptation and climate change vulnerability (O'Brien, 2021). Kates et al. (2012) describe transformational adaptation as forced upon us by crisis, demanding large-scale action, affecting whole regions or resource systems, or involving the complete transformation of a place, or even location shifts. In one way, stormwater management is an appropriate example because climate change, increasing precipitation levels and urban densification are currently forcing change and transformation. Pelling et al. (2015) describe transformative adaptation as adaptive actions that can shift existing systems and institutions onto alternative development pathways before existing adaptation measures are exhausted. Alternative stormwater management has the potential to be such an example of transformative adaptation, potentially affecting and shifting urban life with its range of multiple benefits.

This raises the issue of how it is equally essential to promote transformative adaptation measures that could help people envision and develop a just, equitable and sustainable future for all humans and other actors (O'Brien, 2021). The stormwater management shift from building traditional gray stormwater infrastructure to ambitious plans for implementing holistic nature-based solutions such as BGI also promotes new ambitions to address growing social, technological and environmental complexity and uncertainty (Franco-Torres et al., 2020). This new urban water paradigm reconceptualizes rainwater in cities as a newly valued resource compared to the previous understanding of risk (Franco-Torres et al., 2020; Meilvang, 2021). Using rainwater to enhance the quality of urban space has also become a way for actors to promote their cities as desirable places to live (Meilvang, 2021). Reflecting on which values and interests the co-benefits of BGI are associated with during the process of implementation becomes particularly relevant in this context.

2.4 | The values in holistic BGI planning

There are no value-neutral responses to climate change, and some climate actions will have adverse outcomes for some actors and positive effects for others. Thus, visibility and transparency regarding the values, interests and intentions behind transformative adaptation is critical for equitable climate action processes (O'Brien, 2021). Values can be defined as what people deem to matter, and the role values play in transformation processes is increasingly gaining interest in and outside academia (Rosenberg, 2021). There are multiple ways to conceptualize values, including in the literature on stormwater management. In a BGI co-benefits context, actors emphasize how specific measures can provide added values (Sharifi, 2021). As previously mentioned, co-benefits could refer to ecosystem values, recreational values (Liao, 2019) and economic values (Alves et al., 2019). Several scholars claim that ecosystem service frameworks and land-use planning would benefit from emphasizing non-monetary values more (Kati & Jari, 2016; Raymond et al., 2017). The value of rainwater as a quality in urban settings can also be presented as a distinct value (Franco-Torres et al., 2020; Meilvang, 2021).

Prominent transformation scholars argue that re-politicizing climate change and addressing the root causes of risk and vulnerability requires the conflicting values, interests and different understandings of climate change to be addressed (O'Brien & Selboe, 2015; Pelling, 2011). In line with this argument, we also want to accentuate how the potential synergies between values and interests could contribute to transformative adaptation strategies. Co-benefit interests, objects and values often relate to specific professionals involved in BGI development, such as water engineers, landscapers and planners (Meilvang, 2019). In this regard, Kvamsås (2021) shows that stormwater planning actors from various disciplines find it beneficial to identify shared interests and unified solutions because it ensures support for separate professional interests such as cleansing stormwater or securing biodiversity. This could indicate a potential for developing synergies between interests and values.

Conceptualizing values as being held by individuals differs from conceptualizing them as socially constructed discursive practices used to legitimize society (Rosenberg, 2021). A socially constructed value perspective sees values as being formed collectively rather than individually, making collective values potentially different from what people deem to matter individually (Rosenberg, 2021). This aspect is vital when exploring the connection between co-benefits, values, and actors representing professional disciplines more than individual opinions. Such a value perspective could contribute to the literature on stormwater planning because it helps to highlight what matters to the specific actors in the various phases of BGI planning and implementation. The whole case study could further contribute to understanding BGI as a transformative adaptation strategy, providing empirical examples of how to investigate and address values in adaptation planning.

