

Uncovering the Role of Urban Governance Practices for Nature-based Solutions:

Investigating the Instrumentalization Pathways in European Cities

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Abstract

Nature-based solutions (NbS) have proven effective in addressing urban sustainability challenges. This thesis focuses on bridging the gap in NbS short-term interventions, scale, and financial barriers. It examines the instrumentalization and implementation of successful long-term interventions from a policy and urban governance perspective, aiming to inspire cities and identify commonalities. The study utilizes the Urban Governance Atlas (UGA) knowledge platform in collaboration with Ecologic Institute (Germany), to analyze 150 NbS instrument cases from European cities. Through this comprehensive cross-sectional analysis, key trends, and patterns of successful NbS implementation are identified, with an emphasis on stakeholder engagement, governance, and policy development involving local governments and civil society.

This thesis highlights the pivotal role of universities in driving experimentation and identifies "governing by enabling" as the dominant approach, where local governments facilitate policy instrumentalization. Horizontal collaboration among sectors and departments emerges as a crucial factor while emphasizing that empowerment does not necessarily translate into improved sustainability outcomes, whereas collaboration serves as the common mode of participation for good practice instruments. Moreover, it identifies six key actions across 29 economic and fiscal instruments (EFI), underscoring the pressing need for upscaling NbS and the untapped potential of co-financing from the private sector and development banks, with current funding primarily reliant on local public budgets.

The study leverages the wealth of information in the UGA to provide actionable knowledge derived from 150 European good practice cases, informing the design and implementation of future NbS policy instruments and governance models. By employing robust science-policy techniques, this research contributes to the literature on urban governance and NbS, offering a set of key recommendations for sustainable urban development to guide policymakers, practitioners, and researchers in deploying and maintaining urban NbS.

Keywords: Urban Climate Governance, Urban Nature-based Solutions, Citizen Engagement, Economic and Fiscal Instruments, Sustainable Financing.

Executive Summary

In a world where human activities have profoundly impacted the environment, the urgency for sustainable urban development has become undeniable. Conventional urban infrastructure solutions have fallen short, exacerbating ecological footprints instead of reducing them. In response to this pressing challenge, the concept of Nature-based Solutions (NbS) has emerged as a promising alternative, offering a way to mitigate the effects of urbanization and climate change. They represent a transformative approach to urban sustainability, encompassing a diverse array of nature-inspired interventions that can address multiple challenges simultaneously. However, despite their potential, the mainstreaming of NbS faces significant barriers, emphasizing the critical role of effective governance and collaboration in instrumentalizing policy instruments and their successful implementation.

Research Scope

This study aims to explore the interconnections among policy instruments, urban governance, and participation, providing valuable insights to inspire cities to implement and maintain NbS effectively. By addressing the limitations of short-term projects, financing, social marginalization, and unsustainable interventions, this research offers both practical and policy lessons. It also sheds light on the enablers, challenges, and dynamics of governance, contributing to the advancement of sustainable urban development practices. Additionally, the study highlights 29 economic and fiscal instruments (EFI), offering an in-depth analysis of their implementation, stakeholders involved, range of applications, financing mechanisms, and potential financing innovations. By bridging gaps in the existing literature, this research aims to provide valuable knowledge for sustainable NbS scaling and funding.

Research Framework and Questions

This study presents a contextualized framework for analyzing governance and engagement in the Urban Governance Atlas (UGA) with a focus on multilevel governance (MLG) see in Figure 1. MLG encompasses hierarchical distribution of competencies and authority (*Type I*) as well as interconnected spheres of authority (*Type II*) in addressing specific issues (Hooghe and Marks, 2001; Betsill and Bulkeley, 2003). Additionally, the study categorizes urban climate governance modes based on previous research by Bulkeley & Kern (2006), Kern & Alber (2009), and Neij & Heiskanen (2021). These modes include *Self Governance*, where local governments act as consumers and role models; *Governing by Provision*, emphasizing municipalities as service providers and securing climate action financing; *Governing by Authority*, with a regulatory role enforcing climate-related regulations; and *Governing by Enabling*, involving municipalities as facilitators fostering community engagement and partnerships. The study also incorporates the Participation Ladder, inspired by Luyet et al. (2012), Wilker et al. (2016), Greaves (2017), and Kiss et al. (2021), which outlines five levels of participation: *Inform*, *Consultation*, *collaboration*, *co-decision*, and *empowerment*.

To enhance comprehension of the UGA cases under investigation, this thesis project employs a theoretical framework to analyze two primary research questions and three hypotheses.

RQ#1: What are the key trends and patterns in governance and civic participation of policy instruments related to NbS in the Urban Governance Atlas?

- HP#1a: Effective policy instruments for nature-based solutions in urban areas are more likely to involve vertical and horizontal collaboration among different actors and levels of government.

- HP#1b: Effective policy instruments for nature-based solutions in urban areas may use different modes of governance, but the dominant approach is likely to be enabling governance.
- HP#1c: Public participation is crucial for designing and implementing effective policy instruments for nature-based solutions in urban areas. Successful public participation requires collaboration or empowerment approaches.

RQ#2: What are the key lessons learned from the economic and fiscal instruments for NbS based on the data analyzed in the Urban Governance Atlas?

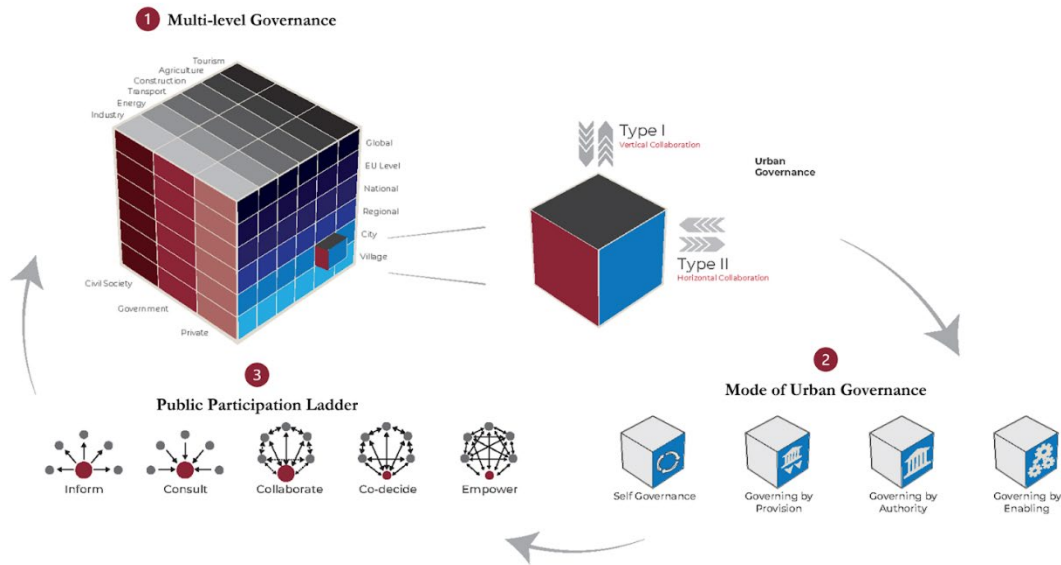


Figure 1 Thesis framework for analyzing the governance and engaging arrangements of NbS cases.

Source: Author-owned illustration

To answer the research questions, this thesis employs a four-stage methodology to investigate the 150 UGA cases. The first stage involves a comprehensive literature review, encompassing grey and academic literature as well as INTERLACE project documents. The second phase utilizes quantitative analysis, employing statistical methods such as descriptive, regression, network analysis, and random forest classifier to identify key patterns and trends. The third phase focuses on qualitative content analysis to extract common success factors and lessons learned from economic and fiscal instruments. Finally, in the fourth phase, *eight experts* were interviewed to validate and enhance the study's insights, capturing their opinions and criticisms.

Key Findings and Discussion

The thesis provides valuable insights into the landscape of policy instruments within the UGA and their interconnectedness. Figure 2 illustrates the key trends derived from the analysis. The findings indicate that collaboration across different levels and sectors is prevalent, with a particular emphasis on horizontal collaboration among context-based sectors and actors. *Governing by enabling* emerges as the dominant mode, characterized by partnerships, collaboration, and experimentation. In terms of public participation, *collaboration* is the dominant type, while one-way communication modes such as inform and consult still have a significant presence compared to best practice instruments. *Network analysis* reveals that crucial variables for effective

NbS implementation include horizontal collaboration, an active role of government as an initiating body, deployment of legislative and regulatory instruments, strategic agreements, and cooperative instruments at the municipal level. However, the study also highlights the need for further investigation to understand how changes in individual variables can impact overall policy development, outcomes, and spillover effects.

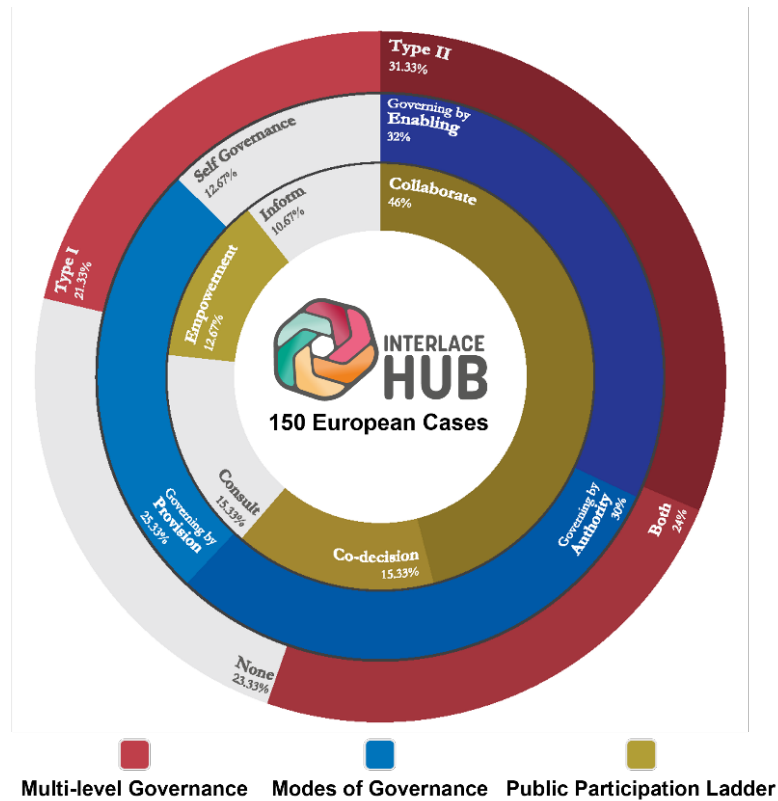


Figure 2 Overarching results based on the thesis framework.

Source: Author-owned illustration

The *regression analysis* highlights key factors for ensuring the effectiveness of NbS instruments in the UGA context. These factors include the presence of monitoring and evaluation mechanisms, careful consideration of implementation scale, and a focus on collaboration within multi-level governance, particularly horizontal collaboration. The feature analysis identifies three critical variables for designing effective NbS instruments: addressing relevant challenges such as human health, comfort, well-being, and ecological connectivity; incorporating good practice criteria to replicate successful characteristics; and emphasizing collaborative multi-level governance instruments both vertically and horizontally.

The *content analysis* of the study on economic and fiscal instruments revealed six key lessons learned and success factors. These include the importance of political leadership and long-term vision, coupled with sustained financing that extends beyond policy cycles. The presence of co-governance and co-implementation, supported by decentralized governance structures, emerged as crucial factors. The strict adherence to requirements such as native species and solutions, continuous monitoring and evaluation, and citizen involvement were also significant.

Additionally, promoting genuine engagement without greenwashing and leveraging city-scale branding were found to attract more investment and attention. Building partnerships through intermediaries and city-to-city outreach for learning from mistakes were identified as beneficial practices during the interviews. Furthermore, the seven characteristics of good urban governance practices, including local appropriateness, replicability, support for multifunctional NbS, long-term sustainability, effectiveness, innovation, and a solid business case, offer a valuable framework for navigating policy instrument development and implementation. However, further research is needed to examine how these characteristics can either facilitate or impede each other and to evaluate the validity of the assumption that a policy instrument is successful if it possesses at least one of these characteristics.

Through hypothesis testing, this thesis confirms that utilizing MLG instruments, particularly *horizontal collaboration* and collaboration with public actors for co-planning and co-implementation, as well as the role of municipalities as enablers and facilitators for experimentation and partnerships, are crucial aspects for the effectiveness of locally appropriate policy instruments that support multi-functional solutions. The research also supports the findings of van der Jagt et al. (2021) on the importance of accelerating the adoption of reflexive governance modes as a means to accelerate sustainability transitions and push the boundaries of ambitious targets.

The results align with the available literature, including the correlation found by Kiss et al. (2021) in 49 cases, which suggests that public engagement does not necessarily lead to higher environmental sustainability outcomes, as evidenced by 25% of the good practice instruments that had a consultation-type engagement. However, this opens up potential avenues for further research, which argues that well-implemented consultation can result in positive social and environmental outcomes while mitigating the risks and barriers associated with empowering modes. This research emphasizes the significance of flexibility in scheduling, funding, and raising political and public awareness as vital factors in achieving successful outcomes.

Furthermore, this study highlights the untapped potential of financing as a co-implementation mechanism. It is evident, in line with existing literature, that the main funding sources come from the public sector, particularly local budget authorities. However, private sector engagement and development banks remain largely untapped. The visibility of EU funding programs is noteworthy. It is important to acknowledge that calling for increased co-financing necessitates trade-offs and may have implications for social justice outcomes.

To ensure fairness, accompanying these investments with a comprehensive social plan that provides local communities access to employment opportunities is crucial. The study identifies a range of innovative financing pathways, including blending financing, PPPs, outcome-based approaches, crowdfunding, and the significant role of development green banks and funds in providing seed investments and funding for scaled-up NbS implementation. Lastly, the study emphasizes the critical role of knowledge platforms like the UGA in opening avenues for lessons learned and drawing insights. Intermediaries play a crucial role in fostering city twinning, matching with funding opportunities, framing strategies, establishing partnerships, and facilitating networking channels to promote knowledge exchange, resource sharing, and learning from failures and unsuccessful attempts.

Conclusion and Key Recommendations

In conclusion, this thesis contributes to a pathway toward a sustainable and resilient future through the implementation of urban NbS. The findings provide valuable recommendations for academia, practitioners, and city leaders to drive effective policy development, foster collaboration, and secure financing for NbS initiatives. By conducting comprehensive assessments, exploring alternative governance modes, and developing standardized tools, academia can contribute to the knowledge base and support evidence-based decision-making. Practitioners are urged to leverage the study's insights to design and implement NbS instruments that attract financing, share lessons learned, and foster collaborations. City leaders play a crucial role in prioritizing collaboration, reflexive governance, and vertical partnerships while fostering knowledge exchange and resource sharing through city intermediaries.

As we face the interconnected challenges of climate change, the implementation of NbS policies emerges as a transformative solution. This study extends beyond Europe, inspiring prospective cities worldwide to embark on their sustainability journey. By embracing multi-level governance, effective governance mechanisms, inclusive participation through collaboration, and sustainable financing, we can accelerate the necessary societal shift. It is time to redefine the value of nature, reassess policy outcomes, and adopt cooperative and collaborative approaches. Collectively, we can usher in a new era of urban sustainability and pave the way for a resilient urban future.

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Abbreviations

AbCI- Agreement-based or Cooperative Instruments
America and Europe
CELAC - Community of Latin American and the Caribbean States
EC - European Commission
EFI – Economic and Fiscal Instruments
EU - European Union
GCF - Green Climate Fund
GHG - greenhouse gas
ICELI - International Council for Local Environmental Initiatives
INTERLACE - International Cooperation to Restore and Connect Urban Environments in Latin
ITF - Impact Task Force
KCII – Knowledge, Communications, and Innovative Instruments
LRSI – Legislative, Regulatory, and Standards Instruments
MLCG – Multi-level Climate Governance
MLG - Multi-Level Governance
NATURVATION - NATure-based URban innoVATION
NbS - Nature-based Solutions
NGOs – Non-governmental Organizations
PPPs - Public-Private Partnerships
TNOs – Transnational Network Organizations
UGA - Urban Governance Atlas
UNA - Urban Nature Atlas

1 Introduction

Efforts to transition to a low emission economy depend heavily on collaboration between national and local governments. Local governments, as democratically elected bodies below the state level, have significant potential for climate change mitigation due to high energy consumption and greenhouse gas concentrations in urban areas (Bulkeley & Betsill, 2005). In response to increasing climate-related catastrophes, such as flooding and intense heat waves, local governments have started incorporating climate adaptation and mitigation into their policies.

The concept of Nature-based Solutions (NbS) has emerged as a promising alternative of grey solutions, offering an integrated and inclusive way to mitigate the effects of urbanization and climate change. NbS represents a transformative approach to urban sustainability, encompassing a diverse array of nature-inspired interventions that can address multiple challenges simultaneously. However, the extent of their long-term implementation and instrumentalization varies based on factors such as officials' commitment, awareness, national support programs, and participation in transnational and national networks (Kern & Alber, 2008; Adriázola et al., 2018).

The importance of cities in achieving sustainable development goals was emphasized in the Brundtland Report in 1987 (Bulkeley & Betsill, 2005). As test beds for climate governance experiments, cities play a crucial role in implementing national policies and ensuring local compliance that supports NbS. Successful experimentation at the urban level can inspire other cities and influence national and international actions. Therefore, it is crucial for national governments to engage with state and local governance levels, empowering them to address climate change action and learn from diverse local contexts (Corfee-Morlot et al., 2009). Political leadership at the national level, coupled with financial and provisional support, can strengthen local pioneers and foster the diffusion of best practices, cooperation, and competition among cities (Jänicke, 2015). The literature in Kern and Bulkeley (2009) and (Jänicke, 2017) highlights the role of intermediaries, such as Transnational Network Organizations (TNOs), in facilitating collaboration, linking actors and resources to drive multilevel governance and policy integration between national, subnational, and non-state actors.

Europe aims to become the world's first climate-neutral continent by 2050. The fact that 80% of EU greenhouse gas emissions are related to urban activities illustrates the importance of implementing urban-level solutions like Urban NbS (Jänicke, 2015). European cities are at the forefront of NbS implementation, aiming to address social needs, improve natural environments, drive green innovation, create green jobs, and enhance urban resilience (European Commission, 2020). Over the past decade, the adoption of policy instruments has undergone significant evolution in mainstreaming NbS deployment. As Europe has already established a solid foundation for implementing NbS policies, it serves as a valuable resource for cities seeking to advance their understanding of NbS and develop context-specific policies and solutions.

To effectively formulate and approve Urban NbS policies, coordination among stakeholders and policy leaders is necessary to address priorities, strategies, and monitoring mechanisms (Corfee-Morlot et al., 2009). The Urban Governance Atlas (UGA) provides valuable knowledge on the urban governance capacities of 150 policy instrument cases utilized by 100 European cities to promote or maintain NbS. Analyzing the common key trends of these cases can

contribute to the growing body of NbS research and inform future policy practices. By adapting successful NbS practices from Europe to their local contexts, prospective cities can effectively address pressing environmental challenges, promote sustainable development, and enhance the well-being of their communities.

1.1 Problem definition

The advent of the Anthropocene¹ epoch has spurred a growing imperative to pursue sustainable urban development, in light of the profound impact that human activities have had on the environment (Frantzeskaki, 2019; Laforzezza & Sanesi, 2019; Mendonça et al., 2021). Conventional urban infrastructure solutions have typically prioritized the construction of gray assets such as concrete and steel, which can exacerbate urbanization's ecological footprint (Laforzezza & Sanesi, 2019). As such, the need for a more environmentally responsible approach to urbanism has become increasingly urgent. Urban systems' pressures and high vulnerability are escalating due to rapid climate changes, increased population growth and consumption patterns, and how modern urbanization and socio-ecological trends are entwined (Mendonça et al., 2021). According to the UN DESA (n.d.), it is estimated that 70% of the world's population will live in cities; Also, climate risks are expected to decline the GDP annually by up to 80%. These emerging pressures call for urgent actions and rethinking approaches. In response to this challenge, the concept of spatial green infrastructure has emerged as a promising alternative that can help to mitigate the effects of urbanization and climate change.

Contemporary society continues to grapple with the significant challenge of achieving sustainable urban development, as noted by Kabisch et al. (2017) and McCormick et al. (2013). Prominent scholars have posited that NbS represent a promising approach to advancing urban sustainability, particularly with respect to ecological, social, and economic sustainability challenges (Davies & Laforzezza, 2019; Kabisch et al., 2017; Laforzezza et al., 2018). The novel (NbS) encompasses a diverse array of nature-inspired interventions, such as green roofs and facades, sustainable drainage systems, and other forms of green infrastructure (Dorst et al., 2019, Kabisch et al., 2019). The use, conservation, and restoration of nature through NbS can address multiple sustainability challenges at once, such as flood and heat risks, ecosystem degradation, and urban regeneration.

Over the past decade, various UN institutions² and international conservation organizations have implemented community-led NbS projects worldwide, mainly for adaptation and ecosystem-based disaster risk reduction (Rizvi, 2014; Seddon et al., 2020). According to Reid et al. (2018), these initiatives have shown that NbS can offer low-cost solutions to climate change impacts and provide multiple advantages over-engineered solutions. The pioneering NbS initiatives were undertaken with the goal of fostering a shared understanding of the concept of NbS across diverse stakeholder groups and clarifying its place within the broader spectrum of ecosystem-based approaches (Dorst et al., 2019; Faivre et al., 2017; Seddon et al., 2020). Furthermore, according to Seddon et al. (2020) and their systematic review, NbS can offer a broader range of ecosystem services, particularly to vulnerable sectors of society, and protect against various impacts at a lower cost. However, while increasing research is backing up these observations, there still knowledge gaps, particularly in comparing the cost-effectiveness of NbS

¹ Refers to the current geological epoch characterized by significant human impact on Earth's ecosystems and geological processes.

² UN Environment Programme, UN Development Programme, and Food and Agriculture Organization.

to alternatives (Seddon et al., 2020). Therefore, rather than viewing NbS as an alternative to engineered approaches, focusing on finding synergies among different solutions is better.

Indeed, urban environments are increasingly being recognized as prime targets for implementing NbS strategies. According to scholars and literature on urban sustainability, cities are intricate systems encompassing more than just their physical boundaries and structures (Mendonça et al., 2021). Regarding the effectiveness of nature-based solutions (NbS) in urban settings, they can be integrated within the intricacies of the complex systems of cities and interact with the various concentrations of socio-ecological systems and institutional contexts (Kabisch et al., 2016; Frantzeskaki, 2019). Moreover, NbS is regarded as a promising approach to transforming urban areas, envisioning a systemic change in how cities are designed and built (European Commission, 2015; Faivre et al., 2017; Kabisch et al., 2017). As a result, various stakeholders are calling for wider integration of NbS into urban development practice and policy (Cohen-Shacham et al., 2016; Faivre et al., 2017; Laforteza & Sanesi, 2019). Enabling the integration of NbS requires a range of policy instruments at the local level to promote the use of NbS in urban development. Such policy instruments can include regulatory frameworks, financial incentives, and knowledge-sharing platforms.

Policy instruments can significantly influence the direction and speed of sustainability transitions. These mechanisms can address the persistence of established socio-technical systems, also known as lock-ins (Edmondson et al., 2019; Kivimaa & Kern, 2016). The instrumentalization of policies is technique policymakers use to achieve their goals (Mickwitz, 2003; Wurzel et al., 2013), which can play a crucial role in shaping the mainstreaming of urban NbS. The empirical research conducted by Van der Jagt et al. (2021) demonstrates that adopting policy mixes, which combine various types of instruments with supporting the mainstreaming of urban NbS, is successful in enrolling multiple stakeholders in NbS efforts in urban areas. This success is attributed to regulations supported by financial and soft instruments that alter social norms and cognitive routines, which aligns with the argument presented by Jänicke and Lindemann (2010).

Despite urban NbS being recognized for their potential as urban infrastructure, the mainstreaming of these novel solutions has yet to be achieved due to several barriers. These include inadequate policies and regulations, limited financial resources, insufficient stakeholder engagement and coordination, and inadequate knowledge and understanding of NbS among practitioners and decision-makers, as highlighted in several studies (Davies and Laforteza, 2019; Dorst et al., 2021; Frantzeskaki et al., 2019; Wamsler et al., 2020). In light of these findings, it is evident that the successful adoption and efficacy of NbS strategies are closely intertwined with effective governance and local policy that can both facilitate and regulate their implementations (Xie & Bulkeley, 2020; Seddon et al., 2020; Mendonça et al., 2021). Therefore, it is imperative that local policy instruments actively promote the adoption of NbS, as it is a crucial factor in the successful implementation of sustainable urban development.

Exploring the nexus between policy instruments and the effective integration of NbS represents a crucial and pertinent avenue of inquiry within the realm of sustainability transitions. The instrumentalization of policies in urban settings is needed to strengthen NbS's potential and sustain its initiatives. The thesis aims to contribute to understanding the trajectories of good practices of policy instruments dedicated to deploying or maintaining NbS at urban levels. The UGA knowledge platform analysis will help provide a comprehensive understanding of these instruments' critical enablers and challenges in the design and implementation phases. In addition, understanding the dynamics of modes of governance in these instruments can advance knowledge and identify room for improvement when transposed to other prospective cities.

Furthermore, the research can enrich the literature on experimentation governance and its relation to urban climate policy.

1.2 Aim and Research Questions

To fully unlock the potential of NbS and ensure the longevity of its initiatives, there is a pressing need to leverage policy instruments in urban contexts. Accordingly, this thesis seeks to shed light on the trajectories of *good practice* policy instruments that are designed to facilitate the deployment or maintenance of NbS at the urban level. Leveraging the Urban Governance Atlas (UGA) knowledge platform analysis, this research provides a comprehensive understanding of the critical factors that shape these instruments during both the design and implementation phases. By examining the dynamics of governance modes within these policy instruments, this study aims to generate new insights and identify areas for improvement that can be applied to other prospective cities. Ultimately, this research has the potential to enrich the literature on experimentation governance and its connection to urban climate policy.

The findings of this study are relevant to prospective cities that are seeking to achieve sustainability transitions. The insights and patterns extracted from the UGA can be used to inform the design and implementation of policy instruments for promoting NbS in urban areas. By identifying the key lessons that can be drawn from the different types of policy instruments, cities can get inspired and leverage this knowledge to optimize their own policy instruments and ensure the success of their sustainability transitions. Furthermore, cities can anticipate and proactively address potential challenges by understanding emerging governance patterns and modes. Additionally, adequate funding is a significant challenge for mainstreaming NbS. Thus, understanding the emerging governance patterns and modes regarding economic and fiscal instruments is crucial.

Economic and fiscal instruments are critical in promoting NbS in urban areas by incentivizing private investment in green infrastructure and generating revenue to support NbS initiatives. Nevertheless, designing and implementing these instruments can be intricate, and the governance patterns and modes that emerge in relation to them can significantly affect their efficacy. Therefore, comprehending these governance patterns and modes is vital for policymakers and practitioners who aim to implement effective economic and fiscal instruments to promote NbS and support sustainable urban development. Overall, this research has the potential to contribute to a more sustainable and resilient urban future.

- RQ#1: What are the key trends and patterns in governance and civic participation of policy instruments related to NbS in the Urban Governance Atlas?
- RQ#2: What are the key lessons learned from the economic and fiscal instruments for NbS based on the data analyzed in the Urban Governance Atlas?

1.3 Ethical considerations

This research study centers on the examination of governance and participation arrangements and their critical role in the implementation and instrumentalization of NbS in urban areas. Furthermore, the research aims to delve into the lessons learned and experiences regarding economic and fiscal instruments. The author's keen interest in urban governance, along with the identification of gaps in the literature on urban climate governance, has spurred this research.

To achieve the research objectives, the author has extensively covered 150 policy instrument cases published in the UGA, as seen in (Annex A) and Figure 3. The UGA provides a comprehensive and valuable resource that offers insights into various policy instruments used in different urban areas globally. Through this approach, the research study intends to provide a detailed analysis of the effectiveness of different governance arrangements and policy instruments in the implementation and instrumentalization of NbS in urban areas.

This research study is a significant contribution to the literature on urban climate governance, providing a much-needed focus on the role of governance arrangements in NbS implementation. By identifying gaps in the literature and utilizing the UGA's policy instrument cases, the author aims to contribute to a better understanding of the challenges and opportunities associated with urban climate governance and provide recommendations for improving the effectiveness of governance arrangements and policy instruments in NbS implementation.

To ensure the validity of the literature review and maximize the insights gained from the Atlas, the author has delimited the research as illustrated in Figure 3 to focus on the European scope and fiscal and economic instruments listed in the Atlas. Furthermore, the author has decided to concentrate on external building greening as a targeted urban area, as it is identified as an interesting area to tackle in the literature. These delimitations are driven by the need to provide a comprehensive understanding of governance arrangements and financing mechanisms used in implementing NbS in urban areas while maintaining the research's scope and feasibility.