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3 | METHODS: STUDYING BGI PLANNING AND IMPLEMENTATION

3.1 | A case study research approach

In order to explore how stormwater planning actors address the co-benefits and conflicts in BGI development, we have used a case study research approach (Yin, 2009) to investigate local BGI planning processes in Bergen and Tromsø, Norway. The studied locations were selected because they were the first two municipalities in Norway to develop dedicated municipal stormwater sector plans. The cities share a national adaptation policy but have specific local climatic, geographical, cultural, and institutional conditions affecting the two studied stormwater planning processes. Thus, they represent two locations in which BGI measures need specific local adjustments and adaptation. Their experiences could be directly relevant to cities and towns with similar climatic conditions.

Bergen is a port city on the west coast of Norway with a strong identity as Europe's rainiest city (Bremer et al., 2020). Tromsø is a climatically subarctic city located in Northern Norway, experiencing challenges related to precipitation episodes combined with ice, snow and freezing ground (Kvamsås, 2021). The two cities are illustrative examples of municipalities that work purposefully to promote BGI in planning as alternative solutions for stormwater management. They also highlight the challenges concerning slow BGI implementation and mainstreaming. The analyzed sector plans are new but form part of more extensive strategic work on BGI implementation in the two cities, comprising BGI policies and pilot projects. Their experiences of BGI implementation could be relevant for other cities, particularly those in the early stages of BGI development.

In line with the Yin (2009) case study definition, the research involved investigating a contemporary phenomenon within its real-life contexts, acknowledging that the boundaries between phenomenon and context are unclear. The data come from observing policy planning processes, qualitative interviews with relevant planning actors, and a policy document analysis of two municipal sector plans for stormwater management. As social science generally does not produce context-independent theory, this case study approach is well suited to generating the context-dependent knowledge that social science can provide (Flyvbjerg, 2010). As for generalizing the findings of this study, we use analytical generalization and thus generalize the results to broader theoretical propositions, not to populations or universes (Yin, 2009). This is not a sample case (representing statistical generalization) and the goal is to expand and generalize theories (Yin, 2009). In this paper, the case informs alternative stormwater management literature and contributes to transformative adaptation theory (Figure 1).

FIGURE 1 Map of Bergen and Tromsø, Norway. *Source*: Map created using Google My Maps in google.no/maps

3.2 | Observation and interviews

We observed the planning process in Bergen by participating in local working group meetings, reference group meetings with different municipal departments, external information meetings, professional seminars, as well as information workshops with internal municipal professionals and private consultants from spring 2018 to fall 2019. The observations involved listening and taking notes at meetings, with the aim of not disturbing the process. Importantly, information was also obtained from field conversations before and after these meetings. This observation method provides an in-depth understanding of the varying values and interests in a complex planning process. Combining observation methods with, for example, qualitative interviews, can also be a helpful way of obtaining knowledge about a phenomenon from different perspectives, including information the researcher does not directly request (Thagaard, 2009).

We conducted 11 interviews with municipal planning actors and seven interviews with private planning actors in Bergen and Tromsø. The municipal actors were mainly selected based on their involvement with the ongoing planning processes. The private actors in Tromsø were recruited based on their involvement and knowledge of the plan. The private actors in Bergen were recruited mainly from the municipal information seminar about the sector plan for private actors. Most of the municipal planning actor interviews were conducted in person in September and October 2019. The private actor interviews were mainly conducted online in September and October 2020. Three of the 18 interviews were group interviews, each with two interviewees. The researcher also had ongoing communication with the project coordinator in Tromsø and conducted one follow-up interview online about the planning process in June 2020. See Table 1 for a list of observation points and interviews.

3.3 | Data analysis

All interviews were recorded and transcribed by the researcher. Listening to the interviews and transcribing them was the first step to

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TABLE 1 List of observation points and interviews