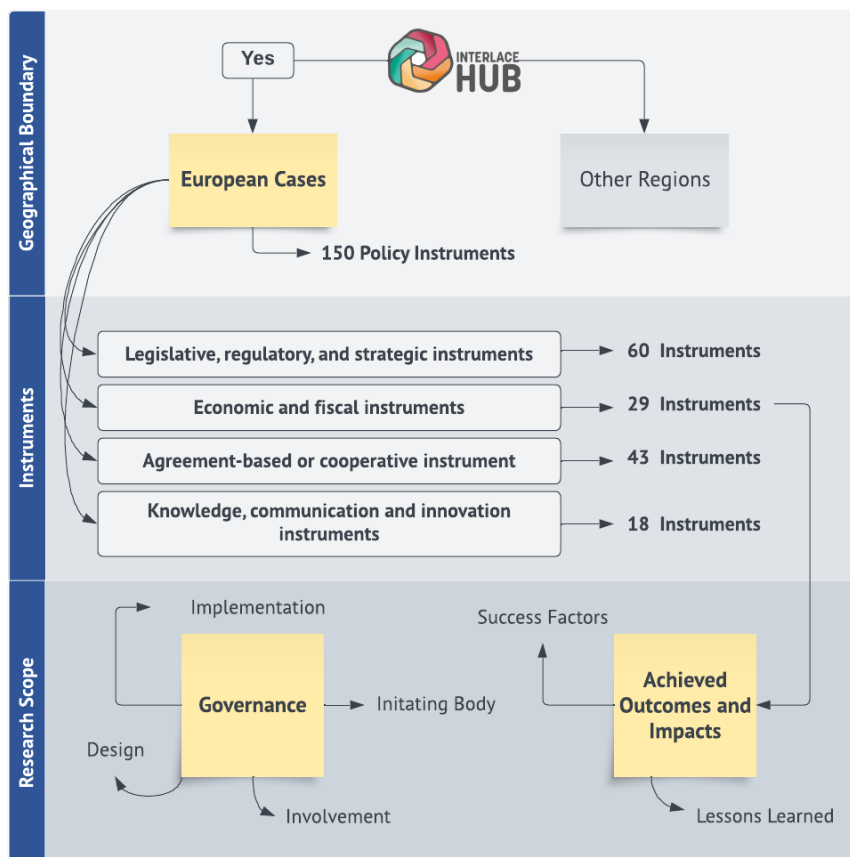


Figure 3 Research scoping and illustration of the data used from the UGA

Source: Author-owned illustration

1.3.1 Urban Governance Atlas

The INTERLACE³ project has created a valuable resource known as the Urban Governance Atlas (UGA)⁴, which comprises 250 policy instruments promoting or maintaining NbS in urban areas. The UGA is an online database that systematically categorizes policy instruments and provides essential information about each case study, including the city, population, and instrument category. Additionally, the UGA includes sub-sections that document the challenges addressed, governance, financing, monitoring, evaluation, and impacts of each instrument case. The process of the UGA followed agile methodology in finalizing its parameters and typology (Box 1).

This knowledge product is an excellent practice tool for researchers and policymakers seeking to understand NbS instruments in cities. Moreover, it is essential to differentiate the UGA from the Urban Nature Atlas (UNA)⁵. While the UNA serves as a repository of NbS case studies and their outcomes/challenges, the UGA focuses on offering insights into available policy instruments and their associated governance processes. Therefore, the UGA provides complementary information on NbS policy instruments and governance challenges.

Box 1

The INTERLACE project embraced an adaptable and iterative methodology, known as agile, throughout its implementation, including the creation of the UGA. This approach to project management and software development stresses the importance of adaptability, flexibility, and continuous value delivery. To achieve these goals, the UGA incorporated an external feedback mechanism on its typology, data collection method, and parameters from a task force called the Impact task force (ITF). This group was composed of 14 experts from a diverse range of organizations, including academia, practitioners, and transnational groups, such as the City of Chemnitz, Environmental Office, TECNALIA, Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona, Norwegian Institute for Nature Research, Climate Alliance, Sendzimir Foundation, MSP Institute, Youth4Nature, WWF Colombia, Humboldt Institute Colombia, and Trinity College Dublin. The purpose of this task force was to provide external support and validation of the Atlas questionnaire, policy instrument typologies, and parameters. As a result, the final version of the questionnaire included was concluded based on the feedback mechanism. Source: (Interview A, 2023)

The ITF played a significant role in modifying the broad categories adopted for the UGA. The categorization process drew upon a combination of desk research, the expertise of the Ecologic Institute, the NATURVATION⁶ project, and input from other relevant projects. The UGA classifies policy instruments into several distinct categories and sub-categories (see Figure 4). These categories are further elaborated upon in Annex B. It is worth noting that while each category is described in an ideal form, in practice, policy instruments are often utilized in combination as part of a broader policy mix. For example, economic incentives are frequently grounded in legal frameworks, which, in turn, may be supported by communication strategies and innovative solutions (Informative instrument).

³ International Cooperation to Restore and Connect Urban Environments in Latin America and Europe (INTERLACE). This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869324

⁴ <https://interlace-hub.com/urban-governance-atlas>

⁵ The most extensive collection of urban NbS thus far, It was created in 2017 as an output of Naturvation project: <https://una.city/>

⁶ NATure-based URban innoVATION is a 4-year project, funded by the European Commission and involving 14 institutions across Europe. It sought to develop understandings on what NbS can achieve in cities, examine how innovation can be fostered in this domain, and contribute to realising the potential of NbS for responding to urban sustainability challenges

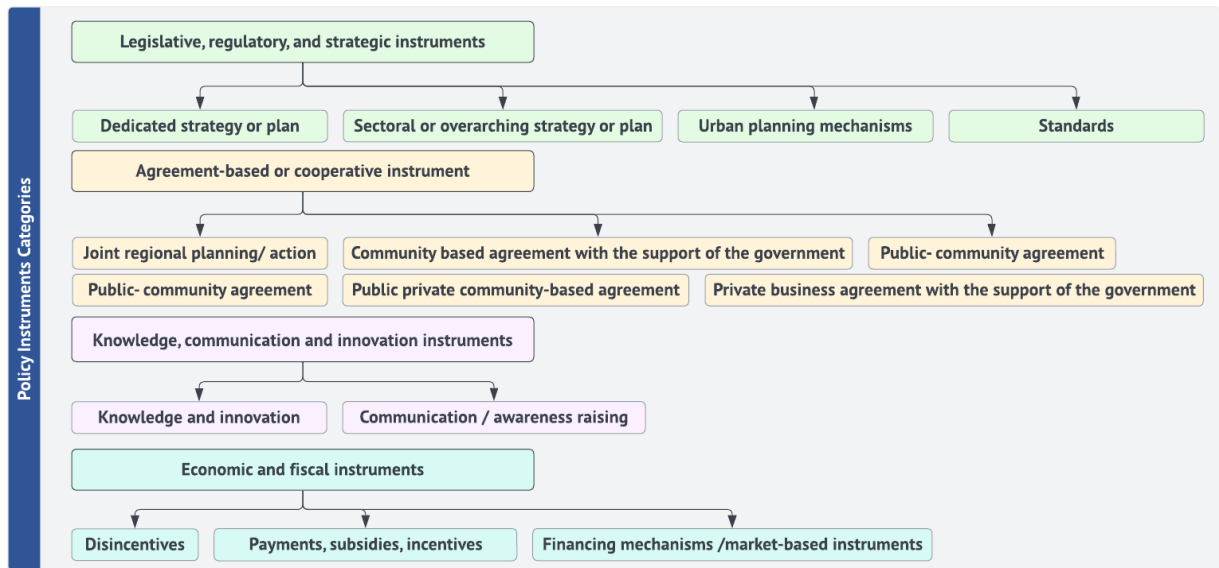


Figure 4 Categorize and sub-categorize NBS policy instruments.

Source: Author-owned illustration based on (Davis & Burgos, 2022)

The UGA examines various aspects of the governance of policy instruments, including their design, implementation, financing, success factors, lessons learned, and outcomes and impacts achieved or planned. The UGA seeks to showcase *good practice* policy instruments that meet at least one of the eight criteria listed in Box 2, either in a unique or noteworthy way (Davis & Burgos, 2022). These instruments may be at various stages of implementation, displaying potential, proven success, or replication in other locations. It embraces a flexible approach, allowing it to incorporate policy instruments from diverse social, cultural, and geographical backgrounds (Davis & Burgos, 2022).

Box 2

1. Inclusivity: Encourages participation from all relevant stakeholders, ensuring that those impacted by the policy instrument have a say in decision-making processes.
2. Effectiveness: Has been successfully implemented, tested, and accepted as a viable solution for achieving its objectives while being cost-effective.
3. Multifunctionality: Designed to support the deployment or maintenance of NbS that address multiple objectives and produce diverse co-benefits, including social equity.
4. Long-term sustainability: Has a monitoring system in place, is legally enforced, or has secured long-term funding to ensure its sustainability.
5. Locally appropriate: Consistent with the local institutional-cultural context in terms of design, framing, and approach.
6. Scalability/Replicability: Has been replicated elsewhere, can be applied in other cities and contexts, and adopts a flexible approach for transferability.
7. Innovation: Utilizes an innovative approach, such as exploring new financing sources and types of public-private partnerships/cooperation.
8. Policy Business Case: Contributes to the financial feasibility of NbS implemented by private businesses, non-profit organizations, or households while aligning with policies.

Sources:(Davis & Burgos, 2022)

1.3.2 Geographical Scope

The wealth of literature that has emerged at the EU level over the past decade provides a solid foundation for our research. Notably, larger research projects, as noted by Pauleit et al. (2019), such as the project GREEN SURGE⁷ (2013-2017) and more recent projects within the EU's Horizon 2020 on NbS by Bulkeley (2020) have highlighted the need for further scholarly work. According to Faivre et al. (2017), the EC has been increasingly interested in the concept of NbS since 2013. As a result, there have been several initiatives to clarify and operationalize the concept through consultations, dialogues, research, and policies. The potential of NbS in addressing sustainability challenges and improving urban resilience has been recognized institutionally by the EC, in parallel by publishing a strategy on NbS, which stressed the importance of integrating them into urban planning and development policies (European Commission, 2015).

In fact, Europe is at the forefront of promoting NbS policies, with the EC making significant efforts to mainstream them across its Member States and beyond. European cities are pioneering NbS implementation not only to address social needs and improve the environment but also to drive green innovation, create green jobs, and enhance urban resilience (Kiss et al., 2019). While many policy instruments have evolved to mainstream NbS deployment, there is still a need to focus on empowering local policy instruments and distinguishing between urban and rural areas to maximize existing NbS interventions. The EU's commitment to establishing itself as a global leader in NbS research, innovation, and the international market is demonstrated by adopting updated and new policy instruments, funding mechanisms, and medium.

Therefore, as Europe has already established a solid foundation for implementing NbS policies, it serves as a valuable resource for cities seeking to advance their understanding of NbS and develop context-specific policies and solutions. By drawing inspiration from good practice NbS practices in Europe and tailoring them to their local needs, prospective cities can effectively address pressing environmental challenges, promote sustainable development, and enhance the well-being of their communities. Furthermore, by leveraging the knowledge and experience gained through this process, cities can contribute to the growing body of NbS research and help inform future policy practices.

1.3.3 Governance and Participation

Effective implementation of NbS in urban settings requires good governance. This involves formal and informational institutions, mechanisms, and processes of collective decision-making that enable stakeholders to coordinate their autonomous needs, interests, and interactions with the environment at different levels (Tacconi, 2011). Scholars have increasingly emphasized the importance of collaborative governance to support the instrumentalization of sustainability transitions and ensure inclusive and equitable decision-making across social groups (Bulkeley, 2020; Kiss et al., 2021; Pauleit et al., 2019). Citizen engagement in the planning, design, and maintenance of commons like NbS is crucial for co-benefits, and diverse platforms are needed for dialogue and reflexive governance (Kiss et al., 2021). However, the current NbS approaches' contribution to urban governance, financing, and avoiding green gentrification is still unclear (Xie & Bulkeley, 2020; Bulkeley et al., 2020).

The literature on urban governance for sustainable urban development has identified several gaps. In a review by Pauleit et al. (2021), which includes papers by Pauleit et al. (2019), Tzaninis

⁷ <https://cordis.europa.eu/project/id/603567>

et al. (2020), Van der Jagt et al. (2023), and Wolfram et al. (2019), one such gap is the lack of attention to multi-level and multi-actor governance models that integrate different sectors, strategic planning of green infrastructure, and collaboration across decision-making boundaries. Additionally, there is a need to explore innovative financing mechanisms for urban greening initiatives due to budget constraints.

Translating initiatives into concrete actions within institutions is crucial for effective urban governance. Another critical gap is the limited focus on participation and cooperation, necessitating more inclusive and just planning and governance models. Additionally, exploring co-created or citizen-led urban greening initiatives is important. Understanding power structures and mechanisms between governments, companies, and civil society is essential for better influencing relationships and impacting NbS planning and implementation. Addressing these gaps promotes effective, equitable, and sustainable urban governance for NbS. Further research is needed to successfully implement and scale NbS instrumentalizations in urban settings. The study provides valuable insights for prospective cities to learn from existing governance and participation practices, serving as a steppingstone for their urban greening journey.

1.3.4 Economic and Fiscal Instruments

The successful adoption of NbS is still limited by financing constraints. The implementation of NbS faces a significant challenge due to financial barriers, including limited funding options and a discrepancy between the long-term benefits of NbS and the short-term nature of funding schemes (Seddon et al., 2020). Municipalities require greater resources and decision-making authority to overcome these barriers, and it is vital to investigate private investment options that arise from economic opportunities related to NbS (Frantzeskaki et al., 2017; Hoyle et al., 2017; Van Ham & Klimmek, 2017; Seddon et al., 2020). Nearly three-quarters of NbS are financed by the public sector, with local authorities' budgets providing the primary funding source through direct funding or subsidies, according to Dora et al. (2018) in an analysis of the Urban Nature Atlas (UNA).

According to the literature on the European context, NbS is financed by both public entities and private actors, but the procedures for obtaining funding vary significantly. While most funds in the EU for NbS come from the public sector, the potential of private-sector financing is largely untapped (Toxopeus & Polzin, 2020). NbS in urban areas are still seen as a burden on the public sector, but there has been a growing range of hybrid financing solutions in response to ambitious city goals (Mell, 2018; Toxopeus & Polzin, 2020; Mayor et al., 2021). Having a clear understanding of how good practices were institutionalized through NbS implementation is crucial for prospective cities to gain inspiration and insight into how to manage their fiscal and economic resources. Therefore, by concentrating on the fiscal and economic instruments subgroup, this research aims to uncover valuable insights and lessons learned regarding the "how" and "what" of NbS instrumentalization and implementation.

1.4 Joint Research with Ecologic Institute

The research coordinated an academic collaboration between the International Institute for Industrial Environmental Economics (IIIEE) and the Ecologic Institute to facilitate the thesis research. This collaboration was formalized through an internship agreement, granting the author access to unpublished documents, a tabular format of the UGA, and further assistance. There were no conflicts of interest or financial support involved. Guided by McKenna Davis, a senior fellow at Ecologic Institute, the author explored the UGA methodology and gained more profound insights. McKenna Davis also assisted in accessing organizational documents and providing the UGA database in tabular format. Both Kes and McKenna supported the author

in contacting experts for the expert validation phase (*explained in 4.3.3-Expert Validation*). Despite the internship contract's access facilitation, the author did not receive financial support from the environmental think tank.

1.5 Ethical Considerations

The research conducted in this study was undertaken with various ethical considerations in mind. Firstly, there were no conflicts of interest involved during the joint research with the Ecologic Institute, and the study was not funded by any external organization. Furthermore, the researcher's supervisor was the only individual in a position to influence the analysis and conclusions, thereby reducing the risk of undue influence. The insights provided by McKenna Davis focused on the data methodology related to collecting policy instruments, potential justifications for the findings, and gaps discovered.

Throughout the study, ethical considerations such as confidentiality, informed consent, and potential conflicts of interest were maintained. It is important to note that any relationships with scholars and experts in phase 4 were established solely to gain perspectives and insights into the study's findings. To ensure transparency and attribution, the researcher has taken measures to clearly attribute ownership of ideas, text, and images throughout the thesis. Additionally, the research design was reviewed against the criteria for research requiring an ethics board review at Lund University. It was determined that no statement from the ethics committee was necessary.

1.6 Main Audiences

This research study, utilizing quantitative and qualitative methods, provides explanatory insights for urban stakeholders interested in promoting sustainability through NbS. These stakeholders encompass government officials at local and national levels, practitioners, non-governmental organizations, and intermediaries. It is important to note that the research does not offer a universal solution but rather serves as inspiration for stakeholders in designing and implementing their own policy instruments, governance modes, participation strategies, and financing innovations. The author emphasizes the uniqueness of each context, emphasizing the need for tailored approaches to urban governance.

Additionally, this research offers value to academics interested in urban governance literature by identifying areas for further investigation and supporting existing literature with practical findings. Ultimately, the research contributes to the ongoing discourse on urban governance and sustainability, encouraging stakeholders to develop context-specific and locally appropriate instrumentalized NbS for their communities. *Chapter 8 (Recommendations)* of this study provides dedicated key recommendations for various stakeholders, including city leaders, academia and researchers, and practitioners, including intermediaries, in this field.

1.7 Disposition

Chapter 1 (Introduction) introduces the research, including the topic, problem, aims, and questions. It outlines the research scope, discusses ethical considerations, and identifies the intended main audience.

Chapter 2 (Literature Review) conducts a comprehensive literature review to identify current reviews and research gaps in urban climate governance and financing of NbS. It focuses on enablers and barriers in this field.

Chapter 3 (Theoretical Framework) introduces a conceptual framework of key concepts, including Multi-level Governance, Modes of Governance, and Public Participation.

Chapter 4 (Research Design, Materials, and Methods) presents the research design, methodology, and stages used in the study.

Chapter 5 (Results & Analysis) describes and analyzes the research findings based on the research questions and hypotheses.

Chapter 6 (Discussion) provides an in-depth discussion of the findings' significance and implications, particularly in emerging research areas such as urban experimentation, multi-level governance, financing innovation, intermediaries, and social innovation in co-creation. It also discusses future research and reflects on the limitations of the research and the UGA database.

Chapter 7 (Conclusion) presents final conclusions and recommendations based on the research.

Chapter 8 (Recommendations) expands on key recommendations for city leaders, academia, researchers, and practitioners.

2 Literature Review

2.1 Implementing and Financing Nature-based Solutions

Urban nature-based solutions (NbS) are emerging as a promising approach for addressing sustainability challenges in urban areas. International policy and business discourse are increasingly embracing NbS. The solutions provide enormous potential to address both the causes and the effects of climate change while promoting biodiversity and safeguarding the supply of ecosystem services essential to human well-being (Seddon et al., 2020). Scholars, including Seddon et al. (2020), highlight the need to systematically address the benefits of NbS and recognize the trade-offs from different stakeholders' perspectives. This literature review was focused on understanding the current knowledge accumulated in urban biodiversity governance and NbS practices from European cities.

NbS offers a promising approach to addressing cities' complex challenges. These solutions harness the transformative potential of nature to provide social benefits, involve citizens, and allow for the replication and scaling of local ecosystem-based adaptation strategies (Dorst et al., 2019; Toxopeus & Polzin, 2021). The increasing need to strengthen local resilience in the face of climate change has spotlighted the role of NbS as a means of developing innovative solutions for adaptation and mitigation. The integration of green infrastructure, such as green roofs, urban forests, and green walls, into urban landscapes can provide multiple benefits, including improved air and water quality, climate resilience, and biodiversity conservation.

However, despite the growing interest in NbS, challenges remain in their widespread adoption and implementation. For example, external building greening interventions and the knowledge accumulated, such as life cycle cost savings and improved living and working environments, the adoption of these practices by project owners and other sector stakeholders requires incentives, and these incentives need to be instrumentalized to match long-term planning and goals (Olubunmi et al., 2016). The overarching challenges include lack of political support, limited funding, and the need for interdisciplinary approaches to design and implementation.

According to Kabisch et al. (2016), Ershad Sarabi (2019), Davis and Naumann (2017), and Santoro et al. (2019), the uncertainty, process, and effectiveness of nature-based solutions (NbS) represent major barriers to the mainstreaming of policies. The lack of comprehensive information about the implementation and benefits of NbS is a significant obstacle for decision-makers. NbS involves multiple uncertainties, and the limited information available has primarily remained in academia with restricted diffusion, leading to low public acceptance. Consequently, more comprehensive information and evidence regarding the creation, implementation, management, and effectiveness of NbS across different scales are necessary to reduce uncertainty and conflicts among actors.

Nevertheless, there are opportunities to address these challenges. Engaging stakeholders and communities in the design and implementation process, using new technologies and data to improve decision-making, and exploring innovative financing mechanisms for NbS are all counted as key enablers in overcoming these challenges. Furthermore, the successful implementation of NbS requires the participation and engagement of local communities and the integration of nature-based approaches into urban planning and decision-making processes (Toxopeus & Polzin, 2021). By involving citizens in the design and management of NbS, cities can foster a sense of ownership and stewardship, leading to greater acceptance and long-term sustainability. Additionally, replicating and scaling successful NbS initiatives can spread the

benefits of these solutions beyond the local level and contribute to developing more resilient and sustainable cities globally.

Nature-based solutions (NbS) have been identified as a promising strategy for achieving urban sustainability at different levels of government. The European Commission has adopted the concept for its research program, Horizon 2020, with an explicit focus on urban areas. According to Maes and Jacobs (2015), NbS can be defined as "any transition to a use of ecosystem services with decreased input of non-renewable natural capital and increased investment in renewable natural processes." Despite their potential benefits, the implementation of NbS faces numerous complex barriers, as highlighted by scholars such as Kabisch et al. (2016) and Seddon et al. (2020). These barriers are illustrated in (*Chapter 2.2 - Barriers to Implementing Nature-based Solutions*) based on the main thematic categorization of Institutional change risks, Socio-institutional dynamics (including Inadequate Funding), Institutional divides, Carbon lock-in leadership, and Cross-cutting limitations. These barriers are derived from the knowledge available in literature.

Financing is a critical aspect of implementing urban NbS. While the benefits of NbS are well recognized, funding for their implementation remains a significant challenge to ensure long-term sustainability. Moreover, the literature tends to examine the finance domain separately from other structural fields of urban development and regulatory functions, creating a siloed understanding of finance (Dorst et al., 2022). In cities, densification strategies exacerbate the challenges of financing NbS, as noted by Toxopeus et al. (2021), Mayor et al. (2021), and Hagedoorn et al. (2021). These challenges can be linked to management change, partnership working, monitoring and evaluation, and government policy.

Public funding, including government grants, tax incentives, and subsidies, have traditionally been the main source of financing for NbS projects. However, due to the increasing demand and necessity to upscale NbS projects, private-sector investment has become increasingly important in financing such initiatives. Private investors are attracted to NbS projects due to their potential long-term financial returns, as well as their social and environmental benefits. Additionally, innovative financing mechanisms, such as green bonds and public-private partnerships (PPP), are being used to finance NbS projects (Droste et al., 2017; Kabisch et al., 2017; Ershad Sarabi et al., 2019; Frantzeskaki 2019). Green bonds offer investors the opportunity to invest in environmentally sustainable projects, including NbS, while PPPs involve collaboration between public and private sectors in the planning, financing, and implementation of NbS projects, which can help leverage private sector resources while ensuring public oversight and accountability (Frantzeskaki et al. 2014; Graham and Ernstson 2012).

Furthermore, the economic opportunities from implementing NbS are being recognized at multiple levels of governments and actors, for example. EU-funded projects are partnering with research institutions and intermediate organizations to explore long-term financing options and new funding options through pilot projects, as reported by Wilk et al. (2020). As such, the research in this field is advancing considerably, and the funds made available for delivering NbS are constantly evolving, as highlighted by Mell (2018). The financing of NbS can be supported through various channels, including public funding, private investment, and innovative financing mechanisms such as green bonds and public-private partnerships.

2.2 Barriers to Implementing Nature-based Solutions

Implementing NbS in urban areas is a promising approach to addressing sustainability challenges. However, several barriers to their uptake must be addressed to ensure their success.

According to Kabisch et al. (2016), the primary challenge to the implementation and expansion of NbS in Europe is the uncertainty and risk associated with institutional changes at the urban planning level. Other challenges include the lack of consideration for short-term actions and long-term plans, siloed decision-making, language barriers, and the focus on city growth (Kabisch & Haase, 2013; Kabisch, 2015; Hansen et al., 2015). These factors impact the sustainability of NbS and emphasize the need for long-term, locally appropriate instruments. To overcome these barriers and harness opportunities, it is crucial to have a comprehensive understanding of them as interrelated factors (Kabisch et al., 2017). Moreover, a typical and broader barrier city administrations often face is providing sufficient budgets for NbS implementation or maintenance projects (Hansen et al., 2015; Kabisch, 2015). The comprehensive mapping of barriers is captured in Table 1.

Furthermore, addressing these barriers is essential for the successful implementation and expansion of NbS in urban areas. Governments, policymakers, and stakeholders must work together to develop long-term, locally appropriate instruments and ensure sufficient funding for NbS projects. By doing so, they can overcome the challenges associated with institutional changes, siloed decision-making, and language barriers, among others, and create more sustainable and just cities.

Table 1 Overview of the barriers in implementing nature-based solutions based on literature.

Thematic area	Key Barrier	Context	Reference
Institutional change risks	Fear of unknowns	Risks associated with the implementation and maintenance of NbS in cities and the potential changes to city planning. This is beyond the scope of city planners' capacities and is more related to the awareness of local policymakers on having misperceptions about the drawbacks of green installations in urban areas. With local urban policy officers and planners often being risk averse, these unknowns create roadblocks for the uptake of NbS in cities.	(Kabisch et al., 2016)
	NbS uncertainty, process, and effectiveness	Lack of information about NbS implementation and benefits is a significant barrier for decision-makers. NbS involves multiple uncertainties, and the limited information available has mainly remained in academia with restricted diffusion, leading to low public acceptance. There is a need for more comprehensive information and evidence regarding the creation, implementation, management, and effectiveness of NbS across different scales to reduce uncertainty and conflicts among actors.	(Kabisch et al., 2016; Ershad Sarabi et al., 2019; Davis & Naumann, 2017; Santoro et al., 2019)
Socio-institutional dynamics	Inadequate regulations	Regulations for NbS implementation are fragmented and not always comprehensive. They often favor traditional gray infrastructure solutions, and some regulations may not consider all environmental components. Even when appropriate regulations are in place, there may still be a need for increased enforcement to ensure their implementation.	(Ershad Sarabi et al., 2019; Davies & Laforteza, 2019; Santoro et al., 2019; Seddon et al., 2020)
	Discountunity of short-term actions and long-term planning	Short-term thinking hinders long-term planning, implementation and maintenance of NbS, leading to insufficient funding and unclear responsibilities. Scientifically validated options and knowledge may not be available during policy windows, resulting in a disconnect between policy and science. Green infrastructure policies are subject to change during political cycles.	(Kabisch et al., 2016)

Thematic area	Key Barrier	Context	Reference
	Discountunity of short-term actions and long-term goals	The gap between short-term actions and their connection to long-term plans and objectives is challenging. Many NbS research projects are limited in duration, and there is a need for long-term projects to address post-project implementation and maintenance issues. Additionally, the focus should shift from researching NbS design and early-stage implementation to monitoring their impact on human-environment relationships over time. This aligns with the shift in ecological research towards social-ecological research.	(Kabisch et al., 2016)
	Inadequate Funding	Financial barriers are a significant issue for NbS implementation, with limited funding opportunities and a mismatch between long-term NbS benefits and short-term funding schemes. Municipalities need more resources and decision-making power, and exploring private investment through economic opportunities related to NbS is crucial.	(Frantzeskaki et al., 2017; Hoyle et al., 2017; Van Ham & Klimmek, 2017; Seddon et al., 2020).
Institutional divides	Siloed decision-making	The challenge of traditional city department structures and their sectoral language can cause knowledge to be confined to silos. This can result in NbS projects not fitting into existing decision-making structures and creating difficulties in establishing interactions with strong stakeholders such as other public bodies, housing associations, investors, and developers.	(Kabisch et al., 2016)
	Institutional fragmentation	The traditional structures of city departments and their use of specific language can create "sectoral silos" that trap knowledge and limit the ability of NbS to be incorporated into decision-making processes. The division of responsibilities among various departments and agencies can also lead to confusion about who is responsible for the ownership and long-term management of NbS.	(Frantzeskaki et al., 2017; Davis & Naumann, 2017; Sarabi., 2019)
Carbon lock-in leadership	A paradigm of growth/growth obsession of cities	Even in declining economic and demographic conditions, cities prioritize growth strategies and growth-focused visions. This leads to a reduction in green spaces and a lack of focus on the development and maintenance of these spaces. Finances for green development are also limited, leading to budget constraints and reductions in staff and expertise. Complicated EU funding options also challenge cities, as they require co-financing and additional administrative resources.	(Kabisch et al., 2016)
	Path dependency	Organizational decision-making is limited by past experiences and can lead to resistance to change. In addition, stakeholders in urban areas are used to using gray infrastructure, which can make it challenging to adopt NBS. Therefore, changing individual and societal behavior is necessary to break the path of dependency and shift towards NBS.	(Santiago Fink, 2016; Davies & Laforteza, 2019; Ershad Sarabi et al., 2019; Seddon et al., 2020)
Cross-cutting limitations	Limited land and time availability.	The barriers of limited space and time to NbS implementation are noted in the literature. NbS demands more land and time to achieve benefits compared to traditional gray infrastructure. The scarcity of land, especially in urban areas, poses a challenge for NbS implementation. The slow realization of NbS benefits, particularly in the long term, may discourage short-term-focused local actors. The success of NbS requires long-term collaboration among various stakeholders, necessitating a long-term perspective on NbS and its benefits.	(Krauze & Wagner, 2019; Albert et al., 2019)

Source: Author-owned table, references of text in the column.