Observations at municipal stormwater planning meetings and workshops in Bergen
1. Introductory meeting—Department of Water and Sewerage, Bergen municipality
2. Meeting/workshop—Department of Water and Sewerage, Bergen municipality and the Norwegian Natural Perils Pool
3. Project group meeting—Municipal sector plan for stormwater management
4. Project group meeting—Municipal sector plan for stormwater management
5. Reference group meeting—Municipal sector plan for stormwater management
6. Project group meeting—Municipal sector plan for stormwater management
7. Meeting, zoning plans—Bergen municipality and private consultants
8. Information workshop about the municipal sector plan for stormwater management for municipal departments in Bergen municipality
9. Information workshop about the municipal sector plan for stormwater management for private consultants in the Bergen area
Interviews with municipal planning actors, Bergen and Tromsø
1. Interview—Department of Water and Sewerage, Bergen
2. Interview—Department of Urban Environment, Bergen
3. Interview—Department of Planning and Building, Bergen
4. Interview—Department of Planning and Building, GIS, Bergen
5. Interview—Department of Planning and Building, Bergen
6. Group interview—Department of Urban Environment, Bergen
7. Interview—Department of Water and Sewerage, Tromsø
8. Group interview—Department of Urban Environment, Parks and Recreation, Tromsø
9. Interview—Department of Planning and Building, Tromsø
10. Interview—Department of Water and Sewerage, Tromsø
11. Follow-up interview—Department of Water and Sewerage, Tromsø
Interviews with private planning actors, Bergen and Tromsø
12. Interview—Private consultant, construction entrepreneur, Bergen
13. Interview—Private consultant, planning firm, Bergen
14. Interview—Private consultant, planning firm, Bergen
15. Interview—Private consultant, engineering, and planning firm, Bergen
16. Interview—Private consultant, landscape gardening entrepreneur, Bergen
17. Interview—Private consultant, advisor water and sewerage, Tromsø
18. Group interview—Private consultants, engineering, and planning firm, Tromsø

gaining an overview of the material and starting the process of interpretation (Braun & Clarke, 2006). In addition, observations at meetings and workshops resulted in extensive personal field notes. The second stage of analysis was to systematize the text material into thematic categories. This analysis approach aligns with thematic analysis methods that can help organize and describe qualitative data material in rich detail and help identify, analyze, and report patterns and themes in qualitative data sets (Braun & Clarke, 2006).

The interviews were structured and provided two sets of basic categories. The first set relates to the planning and implementation processes of the stormwater sector plans and specific BGI measures such as the preplanning phase, planning phase, measure designing phase, implementation phase and the potential maintenance phase. These categories mirror categories in systematic decision-support frameworks such as the adaptive management decision-making framework (Brears, 2018). The second set of categories concerned cross-cutting themes such as knowledge/experience, challenges/opportunities in BGI work, working methods, BGI development over time, as well as local conditions for BGI implementation.

Reflecting on what constitutes relevant themes and categories in qualitative research analysis (Braun & Clarke, 2006), the themes concerning co-benefits and conflicts in the implementation phase became prominent in the material. The process of visiting and observing relevant BGI measures in Bergen and Tromsø was also crucial to understanding the final design. The data material is presented using relevant examples illustrating how the actors perceived and addressed the co-benefits and conflicts in the planning and implementation of BGI in Tromsø and Bergen.

3.4 | Policy document analysis

Document analysis has a long tradition in qualitative research and consists of systematic analysis of written (or audio-visual) depictions (Thagaard, 2009), for example, policy documents. The two documents analyzed here were the Bergen municipal sector plan for stormwater management 2019–2029 and the Tromsø municipal sector plan for stormwater management 2019–2032, both of which are Norwegian policy documents. The document analysis started with a thoroughly review of the two planning documents to identify the main themes. We then constructed a table of all references to the co-benefits/multiple benefits/multifunctionality from the two planning documents. Potential conflicts were categorized in the same way to analyze their role in the policy documents. The categorization helped explain what the two plans emphasized. Furthermore, the categorization demonstrated how co-benefits and conflicts were connected to separate parts of the plan such as the vision, goals and proposed solutions, which further represent concrete implementation phases.

4 | FINDINGS: CO-BENEFITS AND CONFLICTS IN ALTERNATIVE STORMWATER MANAGEMENT

The paper data provide insight into how municipal and private planning actors perceive the co-benefits, conflicts and prioritizations of

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current alternative stormwater planning and implementation. This section starts by presenting the results of the document analysis of the co-benefits and conflicts in the Bergen and Tromsø sector plans for stormwater management. The section then provides reflections and empirical examples from BGI implementation based on observations and interviews with the relevant planning actors.