2.3 Enablers for Implementing Nature-based Solutions

The successful implementation of NbS depends on effective collaboration among various stakeholders, including governments, and removing administrative barriers (Frantzeskaki et al., 2014; Graham and Ernstson, 2012; Seddon et al., 2020). This collaboration must be based on a framework of collaborative governance that provides incentives for enabling NbS uptake (Seddon et al., 2020). Active cooperation and coordinated action between stakeholders are crucial for NbS governance and require alignment of priorities and interests (Dale et al., 2019). However, conflicting, and unsupportive incentives or regulations can significantly hinder NbS uptake (Zhang et al., 2012; Davies & Laforteza, 2019; Dale et al., 2019). Therefore, strong institutions, established planning structures, and local policy instruments are critical drivers in overcoming governance challenges and realizing the benefits of NbS across landscapes and seascapes (Seddon et al., 2020).

Collaborative governance approaches facilitate the co-creation process and dynamic interactions with various city stakeholders through peer learning and valorizing existing knowledge and practices, which are crucial in fostering NbS opportunities (Seddon et al., 2020). These approaches connect demands for action with responsible actors or partnerships, ensuring good governance practices that adhere to transparency, legitimacy, and openness (Seddon et al., 2020). The literature mapping on NbS enablers is extensively covered in Table 2, where enablers are clustered based on embracing experimentation memory, innovative governance approaches, and locally appropriate policy instruments. Overall, implementing NbS requires a collaborative governance framework that fosters stakeholder cooperation, aligns interests and priorities, and provides incentives for enabling NbS uptake. Strong institutions, planning structures, and policy instruments are also critical drivers for overcoming governance challenges and realizing the benefits of NbS.

Table 2 Overview of the enablers in implementing nature-based solutions based on literature.

Thematic area	Key Enabler	Context	Reference
Embracing experimentation memory	Utilizing prior experiences and lessons learned	The valorization of existing NbS knowledge through engagement with networks and communities of practice can enhance its integration into urban planning, fostering stakeholder engagement and overcoming tensions.	(Kabisch et al., 2016; Moseley et al. 2013)
	Knowledge sharing mechanisms and technologies	Knowledge sharing mechanisms and technologies are crucial for the development of NbS as they facilitate the exchange of experiences and best practices in implementing them, promote investments in natural infrastructure, and involve a wider range of stakeholders. Such technologies (e.g. GIS, citizen survey,s etc) are particularly important in urban areas where they offer cost-effective and fast alternatives to physical partnerships. An example of a knowledge repository that supports knowledge sharing for NBS implementation is Oppla.	(Droste et al., 2017; Frantzeskaki, 2019; Kabisch et al., 2017; Van Ham and Klimmek, 2017
	Education and training	Training and education programs targeting different stakeholders are crucial for reducing uncertainties about the functionality of NbS and garnering public support. It is recommended that NbS education receives equal study time as gray infrastructure in training programs to ensure a balanced focus. Beyond professionals, the general public can should also be	(Davies & Laforteza, 2019; Ershad Sarabi et al., 2019; Kabisch et al., 2017)

Thematic area	Key Enabler	Context	Reference
		educated about the basics of NbS through formal classroom education and diverse multimedia methods, such as podcasts etc. This approach can promote greater awareness and adoption of NbS.	
Innovative governance approaches	Collaborative governance	The adoption of collaborative governance, where policymakers work with citizens, businesses, civil society organizations, and others to align action and good governance practices, is a critical NbS enabler. This partnership helps to overcome barriers to NbS adoption and implementation and enables shared risk-taking. The involvement of the urban government is critical in fostering innovative approaches and quick transfer from concepts to action. Municipalities can adopt a proactive approach by prioritizing NbS in their actions.	(Frantzeskaki et al. 2014; Graham and Ernstson 2012)
	Partnership among stakeholders	Collaboration among stakeholders and organizations at multiple levels is crucial for the successful implementation of NbS, which addresses challenges that impact and are impacted by multiple stakeholders. Partnerships and collaborations between organizations at different levels and within the same level are crucial to ensure the generation of multiple benefits. The private sector can support the NbS implementation process by sharing experience and contributing financial resources. Public-private partnerships (PPP) are encouraged as they offer the government sector's top-down regulation and the private sector's flexibility. Collaboration and support should be fostered among different departments and institutions due to the multidisciplinary nature of NbS projects and the benefits that multiple departments can derive from their implementation. An inclusive narrative for NbS is emphasized to bridge knowledge across different city departments.	(Droste et al., 2017; Ershad Sarabi et al., 2019; Frantzeskaki, 2019; Van Ham and Klimmek, 2017)
	Open innovation and experimentation	Experimentation with NbS has been proposed as an effective strategy for implementing and evaluating solutions in a controlled environment. This approach can help identify optimal strategies for NbS development and allow for learning from mistakes without significant losses. In addition, experimentation can encourage appreciation for and acceptance of NbS solutions, such as urban gardening, which has been shown to create a sense of belonging among residents. Urban living labs (ULL) have become increasingly popular in Europe as an experimentation strategy for NBS development, as they facilitate innovation diffusion and interaction among stakeholders at different levels. Experimentation strategies can also provide visible and tangible actions that invite discussions and can alter thinking and perceptions, turning a passive experience "of nature" into an active experience "with nature."	(Frantzeskaki, 2019; Frantzeskaki et al., 2017; van der Jagt et al., 2017)
Locally appropriate policy instruments	Plans, acts, and legislations	Legislation can either hinder or facilitate the implementation of NbS. The role of meso- and macro-level actors is crucial in providing supportive and clear legislation. For instance, legislation at a local level that	(Davis and Naumann, 2017; Ershad Sarabi et al., 2019; van der Jagt et al., 2017)

Thematic area	Key Enabler	Context	Reference
		considers the social-ecological system perspective can facilitate the mainstreaming of NbS concepts. Similarly, national laws such as the Swiss Landscape Concept and the National Planning Policy Framework in the UK can support the implementation of NBS by requiring agencies and municipalities to apply sustainable practices. At the European level, the EU flood directive is an example of legislation that appears to support the development of NbS.	
	Economic instruments	The use of economic instruments and incentives has been identified as an enabler of NbS implementation. Three types of economic instruments include price instruments, quantity instruments, and fiscal instruments, which can change fees and charges for ecosystem services or limit activities affecting nature. Fiscal instruments incentivize developing green infrastructures and NbS by including ecological criteria in fiscal transfer processes. Using economic instruments can encourage stakeholders to implement NbS as the alternative that provides the best value for money. Economic instruments can also come in the form of grants, such as the European grant.	Droste et al., 2017; Ershad Sarabi et al., 2019; Van Ham and Klimmek, 2017)

Source: Author-owned table, references of text in the column.

2.4 Multi-level Climate Governance

Defining multi-level climate governance requires a clear understanding of its three key terms: multi-level, climate, and governance. Multi-level typically refers to how different levels of government interact with each other, both horizontally and vertically. In the context of climate, this term encompasses both adaptation and mitigation (Adri zola et al., 2018). The governance definition retrieved from Adri zola et al. (2018); Fuhr et al. (2018); and Tacconi (2011) is the formal and informational institutions, rules, mechanisms, and processes of collective decision-making that enable stakeholders to influence and coordinate their autonomous needs, interests, and their interactions with the environment at different levels.

The research by J nicke (2017) highlighted that the Rio model of MLG, as executed through the agenda 21 initiative, was noteworthy for its ability to disseminate knowledge and policy from the global level to the local level. However, the report by Bertelsmann-Stiftung in 2013 indicated that despite the success in agenda-setting and policy formulation, the implementation was not as effective. Scholars have noted that MLG can have varying degrees of effectiveness in solving problems depending on the specific policies being implemented. Moreover, the MLG approach remains crucial in assessing the effectiveness of climate action. As suggested by Corfee-Morlot et al. (2009), using an MLG perspective to comprehend the political economy of climate change policy allows us to go beyond a state-centric view and gain a more comprehensive understanding of the interplay between different actors, both vertically and horizontally, across various levels of government.

Multi-level climate governance (MLCG) can be seen as a specific form of multi-level governance that focuses on climate action. MLG enables national, state, and city-level governments, as well as non-state actors, to develop and implement climate change policies (Corfee-Morlot et al., 2009). According to Adri zola et al. (2018), MLCG pertains to the structure and institutions that allocate distinct roles and responsibilities among various levels of government for climate

action coordination and cooperation. It also refers to the specific tools implemented by different levels of government to facilitate and execute climate actions at the local level. In the study of Newig & Fritsch (2009), a meta-analysis of 47 case studies concluded that multilevel and participatory governance involving non-state actors led to more environmentally rational decisions in most cases than top-down approaches. Thus, to tackle climate change issues, successful MLG requires non-state actor participation and coordination among interdepartmental sectors to overcome institutional fragmentation between governmental and local jurisdictions (Corfee-Morlot et al., 2009).

In essence, and according to Jänicke (2015), global climate governance has its unique features, such as horizontal and vertical dynamics, institutional changes, and diverse actors that create opportunities for innovation and diffusion. Jänicke (2017) highlighted horizontal dynamics induced by vertical climate policies as one of the main accelerators for climate governance. It basically refers to scaling up and supporting best practices at lower levels with higher levels. This approach can stimulate horizontal learning at the lower level, where pioneers become benchmarks, partners, or competitors.

The interactions at the sub-national level have become more critical and include cooperation, competition, networking, lesson drawing, and pioneer activities. According to Kern (2019), MLCG allows for innovation to happen at different levels of the governance system, with possible interactions and lessons learned from pioneers that can be shared among all levels. This results in a policy that can encourage horizontal dynamics across all levels. She also added that the system is global in nature because of the base of climate-related knowledge and the global market for climate-friendly technology that has been established (Kern, 2019).

Moreover, the MLCG systems' innovation is driven by higher-level leadership. There are various motives and opportunities at each system level, such as rich regions motivated to transfer successful economic policy to climate policy and poor regions supporting low-carbon technologies to combat unemployment (Kern, 2019). The process of lesson drawing, which involves learning from the best practices of pioneering countries through peer-to-peer diffusion, has become a critical aspect of global climate governance.

According to Kern et al. (2005), this approach is especially significant as it is voluntary, in contrast to the legally binding nature of international climate law. Additionally, Jänicke (2017); Kern et al. (2005); and Rose (1993) discussed that adopting innovative solutions by countries that have already pioneered them is an effective strategy to avoid domestic trial-and-error and learning costs. As the diffusion of these practices increases, it can lead to increased expectations of further diffusion, ultimately resulting in a self-perpetuating cycle⁸ (Jänicke, 2017). Furthermore, lesson drawing, according to Ross (1993), can take place on different levels, and it has proven to be a unique mechanism for fostering learning and innovation.

MLG has become an increasingly important concept in Europe's approach to addressing climate change and similar complex policy challenges. MLG recognizes the need for collaboration between national, regional, and local governments to implement climate strategies. It highlights the mutual relationship between local and national climate action and enables cooperation, information sharing, and influence from businesses and NGOs. It also improves coordination among national line ministries and facilitates sub-national horizontal relationships through networks and coalitions (Corfee-Morlot et al., 2009). The national environmental policy

⁸ creating a cycle that becomes self-sustaining. In this way, a self-perpetuating cycle can lead to the widespread adoption of innovative solutions, without the need for any external input

innovation of member states can interact with the European harmonization mechanism, which promotes a common market (Jänicke, 2015). The EU Commission can allow member states to implement stricter environmental policies and then decide whether to propose a similar regulation for all members (Treaty on the Functioning of the European Union, Art. 114.7; 193).

Furthermore, this can encourage regulatory competition among member states to be the leader in setting European regulations, including those related to climate policy. According to Jänicke (2015), the EU's purposeful strategy of MLCG is reflected not only in its institutional framework for regions/provinces and climate governance strategy for cities but also in other characteristics that provide a green opportunity structure. For instance, the presence of green political parties and public media in EU countries can facilitate the adoption and implementation of climate-friendly policies (Jänicke, 2015).

According to Kern (2019) and Jänicke (2017), most prominent European cities are situated in the Nordic countries, continental Europe, and the UK, with only a few in southern and eastern Europe. Previous research has primarily focused on leading cities, such as Copenhagen, Amsterdam, and Freiburg, and their horizontal upscaling and global city networks (Kern, 2019). The development of the EU climate policy, as described by Jänicke (2015), started at the national and sub-national levels, with countries such as Germany, Denmark, and the United Kingdom leading the way by integrating political and economic experiments and best practices (Kern, 2019). This bottom-up approach paved the way for the adoption of these policies at higher levels, and extending national innovations to the EU has been a strategy for member states to stabilize their role as pioneers and to create a market for climate-friendly and low-carbon technologies (Jänicke, 2015).

The collaboration between the MLCG and the multi-sectoral system offers various opportunities to those involved (Fuhr et al., 2018; Jänicke, 2017). However, this alone is insufficient to bring about the desired change and must be complemented with intentional actions. While the presence of a global climate governance system is a necessary condition, it is the actors and their strategies that are the key drivers of success (Jänicke, 2017). Effective leadership demands knowledge, skill, motivation, and the ability to work within networks. A complementary approach that embraces new ideas, ambitious yet realistic and feasible within the available capacity, is required. With skilled strategic action, the dynamic potential of the global climate-related multi-level governance system can be harnessed, leading to strengthened efforts at multiple levels (Betsill & Bulkeley, 2003; Fuhr et al., 2018; Kern, 2019).

Furthermore, for the continual success of local climate policy, it is not only necessary for a few leading cities to take action but also for follower cities to emulate their efforts and for binding standards to be imposed on laggards who may not take their own initiatives otherwise (Kern, 2019). Although MLCG has been predominantly explored in national-supranational interactions, particularly in the EU, there is still limited research to comprehend the trajectories of urban nature-based solutions policy formation and their drivers of good practice through empirical analysis within the context of MLCG.

2.5 Urban Climate Governance

Urban areas play a critical role in mitigating and adapting to climate change and have evolved into centers of pioneering urban climate governance that can drive efforts (Koop et al., 2017; van der Heijden, 2019). The multi-level system of global climate governance appears to be increasingly irreversible, which is attributed to the growing institutionalization of climate policies, the dynamics of change facilitated by the system itself, and the emergence of new interests that support climate action (Knieling, 2016; Romero-Lankao et al., 2018). The

increased urban risks due to climate change have accelerated momentum toward experimental solutions beyond short-term initiatives (Bulkeley et al., 2020). Over the past twenty years, there has been an increased focus on hastening the transition of socio-technical systems to combat climate change. This increased attention to the climate crisis has resulted in a surge of local climate action initiatives toward institutionalizing and instrumentalizing policies for long-term targets.

Particularly in Europe, the emphasis has been on executing climate action plans at the local level as a pivotal aspect of climate governance, with a substantial proportion of Europeans residing in cities that have set relatively ambitious goals for lowering their carbon footprint (van der Heijden, 2019). Moreover, Adriázola et al. (2018) note that national governments rely on the cooperation of regional and local administrations to effectively execute their climate change policies. As quoted in the research of Betsill and Bulkeley (2003):

“local governments with their many and varied roles are in a strong position to advance the goals of sustainable development as direct or indirect providers of services, regulator, leader by example, community informer, advocate, advisor, mobilizer of community resources and initiator of dialogue and debate” (Satterthwaite, 1997).

Scholars in Betsill and Bulkeley (2003), Jänicke (2017), Knieling (2016), and van der Heijden (2019) agree that to achieve urban sustainability, it is imperative to tackle both local and global challenges in a unified approach. The research conducted by Koop et al. (2017) and Pierre (2019) highlights the possibility of achieving an inclusive, sustainable future by acknowledging and valuing the specific needs of various communities, along with tackling the larger global sustainability issues. Romero-Lankao et al. (2018) emphasize that urban climate governance entails more than just government decision-making; it also requires the active engagement of non-governmental organizations and members of civil society. By collaborating around a shared goal, participatory processes offer the most potential to establish effective response strategies that are also legitimate.

However, challenges in governance, such as differences in electoral cycles and planning horizons, as well as conflicting climate policies, can lead to a gap between a city's climate commitments and its actions (Romero-Lankao et al., 2018). Indeed, political leadership continues to play a major role in driving urban climate governance innovations (Wolfram et al., 2019). While large, affluent, and influential cities led by charismatic figures have emerged as crucial players in climate governance, it is important to recognize that local climate action is not a universal solution (Kern, 2019).

Urban climate governance experiments are facilitated by multilevel governance, with municipal networks playing a key role in shaping the capacity of urban governance. Jänicke (2017) highlights that various national and international city networks have been established, including the International Council for Local Environmental Initiatives (ICLEI) and the EU-based Covenant of Mayors (CGoM) to promote low-carbon development. These organizations aim to facilitate sustainable development and create opportunities for cities and local communities to collaborate and share best practices (Jänicke, 2017). Thus, climate governance varies widely, requiring unique approaches for low- and high-income cities to respond effectively to climate change, with several crucial factors to consider as key facilitators in this process.

The literature on governance capacity has a wealth of research in various fields, including environmental governance, climate adaptation, capacity development, and public administration. Institutional capacity is a key enabling aspect of governance capacity, which mainly emphasizes how the institutional framework, laws, and regulations facilitate actors in

working together to solve mutual problems (Koop et al., 2017). Governance capacity for climate change can be seen as a set of conditions that is required to effect change that accelerates the development of effective solutions (Koop et al., 2017; Knieling, 2016). According to Adriázola et al. (2018), the main types of capacity prominently described in research include the capacity to gain adequate knowledge and information, the capacity to access financial resources, the capacity for effective coordination and collaboration, and finally, institutional and human resources capacity.

The research by Hölscher et al. (2019) has presented a framework for building capacities to promote transformative climate governance, low carbon objectives, and climate mitigation and adaptation initiatives in cities. The framework identifies crucial capacities such as the ability to anticipate and respond to emerging issues, shift away from unsustainable path dependencies, promote innovations and facilitate their adoption, and coordinate multi-stakeholder processes while minimizing trade-offs. Access to knowledge and technical information are important aspects of urban capacity building and can be strengthened through vertical and horizontal collaborations with different governance levels and non-state actors (Pierre, 2019).

Utilizing the opportunity structure presented by MLG can effectively promote ambitious and impactful climate actions. The implementation of smart policies can accelerate the pace of change. According to Jänicke (2017), many empirical cases exist that demonstrate the effective utilization of this dynamic potential, leading to the rapid diffusion of low-carbon technologies and the promotion of effective climate governance. The concept of 'reflexive governance' and 'adaptive management' with interactive 'learning by doing' may be a suitable general framework for steering such actions, as proposed by Voss & Bornemann (2011) and Brousseau et al. (2012). Despite nearly two decades of research driving innovative policy responses to tackle climate change at the city level, there is still a noticeable gap between policy promises and actual implementation (Bulkeley & Betsill, 2005; van der Heijden, 2019).

According to Bulkeley et al. (2015), experimentation has become a prevalent approach for European cities to achieve urban sustainability through NbS. This approach can take various forms and involve different actors in socio-technical systems. Municipal governments are leading the promotion of experimentation, while private actors, NGOs, and community groups also play essential roles. Kern and Alber (2008), Bulkeley and Kern (2006), Beermann et al. (2016), van der Heijden (2019), and Schmalzbauer (2018) have conducted studies that indicate the different modes of governance employed by national and subnational authorities to develop mitigation and adaptation policies. These modes are classified into self-governance, governance by enabling, governance by provision, and governance by authority, as explained in the theoretical research framework (*Chapter 3 -Modes of Urban Governance*). Understanding these modes makes it easier to comprehend the initiatives preferred by local governments and their impact on MLCG outcomes under the existing system.

3 Theoretical Framework

3.1 Multi-level Governance

In multi-level governance (MLG) systems, no individual level of government can attain its objectives alone. It refers to a governance structure that involves not only government actors but also a variety of non-state actors from local, regional, national, and international levels (Betsill & Bulkeley, 2003; Jänicke, 2017). The concept of multi-level global governance was initially introduced in 1992 at the United Nations summit in Rio as a novel approach to promoting sustainable development by involving diverse actors in a comprehensive global mobilization (Jänicke, 2017). In Kern and Bulekeley (2008), the concept of MLG can be interpreted narrowly as the transfer of responsibilities among local, national, and supranational government bodies. Alternatively, it can encompass more than just traditional forms of state regulation and include a broader range of actions and institutions that promote order, such as public-private partnerships (PPPs) and non-state actors. Thus, the MLG approach recognizes that policy issues often transcend traditional jurisdictional boundaries and require the participation and collaboration of actors at multiple levels (Kern and Alber, 2008).

At the EU level, integration and regionalization dynamics have dispersed both authority and resources towards the subnational and supranational levels (Bulkeley & Betsill, 2005). Stephenson (2013) observed that MLG had been extensively studied for the past two decades and concluded that it is the most frequently used term in the research of European policymaking (Stephenson, 2013: 817). Adopting a MLG perspective involves acknowledging and interacting with the various tiers of government and governance structures that shape and challenge urban sustainability (Bulkeley & Betsill, 2005). According to Hooghe and Marks (2001), multilevel governance can be categorized into two types: *Type I*, a hierarchical approach that centers on the distribution of competencies and authority among different levels of government, and *Type II*, a polycentric model that involves multiple interconnected horizontal spheres of authority in governing specific issues (Betsill & Bulkeley, 2003) see Figure 5.

Moreover, Kern and Alber (2008) refer to horizontal collaboration as the interaction within metropolitan regions, between government and non-governmental actors, and networking among cities. In essence, multilevel governance, which Bendline (2019) defined as a form of politics without central authority, can be characterized as a decentralized system. It entails the creation of policy networks through the collaboration of various tiers of government, such as European, national, and subnational authorities, who rely on each other's resources without competing for their scarcity (Hooghe 1996, 18). The former *Type I* focuses on power-sharing and distribution structures among vertical levels, including international, national, state, and local governments. For the latter, *Type II* examines governance interconnections involving horizontal spheres of authority, while citizens and civil society are viewed at the micro level in the multilevel climate governance system (Bulkeley & Betsill, 2005; Jänicke, 2015). The significance of interactions and relationships between different levels of each system is acknowledged by both approaches (*Type I & II*).

Furthermore, MLG presents a flexible and comprehensive approach to analyzing how cities, regions, and national governments collaborate on mitigation and adaptation policies. According to Corfee-Morlot et al. (2009), utilizing an MLG perspective to comprehend the political economy of climate change policy enables us to move beyond a state-centric viewpoint and obtain a more comprehensive understanding of the connections between various actors, both horizontally and vertically across different levels of government. The versatility of the framework of multilevel governance lies in its ability to encompass a diverse range of non-governmental and non-state actors, making it a valuable tool for comprehending their role in

policymaking (Betsill & Bulkeley, 2003; Corfee-Morlot et al., 2009). In the context of climate action, the unique features of each level of the system can affect climate governance as they have different responsibilities, challenges, and opportunities. To apply MLG in our research, I used the UGA as a contextual reference for governance-related information, such as vertical and horizontal collaboration. This information can be beneficial in recognizing the patterns and approaches used in developing each policy instrument and what are the lessons learned.

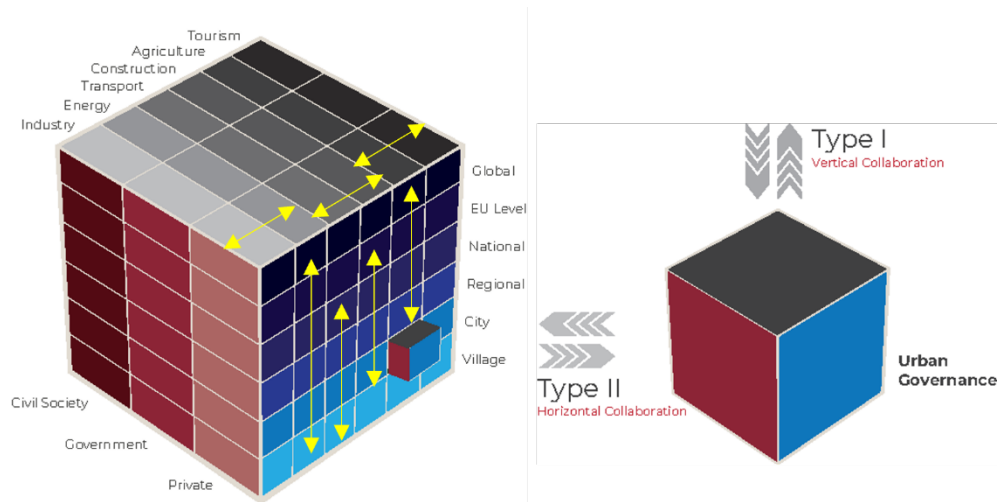


Figure 5 A graphic representation of governance involving multiple levels and stakeholders.

Source: Author-owned visual, adopted from (Jänicke, 2015; Jänicke, 2017).

3.2 Modes of Urban Governance

To better understand the dynamics of urban climate governance in relation to policy instruments at the local level, the four governing modes introduced by Bulkeley and Kern (2006): self-governance, governing by authority, governing by a provision, and governing through enabling, are suggested to furthering the UGA analysis (Annex D). The modes of governance are distinguished by governing capacities which range from traditional forms of state interventions to soft and innovative forms (Kern & Alber, 2009). A comprehensive analysis by Bulkeley et al. (2020) shows that local governments used different power forms to govern. Their capacity to govern ranged from formal to other types, including enabling, persuasion, and direct means of services.

In the past two decades, there has been significant research into the different modes of urban climate governance. To categorize each governance mode, I based the works of Bulkeley & Kern (2006), Kern & Alber (2009), and Neij & Heiskanen (2021) as references. Figure 6 shows *Self-Governance* refers to the ability of municipalities to serve as both consumers and role models. It involves the capacity of local governments to manage their own activities, including adopting environmentally sustainable practices in their operations. The concept of *Governing by Provision* focuses on municipalities as providers of services and resources, with a particular emphasis on securing financing for climate action initiatives. *Governing by Authority* involves the traditional role of government as a regulator, using control and sanctions to enforce regulations related to land use planning, waste management, transportation, and other areas that can impact climate policy. *Governing by Enabling*, on the other hand, involves municipalities acting as facilitators, encouraging community engagement, and coordinating partnerships with various stakeholders. This approach is often implemented through network governance.

Neij and Heiskanen (2021) have highlighted in their literature that good urban governance requires experimentation to enable municipalities to open up new governance structures and informal power structures. In Sweden and Denmark, Smedby and Quitzau (2016) have demonstrated the success of using policy instruments and experimentation modes of governance in the energy sector. Experimentation can occur in various forms, actions, and between actors in the socio-technical systems. Municipal governments are leading the way in promoting experimentation, and new roles for private actors, NGOs, and community groups are also emerging. The increase in urban risks due to climate change and the fragmentation of power has led to an acceleration in experimentation governance beyond land use planning (Bulkeley et al., 2020). Moreover, the recent adoption of NbS in European cities is related to the *modus operandi* of experimentation as a dominant governing mode for cities toward sustainability (Bulkeley et al., 2015).

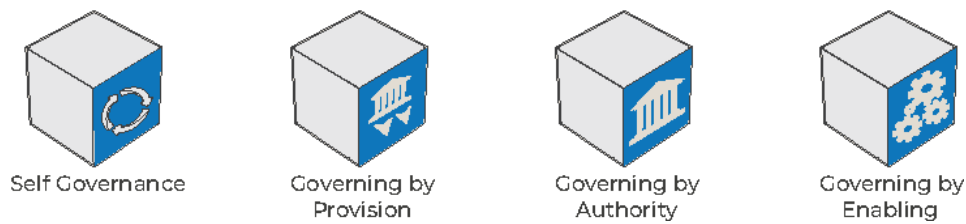


Figure 6 A graphic representation for diving into the Four Governing Modes.

Source: Author-owned visual.

According to Bulkeley's (2019) analysis of fifty-six NbS initiatives under the NATURVATION project, there is no one-size-fits-all approach to developing governance strategies for NbS. Enabling and facilitating have been found to be effective forms of governance, and the analysis reveals twelve proven modes of governance. Additionally, it emphasizes the need for local actors to adopt a locally appropriate approach, with decision-making power exclusively in the hands of city stakeholders. This is important as it overcomes the barrier of a lack of regulatory capacity to govern NbS initiatives and shifts the focus to diversifying forms of governing capacity that can be leveraged through multiple agents of change (Bulkeley et al., 2020).

Since academics did not create the policy instruments database used in our analysis, I cannot rely on specific keywords or academic criteria to determine the governing mode used in each instrument. Therefore, I'll use interpretation and tagging to identify the dominant modes of governance employed in these instruments based on the level of support provided by local authorities and by analyzing the governance sub-section part as a whole. This information is valuable in providing guidance and ideas for future cities or stakeholders who wish to implement policy instruments, as they can learn which instruments may be most effective for their specific needs.

3.3 Public Participation

Citizen participation is defined as a continuum of interactions between institutions and people moderated by various forms and methods of governance (Kiss et al., 2021). According to Luyet et al. (2012), the structuring of stakeholders and their degree of involvement was captured as a procedure that involves categorizing stakeholders into similar groups and assigning each group a particular level of involvement. Arstein (1969) was the first to propose a ladder of citizen participation that included eight steps, thereby establishing the initial framework for citizen participation. Arstein categorized the levels of participation into three groups: non-participation

(manipulation and therapy), Tokenism (informing, consultation, and placation), and Citizen Power (partnership, delegated power, and citizen control).

Public participation, according to the International Association for Public Participation (IAP2), refers to the engagement of individuals who will be affected by a particular decision in the process of making that decision. This can include various activities, from simply informing the public about government actions to allowing them to make decisions themselves. The IAP2 framework for public participation categorizes these activities into five levels, with *Inform* being the lowest level and *Empower* being the highest (Greaves, 2017; IAP2, 2003).