4.1 | The Bergen municipal sector plan for stormwater management

The municipal water sector is a progressive actor in Norwegian climate adaptation work (Hovik et al., 2015; Kvamsås, 2021). In 2015, the Norwegian government published a White Paper on stormwater, recommending that municipalities create municipal sector plans for stormwater management (NOU, 2015). As the first municipality in Norway, Bergen City Council approved the Bergen municipal sector plan for stormwater management in September 2019. This sector plan is an overarching stormwater management strategy to handle stormwater in spatial planning. While it is not a legally binding land-use plan, it provides guidelines for legally binding land-use plans and individual building applications according to the Norwegian Planning and Building Act, including the land-use part of the municipal master plan (BergenKDP, 2019).

The sector plan starts by envisioning Bergen as a clean, beautiful and lush blue–green city, preserving biodiversity and its natural water cycles. The sector plan vision states that "stormwater will contribute to better living conditions, a sustainable and resilient urban society, as well as healthy nature". The main goals of the sector plan entail (1) protecting the natural water cycle, (2) making water a resource for biodiversity, (3) making water an element of urban design, (4) making water support ecosystem services, (5) prevent stormwater from contaminating the environment and (6) prevent climate change from creating stormwater problems (BergenKDP, 2019). Thus, there is a clear focus on the multiple benefits of BGI and a holistic mindset that promotes stormwater as a resource in urban planning.

Notably, the mandate of the municipal stormwater sector plan is to prioritize stormwater goals. That is evident from the plan. The plan describes several potential conflicts between the blue–green objectives and urban densification goals, economic interests, as well as pressure on land-use. For example, ambitions for the high utilization of urban space may conflict with space that is needed to address stormwater, depending on the frequency of flooding (BergenKDP, 2019). The strategy of achieving the sector plan goals is focused on coordinating stormwater planning with spatial planning, meaning assessing and determining stormwater solutions in land-use plans. The sector plan promotes specific principles of stormwater management, including focusing on entire precipitation fields when planning, taking into account the potential consequences upstream and downstream, and addressing citizens' health, safety and economic interests. The plan asserts that stormwater requires local treatment and the prioritization of above-ground blue–green solutions. The strategy is based on Norwegian central government planning guidelines, which state that deselecting nature-based solutions for stormwater management requires specific assessment and argumentation (BergenKDP, 2019; Lovdata, 2018).

The Bergen municipal sector plan promotes a three-step stormwater strategy comprising (1) infiltration (rain gardens, bioswales, open ponds), (2) delaying excess water in basins or wetlands, and (3) providing safe flood routes for stormwater peaks. An essential element of this strategy is to separate stormwater from combined sewage systems to help system capacity and water body quality (BergenKDP, 2019). This could help address some problems concerning contaminated stormwater though it is also often necessary to purify contaminated stormwater. According to the plan's visions and goals, the strategy promotes blue–green solutions and concentrates on managing stormwater above ground.

A substantial part of the Bergen municipal sector plan assesses and presents 14 of Bergen's main watercourses. The presentations include descriptions of each precipitation field, its potential for fisheries, recreation, biodiversity status, and water quality. This is an illustrative example of incorporating multiple co-benefits. The sector plan also contains an online map with stormwater information from various sources and an action plan. One of the reasons for creating the online map is to share information about holistic stormwater management across planning areas and precipitation fields (interview #1). The action plan has seven action points: four points about flood zone assessments, one action point about assessing stormwater discharge points, one about stormwater planning for precipitation fields, and the last concerning stormwater separation projects (BergenKDP, 2019). The action plan shows a clear priority of stormwater management goals.

4.2 | The Tromsø municipal sector plan for stormwater management

Tromsø municipal council approved the Tromsø municipal sector plan for stormwater management in May 2020. The sector plan presents a strategy for how the municipality can prepare for more intense precipitation, longer snowmelt periods, floods, and higher storm surges than previously. The Tromsø sector plan promotes climate-adapted and sustainable stormwater management, aspiring to reduce potential damage and rectify capacity issues regarding existing and future water infrastructure. The sector plan outlines three main goals: (1) prevent material damage, (2) protect the environment and water resources, and (3) use stormwater as a resource in urban planning (TromsøKDP, 2020). Each goal involves measures ranging from upgrading the culverts and pipes of conventional stormwater systems to assessing the potential for opening closed streams and preserving wetlands. There is a strong focus on purifying contaminated stormwater.

The sector plan promotes six measures that provide guidelines for legally binding land-use plans and individual building applications according to the Norwegian Planning and Building Act. The measures are as follows: (1) develop a separated pipe-based stormwater system,

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(2) ensure water diversion in open streams, (3) promote local diversion of rainwater, (4) introduce the Blue–Green–White Factor planning tool, (5) establish safe flood routes, and (6) ensure stormwater purification (TromsøKDP, 2020). While measures 2, 3, and 4 promote blue–green measures and open solutions, the sector plan promotes the multiple benefits of these measures to a lesser extent compared to arguments about protecting the capacity of existing conventional water infrastructure. One of several possible explanations for this could be the climate and topography of Tromsø, which make it challenging to enjoy the benefits of green infrastructure for large parts of the year.

Stormwater problems in Tromsø vary greatly depending on the season. Rain on frozen ground and freezing stormwater are problematic during fall and winter, and the spring snowmelt creates flooding problems. The conventional water infrastructure struggles when freezing and requires strategies to protect its capacity. The Tromsø sector plan is based on a landscape analysis of runoff and waterways in various local landscapes. The landscape analysis divides Tromsø into three types of precipitation field, describing its potential runoff, ways of directing excess water, pipeline capacity and potential risks. The principle behind the stormwater strategy is to combine several measures to make the system resilient (TromsøKDP, 2020). The three-stage strategy (infiltration, delaying, safe flood routes) needs to be adapted to local conditions because the local climate and landscape provide poor infiltration conditions. The seasonally frozen ground increases the importance of the third stage—safe flood routes. When the multiple benefits of BGI are considered in the sector plan, esthetics, and sustainability are keywords.

The action part of the Tromsø stormwater sector plan is quite extensive, containing action points such as investigations ranging from new calculations of precipitation data to assessing ownership of stormwater infrastructure and adapting municipal building applications to include stormwater issues. Implementation of the sector plan in current municipal administrative procedures and working routines is also a crucial part of the action plan. The action plan promotes skills development, measure testing and adapting rainwater diversion solutions to local conditions (TromsøKDP, 2020). Though the Tromsø sector plan has limited focus on the multiple benefits of BGI, BGI is still a key part of the strategy, primarily represented by the locally adapted Blue–Green–White Factor planning tool. However, it could be argued that the stormwater management objectives of the Tromsø municipal sector plan for stormwater management seem to take precedence over multiple co-benefits, including the green elements.

4.3 | How planning actors perceive co-benefits in alternative stormwater planning

There has been increased focus on BGI in Norway over the last decade. Several planning actors have highlighted a severe stormwater flooding event in Copenhagen, Denmark in 2011, emphasizing how the Danish experiences concerning BGI planning have been inspirational for BGI development in Norway (interview #7, #16, meeting #1). A private planning actor explained how they are currently changing the design and color of their company's logo to blue and green to communicate sustainability to their customers as blue–green values are becoming an integral part of urban planning (interview #14). Although blue–green measures are increasingly valued in urban planning, their implementation is still slow. Green elements are often deselected in order to create parking spaces, universal design (urban environments that provide universal access for all), or cultural heritage considerations (interview #13, #5).

In Norway, BGI is primarily combined with conventional and underground pipeline infrastructure, particularly in already built-up areas with existing infrastructure (interview #1). The traditional way of handling increasing precipitation and stormwater is upgrading and resizing the pipes. However, a planning actor stated that "when we have accidents and flooding, it is rarely because of an under-dimensioned pipe, but because of a breach in the whole design" (interview #1). Another planning actor explained that stormwater management is not about millimeter accuracy: "You can never dimension your way out of potential flooding" (interview #17). These statements illustrate what several of the interviewed BGI practitioners say; that the blue–green focus is not just about handling stormwater but about thinking holistically, considering more than one goal, and looking beyond your limited planning area (interview #1, #7, #17). Notably, the two new sector plans that promote blue–green values and multiple benefits are quite overarching. The planning actors emphasized how the potential conflicts often become more challenging when it comes to the details of implementation (interview #1, #7).