This study's framework is influenced by the works of Luyet et al. (2012), Wilker et al. (2016), Greaves (2017), and Kiss et al. (2021), which includes five levels of participation, namely: *information, consultation, collaboration, co-decision, and empowerment* (Figure 7). The first level, *Inform*, entails explaining the project to stakeholders, where the public is provided with information to comprehend the agency's⁹ decision-making process. At the *Consultation* level, stakeholders are presented with the instrument, and their suggestions are collected before decision-making occurs, with or without taking their input into account. It is the basic level of public input, where the agency seeks opinions from the public but makes the final decision itself. *Collaboration* involves presenting the instrument to stakeholders, collecting their suggestions, and making decisions considering their input. Nevertheless, the agency retains its ultimate decision-making power.

At the *Co-decision* level, stakeholders work together towards a mutually agreed-upon solution/instrument and their implementation. It sits between the collaborate and empower levels. Finally, at the highest level of *Empowerment*, stakeholders have delegated the decision-making power over the instrument's development and implementation. The key advantages of this approach include its flexibility to suit various situations, its comprehensive approach that integrates social and technical sciences, and its utilization of practical participatory tools in conjunction with these (Luyet et al., 2012).



Figure 7 The Public Participation Ladder.

Source: Author illustration, concept retrieved from IAP2 (2003), and modified based on research of Kiss et al. (2021) and Wilker et al. (2016).

⁹ Initiating body

4 Research Design, Materials, and Methods

4.1 Research Philosophy and Overview

This research adopts a constructivist and pragmatic approach to gain a deeper understanding of the phenomena in their unique context (Bryman & Cramer, 2012). The study focuses on a *cross-sectional analysis* of the European cases in the Urban Governance Atlas (UGA) and utilizes a pragmatist approach to identify common lessons learned from good practice instruments for promoting urban nature-based solutions through local policy instruments (Creswell & Creswell, 2018).

The research comprises four main phases (Figure 8). Phase one involved a thorough literature review and study of the INTERLACE-related documents. In phase two, a comprehensive statistical analysis was conducted on the 150 European policy instruments from the UGA, identifying key emerging patterns in governance and participation. The analysis in *Chapter 5* provides valuable insights into the urban governance landscape, policy instrument types, and the interconnection of policy variables. The statistical analysis serves as a foundation for connecting unsupported literature to the study's findings and validating existing concepts in urban governance literature (see *chapter 5 - Governance and Participation*).

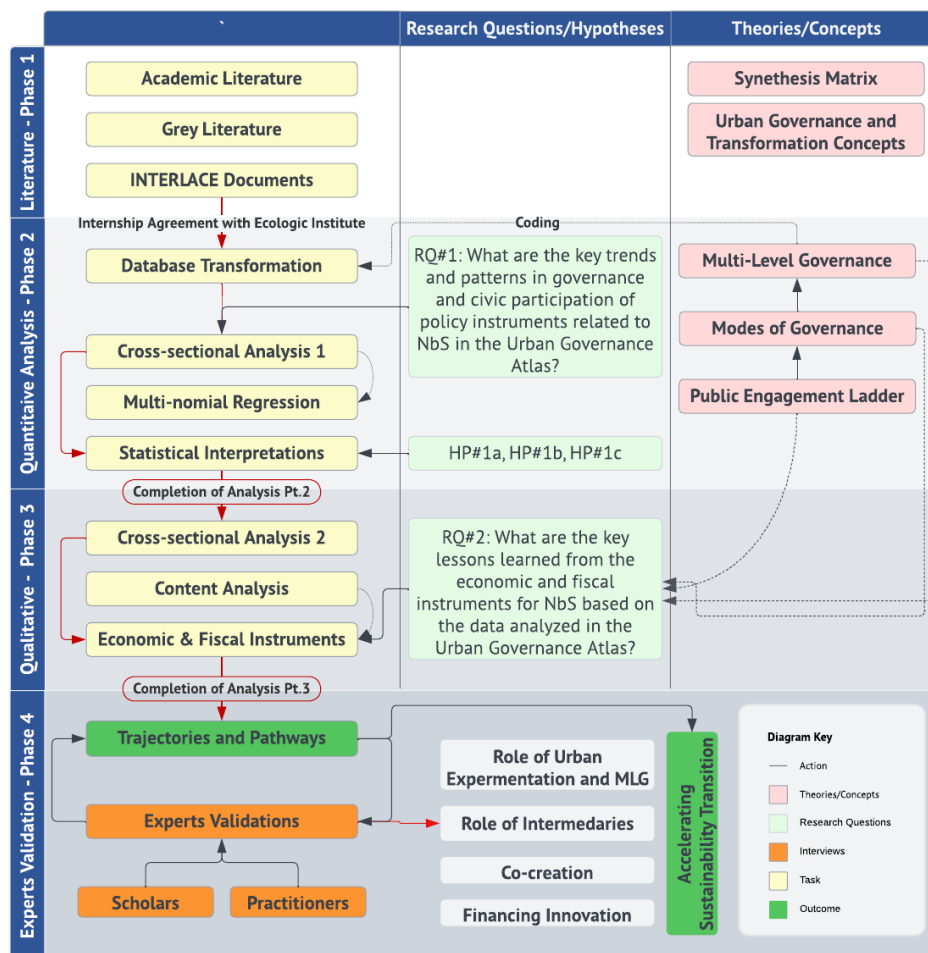


Figure 8 Illustration to visualize the research approach.

Source: Author-owned visual.

Phase three entails a content analysis of the Achieved Outcomes sub-section of the UGA, particularly focusing on the common lessons learned from the Economic and Fiscal Instruments (EFI). The content explores the success factors of each instrument, and validation with other sections was conducted to further substantiate the key aspects learned. In phase four, nine experts were interviewed to validate the analysis and identify additional insights, with a particular emphasis on the role of intermediaries, which was limited in the UGA cases. Academic experts and practitioners provided insights into areas of social sustainability and innovation in financing. The insights obtained from these interviews were incorporated into the discussion (*Chapter 6 - Discussion*) and in formulating the thesis's key recommendations (*Chapter 8 - Recommendations*).

To ensure accuracy and reliability, a triangulation methodology is employed, combining qualitative and quantitative research methods. This approach minimizes the limitations of each method, provides a comprehensive understanding of the research problem, and uncovers hidden insights and knowledge gaps. The triangulation approach enhances the reliability of the research findings and strengthens the analysis (Creswell & Creswell, 2018).

4.2 Research Design

An *explanatory sequential mixed design approach* can be beneficial in obtaining a more comprehensive understanding of complex phenomena. This approach involves initially collecting and analyzing quantitative data and then following up with qualitative data to explore and explain the quantitative results (Creswell & Creswell, 2018). In addition, the sequential design allows researchers to build upon the findings of the initial data analysis and investigate the underlying reasons for the observed patterns or relationships (Teddlie & Tashakkori, 2009).

Our research employed a combination of quantitative and qualitative methods to comprehensively examine the policy instruments' landscape. In phase two, I utilized statistical regression analysis, visually demonstrating the interconnections of variables and providing valuable insights into different policy instruments' relationships and trends.

To complement the quantitative analysis, in phase three, I conducted a qualitative content analysis of the UGA sub-sections (mainly Achieved Outcomes) and analyzed interviews in phase four. Content analysis, as recommended by Teddlie & Tashakkori (2009), allowed us to uncover underlying themes, identify gaps, and assess the validity of our findings from phase two. By examining the UGA sub-sections' content and engaging in interviews with relevant stakeholders, I gained a deeper understanding of potential areas for improvement and developed a more nuanced perspective of the policy landscape.

The study focused on two sub-groups: *Governance* and *Achieved Outcomes and Impacts*. The Governance sub-group examined public involvement in design and implementation and the actors involved. The Achieved Outcomes and Impacts sub-group analyzed lessons learned and success factors, providing valuable insights for future policy development supporting urban NbS. Special attention was given to Economic and Fiscal instruments (EFI) to identify what innovation was used and knowledge that could be shared to prospect cities. However, insights from other policy instrument types were also considered, guided by the findings from phase one. This approach allowed for in-depth exploration of critical areas and a comprehensive understanding of the policy landscape, drawing from a wide range of policy instruments.

Combining both quantitative and qualitative methods in our research allowed us to triangulate our findings, enhancing the reliability and validity of our results. By utilizing multiple research methods, I was able to approach the research questions from different angles, providing an

opportunity to uncover hidden insights and knowledge gaps. This comprehensive analysis of the policy instruments' landscape contributed to the existing knowledge base, bridging case study lessons with literature and identifying areas for improvement (key recommendations - 8) to advance understanding of good practice policy instruments and thus accelerate urban sustainability transitions.

4.3 Data Collection Methods

4.3.1 Policy Instruments

The policy tools in this study possess unique features and meet at least one of the eight good practice criteria (UGA, 2023; Interview A, 2023). A standard definition of policy instruments was established, referring to government tools used to implement policies and influence actions (UGA, 2023; Interview A, 2023). The UGA recognizes the trend toward active citizenship and encompasses instruments initiated by both the government and non-governmental actors formalized by the government e.g. urban gardening that was formalized through policy or government action (Davis & Burgos, 2022). However, the UGA is not fully inclusive of bottom-up initiatives that lack formalization and are limited to short-term approaches. Its focus is on showcasing city achievements and inspiring other municipalities to follow suit (Interview A, 2023).

The UGA knowledge platform lacks full inclusivity by not openly welcoming bottom-up initiatives with short-term approaches that lack formalization by the local government. However, it emphasizes the city perspective to showcase municipal achievements and inspire other cities. This involves recognizing and integrating bottom-up initiatives into the policy framework and governance of NbS, while also encouraging NGOs to collaborate based on existing good practices (Interview A, 2023). It is important to note that the collected data is limited and does not provide a comprehensive representation of the subject matter. The research team deliberately avoided highlighting cases already well-known in academic and grey literature to ensure the uniqueness of the information (Interview A, 2023).

The team responsible for data collection from the UGA adopted a diverse approach in terms of outreach, involvement, and expertise. They promoted an open call for contributions and policy instrument referrals through conferences, city networks, and project consortium partners in Europe and Latin America (Interview A, 2023). An inclusive outreach campaign was conducted through Oppla¹⁰ and various social media platforms in Spanish and English, targeting individuals familiar with policy instruments or closely involved with them. The cases collected involved desk research, interviews, and document analysis. Policy instruments were contributed by individuals involved in their development or experts from the project consortium. A quality assurance process ensured the information's comparability and compatibility across entries, improving clarity without altering the meaning (Interview A, 2023).

4.3.2 Research Database

The UGA database, received in tabular format as part of a joint research agreement, organizes 150 policy instruments into columns corresponding to their sub-sections (explained in *Chapter 1 - Joint Research with Ecologic Institute*). It was created through the collaboration of project consortium partners, direct municipal experts, and desk research, supplemented by phone calls or virtual interviews for clarification. The author contributed nine policy instrument cases

¹⁰ Oppla is the EU Repository of Nature-Based Solutions. <https://oppla.eu/about>

during their MESPOM internship in 2022, enriching the database creation process. Additionally, the author established a partnership between the Ecologic Institute and IIIEE, formalized through an internship agreement outlining responsibilities and external support.

Using the information in the database, the researcher transformed it into a scientific and academic typology, extracting lessons learned, analyzing governance patterns and civic involvement practices, and exploring the connection between practical knowledge and literature. The research focused on the European context and adopted the theory of Multi-Level Governance (MLG) as the system boundary. MLG theory facilitated the identification of the utilization of MLG approach in policy design and implementation, providing a comprehensive understanding of the complex interplay between governance, policy instruments, and nature-based solutions in urban settings, contributing to the current understanding of good practice policy instruments.

4.3.2.1 Database Categorization and Tagging

To ensure that the data fit the purpose of the statistical analysis, I used dummy variables. According to Wooldridge (2009), dummy variables were used in statistical analysis to represent categorical variables as numerical variables, enabling them to be included in regression models and other analyses. Furthermore, transforming the data required coding the qualitative tabular data into a dummy variable's dataset. This approach allowed us to create a dataset that could be utilized for statistical analysis to test the hypotheses and answer research questions.

To code the data, the database was categorized based on theories and academic concepts used in our research. For instance, the Public Participation Ladder was used to categorize engagement based on involvement and approaches used by the public (*informed - empowerment*). The Mode of Governance was identified based on the interpretations of the role of local government in establishing urban policy instruments (*self-governance, provision, authority, and enabling*). Furthermore, the implementation of MLG was assessed by analyzing the collaboration at vertical and horizontal levels and across sectors and determining accordingly whether it went through *Type 1, Type II, or both*.

To simplify the design and implementation process of a policy instrument, the database was transformed and linked to ensure that it used academic language and key concepts in a standardized way. Tagging was performed using a systematic methodology that involved a three-step verification process. In the first step, the instrument description and design sub-section were analyzed to identify whether MLG was used and the type of participation, and the mode of governance employed. In the second step, the fields of vertical and horizontal collaboration, the role of the public in implementation, and the relation of the instrument with other national or regional instruments were examined to validate or amend the tagging. Additionally, the type of participation was interpreted, and a new layer was added to identify the type of MLG utilized. In the tertiary mapping, the 29 economic and fiscal instruments (EFI) were evaluated based on all the available UGA sub-sections, including the impact achieved and lessons learned. The tagging was done manually with a guidebook reminder and examples from the literature to ensure quality assurance while tagging 150 instruments.

Categorical data were coded using dummy variables with unique values assigned to each category. However, continuous values, such as summed-up indices, required an additional step for normalization. For example, a normalized index ranging from 0 to 1 was used to simplify the representation of good practice characteristics and challenges addressed. By assigning a parameter representing 1 divided by the total number of characteristics or challenges, I could calculate the value based on the number included in the policy instrument. This approach

facilitated tracking correlations between more inclusive policy instruments. To illustrate the good practice characteristics Index, I assigned a parameter of 1/7 to each characteristic and calculated the value based on the number of characteristics present in the policy instrument. Similarly, with 17 identified challenges, each challenge was assigned a value of 1/17.

4.3.3 Expert Validation

The interviews in this research validate and enhance findings by connecting practical experience with current literature, addressing research gaps, identifying synergies, and uncovering new insights (Lewthwaite and Nind, 2016). Interviewees were selected based on their contribution and relevance to urban climate governance, co-creation, and multi-level governance, guided by citations from the literature.

In addition to planned interviews with researchers, snowball sampling interviews were conducted based on supervisor recommendations. These interviews (Table 3) were conducted after completing phase three, involving data transformation and statistical analysis. One early identification was interviewing practitioners from TNOs like C40, ICLEI, and EuroCities. Validating their contributions and exploring their influence adds value beyond the information already in the database. Although not the primary focus, these interviews will inform research recommendations.

Table 3 Overview of the interviewees in the expert validation phase.