4.4 | How planning actors perceive conflicts in alternative stormwater planning

The fact that the Norwegian Planning and Building Act promotes holistic stormwater management (Lovdata., 2021) was essential for creating the Tromsø stormwater sector plan. A key measure of the Tromsø sector plan is a planning tool developed by municipalities in south-eastern Norway called the Blue–Green Factor (BGF). The BGF tool is similar to planning tools like the Green Area Factor (GAF) tool, which aims to assess the sustainability of landscape design and construction based on the proportion of green and built-up areas (Juhola, 2018). The BGF tool aims to raise the status of blue and green urban spaces and calculates the degree of blue–green solutions in zoning plans. As snowmelt contributes to the stormwater problems in Tromsø, the municipality adjusted the tool to take into account local climatic conditions by adding a W for White—as in snow—in the now local Blue–Green–White Factor (BGWF) (TromsøKDP, 2020).

In creating the Tromsø sector plan, there were some concerns about the BGWF. One of these concerns was about whether the method would receive local approval as some actors might perceive it as creating additional construction costs. One of the goals of the sector plan is to incorporate the BGWF in the next municipal master plan in Tromsø. An argument for using the BGWF is that it enhances the quality of outdoor space and promotes blue and green values

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(interview #7). Even with these arguments, there were concerns from urban environment actors regarding how the BGWF would shape green area development. When planners and builders focus on reaching some calculated sum of points, it could affect how parks and recreational areas are designed (interview #8). Discussions about snow deposits and valuing snow deposits have been prominent in the BGWF development. It is not unusual to deposit snow from roads in parks and playgrounds. According to urban environment planning actors, this is problematic as road snow contains contaminants and heavy metals, leaving green areas contaminated when the snow melts (interview #8).

In addition to the BGWF, the local diversion of stormwater is key to the Tromsø stormwater plan. Such measures are closely associated with green infrastructure but can also deselect green solutions. The contrast between blue and green objectives and interests are physically visible in rain garden structures in Tromsø, where plants are not guaranteed (interview #7, #8). In a Tromsø schoolyard, new rain gardens have been built purely from sand and stones. The rain gardens have no plants due to practical considerations such as climatic conditions (when will it be green?), maintenance (gardening resources) and children playing (children could destroy the plants while playing). A planning actor questioned whether it was really a rain garden "when it is a bathtub containing sand and stones" (interview #8). The goal of this measure was to prevent flooding in the schoolyard and in the basements of adjacent houses. In these rain gardens, the green co-benefits disappeared.

Still, Tromsø municipality works on adapting rain gardens to freezing temperatures, appropriate to a sub-arctic climate. In a pilot project, the municipality tested alternative granular materials in rain gardens that do not freeze during winter. One of the challenges is that this alternative material does not purify the water in the same way as sand, eliminating the water purifying effect of this blue–green measure (interview #7, #8). Table 2 summarizes the findings in this section, presenting BGI development from before the concrete

TABLE 2 BGI co-benefits and conflicts in Bergen (B) and Tromsø (T)

Co-benefits	Conflicts
Preplanning phase	
Blue–green value development	*Blue–green value development*
B/T: ideas and values related to sustainability, holistic approaches and blue–green urban qualities have increasingly become prominent in urban planning over the last decade	B/T: although the blue–green measures are increasingly valued in urban planning, their implementation is still slow
Planning phase	
Visions/goals of the plans	*Visions/goals of the plans*
B: explicit and holistic blue–green visions in the plans. The main goals focus on broad multifunctionality and co-benefits T: clear focus on preparedness in the plans. The main goals concern potential damage reduction and using water as a resource in urban planning	B/T: the mandate of the municipal stormwater sector plan is to prioritize stormwater objectives B/T: the blue, green and blue–green goals compete with urban densification goals, economic interests, as well as pressure on land-use
Designing phase	
Strategy/measures	*Strategy/measures*
B: clear focus on holistic management of precipitation fields and managing stormwater locally using green surface solutions; combine BGI with conventional systems T: combine open blue–green surface solutions with upgrading and securing conventional systems; intention to add green elements	B: ambition for the high utilization of urban space may conflict with the space needed to address stormwater, depending on the frequency of flooding T: promote blue–green planning tools that can shape (blue–)green area development
Implementation phase	
Action plan/experiences	*Action plan/experiences*
B: actions include assessing flood zones, discharge and separation projects: the multifunctionality and co-benefits are less explicitly present T: extensive action plan including knowledge development, skills development and institutionalization of the sector plan goals, holistic thinking concerning developing stormwater planning	B: green elements are often deselected to accommodate other interests, potential conflicts become more challenging in the implementation phase T: example: rain gardens built purely from sand and stones; a lack of plants due to climatic conditions, maintenance and schoolyard recreation options
Maintenance phase	
Sector plan/experiences	*Sector plan/experiences*
B/T: the sector plans are the first stage of a long-term strategy to develop blue–green solutions B/T: planning actors must test and adapt blue–green solutions to local climatic conditions	B/T: build combined solutions because surface solutions challenge existing infrastructure solutions and local conditions B/T: planning actors need time and resources to test solutions (and try-and-fail)

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planning work to beyond the implementation stage in Bergen and Tromsø. The findings will be discussed further in section 5.

5 | DISCUSSION: ADDRESSING BGI CO-BENEFITS AND CONFLICTS

At the outset of this paper, we argued that holistic BGI development could promote transformative adaptation strategies based on its focus on holistic co-benefits (Alves et al., 2019; Frantzeskaki et al., 2019; Kvamsås, 2021; Raymond et al., 2017). We further argued that understanding this transformative potential could benefit from a value perspective (Heifetz et al., 2009; O'Brien & Selboe, 2015; Rosenberg, 2021). The paper has two aims: (1) to understand how stormwater planning actors address the potential co-benefits and conflicts in BGI planning and implementation, and (2) to conclude how these insights could advance research and knowledge on holistic BGI planning as transformative adaptation strategies.

BGI in Bergen and Tromsø is generally planned and implemented based on initiatives from actors in their respective municipal water departments. The two studied stormwater sector plans are examples of such initiatives. These planning processes actively seek to involve actors from other relevant municipal sectors, such as planning and urban environmental departments, which represent other interests and values. The sector plans explicitly focus on stormwater management as is their mandate, but they also include a focus on holistic co-benefits. For example, the Bergen municipal sector plan has a holistic blue–green vision and six main goals that explicitly focus on broad multifunctionality and co-benefits such as preserving biodiversity and supporting ecosystem services. The visions, goals, strategies and measures demonstrate a desire to transform urban space, combining multiple blue and green interests and goals.

However, the focus on holistic co-benefits is less explicit in the current Bergen action plan, which mainly focuses on flood zone assessment and handling contaminated discharge. This could affect the prioritization of blue or green objectives and elements in BGI implementation. Additionally, the experiences of local municipal and private planning actors demonstrate how green elements are often disregarded in the BGI implementation phase to accommodate interests such as parking spaces and other competing infrastructure. This complements findings in Meerow (2020), showing how water quality targets dominate BGI planning. Importantly, private actors are key to the BGI implementation phase, and their room to maneuver is often heavily dependent on the regulations and initiatives of the municipality.

In the Tromsø sector plan, securing the current water infrastructure and cleansing contaminated stormwater are the main priorities. The Tromsø plan initially focused on preparedness, flood damage control and capacity issues in the existing and conventional stormwater systems. This may partially be due to local climatic conditions that does not always benefit from added green elements. Still, the Tromsø sector plan includes pilot projects that test and adapt blue–green measures to local climatic conditions as part of the planning work. This demonstrates a clear interest in developing blue–green solutions, even when the local climate is not necessarily favorable. The Tromsø action plan also includes extensive and detailed action points with a holistic focus on knowledge development, skills development, and the intention to institutionalize the sector plan goals and develop the entire field of stormwater planning. This indicates that holistic BGI planning is about more than just combining multiple interests and functions. It is also about promoting cross-sectoral collaboration and knowledge development.

Based on these reflections, this paper argues that municipal water actors are motivated to implement BGI beyond stormwater management goals and approach co-benefits and holistic stormwater management as an ideal in stormwater planning. From the Bergen and Tromsø stormwater sector plans and implementation processes, we note a considerable focus on holistic stormwater planning ideals, efforts to develop new knowledge, involve other relevant actors and develop locally appropriate solutions. The potential tensions and conflicts between co-benefits become more evident in actual implementation, which corresponds with the current literature (Finewood et al., 2019). We find that when holistic BGI implementation is initiated by the municipal water actors, the stormwater management aspects dominate the BGI implementation.

Building on the insights that municipal water sector actors seem motivated to implement BGI beyond stormwater management goals, a value perspective contributes to the literature on stormwater planning by highlighting what matters to the specific actors in the various phases of BGI planning and implementation. Kvamsås (2021) previously demonstrated how stormwater planning actors from various disciplines find it beneficial to identify shared interests and unified solutions because it ensures support for their separate professional interests. This could indicate a potential for developing synergies between interests and values. We have previously defined values as what people deem to matter, collectively, as much as individually (Rosenberg, 2021), and have ascribed BGI interests to specific professionals such as water engineers, landscapers, and planners (Meilvang, 2019). Consequently, we can now identify and reflect on how the relevant values are associated with the various co-benefits.

Building on the multiple ways of understanding values in BGI development (Alves et al., 2019; Franco-Torres et al., 2020; Kati & Jari, 2016; Meilvang, 2021; Raymond et al., 2017; Sharifi, 2021) and the Bergen and Tromsø experiences, we will argue that water actors generally are associated with a set of collective blue values, promoting stormwater management goals and interests. As a potential contrast, urban environment actors commonly connect to a set of collective green values concerning biodiversity protection and recreation objectives. In the developing holistic BGI planning ideal that focuses on co-benefits, these values seem to merge into a new blue–green value set that still can encompass contrasts and conflicts, particularly in the vulnerable implementation phase. This is visible, for example, in the discussions concerning using the BGWF planning tool in Tromsø, where awarding points to various blue, green and blue–green measures could reveal conflicts between the different blue and green interests and values.

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6 | CONCLUSION: DEVELOPING BLUE–GREEN VALUES

This paper has shown how planning actors perceive and act on co-benefits and conflicts in BGI planning and implementation. Since it is critical to make the values, interests and intentions behind adaptation visible and transparent to promote equitable and transformative climate action processes (O'Brien, 2021), we have reflected on the connections between actors, values and interests in local BGI development. We conclude that even though blue and green values and interests are often conflicted in the implementation phase, a blue–green value set based on potential synergies from co-benefits is being developed in urban stormwater planning. The prevailing interests in BGI implementation will generally depend on which actor (and associated value set) is initiating and leading the planning and implementation process, combined with the local climatic conditions.

While municipal water actors are being forced to develop new infrastructure solutions because of stormwater risks and injury/damage to people and property, the green values concerning biodiversity protection do not have the same status. If they are to demand more space for the green elements in BGI, the actors who represent green values may need to take increasingly active and leading roles in BGI development processes. One way to promote such leadership could be providing arenas for continued cross-sectoral collaboration and BGI knowledge development. In a world striving to put an economic value on trees, soils, and vegetation and where BGI can be built without green elements (Matsler, 2019), prioritizing green elements beyond what serves human interests could potentially be truly transformative.

Finally, the paper contributes to understanding BGI as a potential transformative adaptation strategy (O'Brien & Selboe, 2015; Pelling, 2011; Wamsler et al., 2021) by providing empirical examples of investigating and handling the co-benefit values and interests in local adaptation planning. These empirical examples illustrate how collective values and interests can develop and unfold across sectors and professional disciplines in BGI planning.

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CONFLICT OF INTEREST

No potential conflict of interest was reported by the author.

ORCID

Hanna Kvamsås https://orcid.org/0000-0002-5472-080X

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