Category	Institute	Date	Interviewee	Duration	Code
Practitioner/ Think-tank	Ecologic Institute	March.07. 2023	Mckenna Davis	60 mins	(Interview A, 2023)
		May.16.2023		35 mins	(Interview I, 2023)
Practitioner/ TNO	United Cities & Local Governments	April.11.2023	Juan Carlos Uribe Vega	35 mins	(Interview B, 2023)
Academia	Lund University	April.20.2023	Yuliya Voytenko Palgan	65 mins	(Interview C, 2023)
Practitioner/ TNO	C40	April.27.2023	Ismat Fathi	60 mins	(Interview D, 2023)
Practitioner/ TNO	EuroCities	May.4.2023	Heather Brooks	75 mins	(Interview E, 2023)
Practitioner/ TNO	ICLEI, Europe	May.11.2023	Daneila Rezzi	90 mins	(Interview F, 2023)
Practitioner/ TNO	ICLEI, WS	May.11.2023	Cecilia Rivera	90 mins	(Interview G, 2023)
Academia	Lund University	May.09.2023	Bernadette Kiss	90 mins	(Interview H, 2023)

Source: Author-owned table.

4.4 Research Process

A literature review was conducted to understand concepts, identify research gaps, and select the theoretical framework for the study. Recent literature within the past 15 years was prioritized, including papers published in 2021 and 2022 by reputable scholars. The work of experienced researchers in the field was also followed to gain insights. The selected literature was relevant to various research areas such as urban governance, NbS, urban sustainability, and multi-level governance, helping identify potential experts for validation and review interviews.

Table 4 presents data collection, sources, and analysis for each research phase. In the second phase, primary data from the UGA was collected, encompassing 150 policy instruments and urban governance practices from around 80 European cities (Annex E). This data provided an extensive overview of instrument types, design, implementation, and actor roles. Analysis of the UGA data generated initial insights into European cities' governance and participation practices related to urban NbS.

To enhance research reliability and validity, experts specializing in urban governance and NbS were selected for expert review. Their expertise and reputation ensured valuable feedback on the research. semi-structured interviews (Table 4) with experts, practitioners, and scholars validated the primary insights and provided in-depth understanding of urban NbS governance and related financing innovation. This comprehensive approach ensured scientifically rigorous findings, discussion, and recommendations.

Table 4 Overview of the data collection, sources, and analysis approaches used in the research.

Scope	Type of Information	Data Collection	Data Analysis
Developing literature review and capturing knowledge in the interplay area of NbS and Governance.	Academic and grey literature included journal publications, webinars, and documents.	Secondary data sources, including academic books and journal articles using google scholar, google search engine, webinars, and LUBsearch.	Thematically organizing the data using Zotero & synthesizing and compiling literature based on research key areas.
Cross-sectional Quantitative Analysis (Governance)	(Total N=155 instruments; N= 29 Economic and fiscal Instruments; N= 56 Legislative, regulatory, and strategic instruments; N= 52 Agreement based or cooperative instruments; N= 4 Knowledge, communication, and innovation instruments).	Primary data sources were obtained from the UGA cases.	<i>Multi-nominal regression</i> analysis to identify significant factors of variables. <i>Network analysis</i> to identify communities and visual significance.
Cross-sectional Qualitative Analysis (Achieved Outcomes and Impacts)	N= 29 Economic and fiscal Instruments	Primary data sources were obtained from the UGA cases.	<i>Content analysis</i> using thematic categorization of theoretical framework, key concepts, and literature.
Experts' validation of primary findings.	Content derived from individual interviews	Primary data was collected through semi-structured interviews.	Manual interview coding.

Scope	Type of Information	Data Collection	Data Analysis
	with scholars and practitioners		

Source: Author-owned table.

4.4.1 Data Analysis

A cross-sectional case analysis was employed as the data analysis approach for this research. In the second phase, statistical cross-sectional analysis, regression analysis, and network analysis were utilized to test hypotheses, estimate relationships between variables, and assess factors contributing to good practice instruments. This analysis provides an aggregate assessment of association magnitude and helps quantify their significance.

In the third phase, cross-sectional case content analysis was performed to examine the lessons learned from economic and fiscal instruments (EFI) in the UGA. This analysis enabled the identification of commonalities and differences within UGA case studies, contributing valuable knowledge to broader research objectives. The UGA database serves as a platform for this analysis, promoting knowledge sharing across various instrument sub-domains, including impact and lessons learned. Specifically, the emphasis is on economic and fiscal instruments, investigating their governance content, good practice characteristics, and lessons learned to address existing literature gaps.

During the expert validation stage, data from semi-structured interviews were manually transcribed, coded, and integrated into the analysis discussions of both phases. Thematic content analysis was employed to examine qualitative data, involving the identification, segmentation, categorization, and summarization of key themes relevant to the policy instrumentalization of urban NbS solutions which can be viewed in the *Chapter 5 (Lessons from Economic and Fiscal Instruments)* and in *Chapter 8 (Researchers, Practitioners, City Leaders)*.

4.4.1.1 Regression Analysis

Cross-sectional regression analysis is a widely used method in various research fields (Cooper, 2010; Wooldridge, 2009). It aims to test hypotheses, estimate relationships between variables, and predict values based on independent variables (Wooldridge, 2009, p. 117). Statistical techniques are applied to identify regularities and tendencies (Cooper, 2010; Wooldridge, 2009). In our case, the analysis involves one categorical dependent variable (policy instrument implementation) with three categories, several independent variables, & data collected at a single point in time (UGA, 2023a). According to Wooldridge (2009), the optimal method for our analysis is *multinomial regression*.

The regression model takes the form of a linear equation, where the dependent variable is predicted based on the independent variables (Wooldridge, 2009). The regression coefficients represent the change in the dependent variable associated with a one-unit change in the corresponding independent variable, while the error term captures unexplained variation (Wooldridge, 2009). Based on literature (Denjean et al., 2017; Eisenberg et al., 2018; Pontee et al., 2016) and good practice characteristics outlined in the UGA (*Box 2 - 1.3.1*), effective policy instruments require comprehensive monitoring and evaluation mechanisms. These mechanisms enable informed decision-making and performance assessment.

The dependent variable categorizes good practice instruments into three levels: *Fully Effective*, *Partially Effective*, and *Limited Good Practice*. Monitoring and evaluation define as Fully Effective, while Partially Effective instruments have monitoring mechanisms but lack comprehensive evaluation. Limited Good Practice instruments fulfill good practice criteria but lack monitoring and evaluation.

The analysis incorporates several independent variables derived from UGA sub-sections: Utilization of Multi-level Governance, Mode of Governance, Public Participation, Category of Instruments (Annex B), Challenges Addressed Index (check *Database Categorization and Tagging*), Scale of Implementation (*National to Municipal*), Relevance to Urban Areas Index, and Good Practice Index. These variables are examined to assess their potential influence on the dependent variable, which measures the effectiveness of the policy instrument. The study aims to identify key factors that contribute to the success of urban governance initiatives by investigating the relationships between these variables and the policy instrument's effectiveness.

4.4.1.2 Network Analysis

The database underwent transformation into nodes and edges, with the main nodes including policy instrument type, mode of governance, public participation ladder, characteristics of good practice, and scale of implementation. Edges were identified and weighted based on the frequency of occurrence between two nodes. The aim of the network analysis was to understand the relationships and variables within the policy instrument network. Measures such as degree centrality, betweenness centrality, and average cluster weight were calculated to identify key nodes and patterns of connectivity. These analysis results can contribute to improving the policy network and promoting the use of NbS for addressing environmental challenges.

Degree centrality allowed us to identify nodes with the most connections, indicating their importance within the network (Lazega & Snijders, 2016). Betweenness centrality helped identify nodes acting as bridges between different parts of the network (Lazega & Snijders, 2016). Average cluster weight provided insights into the strength and importance of connections between nodes (Lazega & Snijders, 2016). Additionally, the degree of modularity was explored, indicating the extent to which nodes formed distinct communities. A higher degree of modularity suggested denser connections within the same community (Lazega & Snijders, 2016). The findings revealed a moderate degree of modularity in the policy network, indicating certain nodes clustered together more closely than others.

4.4.1.3 Content Analysis

The content analysis was conducted manually in two stages. In stage two, each case was carefully examined and tagged accordingly. In phase three, the content analysis aimed to identify common characteristics of success and lessons learned from the economic and fiscal instruments. Initially, key thematic lessons were identified, such as governance and innovation in financing. Then, by connecting these lessons with relevant literature on enablers, a more comprehensive clustering was achieved. However, in some cases, it was necessary to refer back to the governance section to explore any uninvestigated or unclear relationships or drivers.

4.5 Reliability and Validity

The quality of a study's results is impacted by two critical aspects: validity and research reliability. To ensure the reliability and validity of this research, a multi-step approach was adopted. According to Creswell and Creswell (2018), validity pertains to the accuracy and credibility of the findings, while research reliability refers to the consistency and reproducibility of the results

under similar conditions. To ensure the validity of this study, a specific protocol was followed for data collection and analysis, involving multiple steps to examine the data thoroughly and ensure accuracy. First, the primary data source utilized in this study was the UGA, which is a robust knowledge platform that maps the profiles of urban policy instruments based on a structured methodology (Davis & Burgos, 2022). The UGA cases were validated in various methods, including primary data collection from direct stakeholders, desk research, or phone call/interviews validation, which indicates its high reliability as a research instrument, as explained in (*Chapter 4 - Policy Instruments*).

Second, expert validation interviews were conducted with scholars in the field of NbS and urban governance to ensure that the research instrument used in this study was measuring the intended construct accurately (Creswell & Creswell., 2018; Yin, 2014). By conducting these interviews, potential gaps in the interpretation of the instrument trends were identified, leading to new insights. Furthermore, it provided an opportunity to open discussions and improve the construct validity of the study (Bryman, 2015; Creswell & Creswell., 2018). Finally, the study linked findings with the systematic literature review to enrich study discussion. This approach enhanced the external validity of the study by ensuring that the findings are grounded in the existing literature and can be generalized to other contexts (Cooper., 2010). Overall, these measures helped to ensure reliability.

5 Results & Analysis

This chapter is divided into three sections. The first section presents overarching insights from the UGA, highlighting instrument types, adoption correlation with time in years, challenges addressed, and good practice criteria cases profile. The second section answers RQ#1, analyzing the landscape of instruments in terms of governance and participation in relative to the framework elements. The final section addresses RQ#2, providing a funding landscape and six key lessons for good practice economic and fiscal instruments and their common key success factors.

5.1 Overarching Insights from the UGA

5.1.1 Policy Adoption Overtime

A total of 150 instruments from 21 countries and 62 European cities were analyzed in this study (Annex A). The majority of these instruments (40%) were legislative, regulatory, and strategic instruments (LRSI), followed by Agreement-based or cooperative instruments (AbCI) at 28.7%, economic and fiscal instruments (EFI) at 19.3%, and knowledge, communication, and innovative instruments (KCII) at 12%.

To examine the adoption of these instruments over time, their frequency was plotted based on the year of adoption, starting from 1995. Figure 9 show the correlation analysis between instrument adoption and time resulted in an R^2 value of 0.785, indicating a strong positive correlation. This demonstrates that the adoption of local policy instruments promoting NbS has been increasing significantly. In section 6.1.1, I delve deeper into the drivers behind this upward trend.

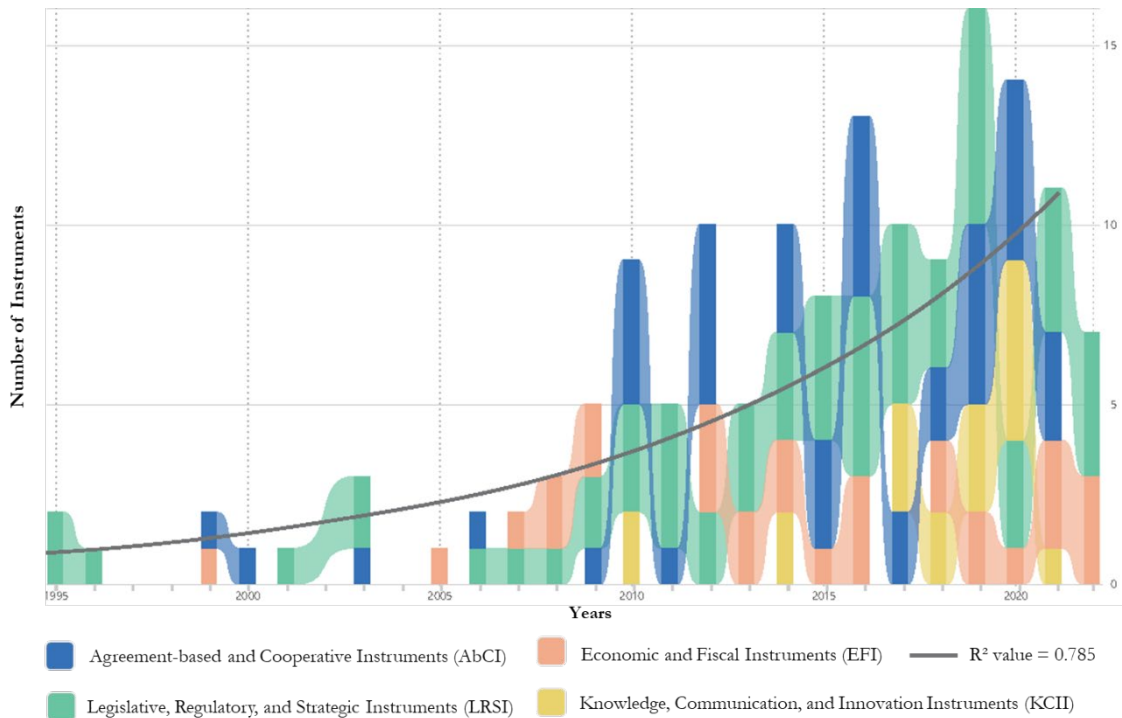


Figure 9 Correlation between the adoption of policy instruments and time in years.

Source: Author-owned visual.

Further analysis of the data revealed interesting trends in the adoption of specific instrument categories. Agreement or cooperative instruments (AbCI) have experienced a notable surge in adoption since 2015, reaching a peak in 2020 with the adoption of five policies. This can be attributed to increased awareness and a high degree of engagement across actors. Similarly, the adoption of knowledge, communication, and innovative instruments (KCII) has been relatively recent, likely due to advancements in communication channels and tools.

In contrast, legislative, regulatory, and strategic instruments (LRSI) have consistently dominated the policy landscape, with a peak in 2019 when six policies were adopted. This suggests that LRSI policies remain solid, and there is untapped potential for innovation. On the other hand, economic and fiscal instruments (EFI) have shown modest adoption over time, without a discernible peak year. This highlights the significant gap in financing that needs to be addressed.

5.1.1.1 Scale of Implementation

The analysis identifies 101 policy instruments implemented at the municipal scale, with four national instruments implemented at the local scale, 11 instruments at the neighborhood level, and 28 instruments at the regional level. Interestingly, no agreement or cooperative instruments (AbCI) were implemented at the national level, indicating that cooperation at the national level is not a well-established instrument type.

Additionally, no economic and fiscal instruments (EFI) were implemented at the inter-municipal and smaller entity level, which may be attributed to the challenges of channeling funding across municipalities and highlights the untapped potential in this area. Furthermore, no knowledge, communication, and innovative instruments (KCII) were implemented at the interregional level, suggesting that people's tendency towards decentralized communication or innovation diffusion at lower levels is more likely in this environment.

5.1.1.2 Challenges in Focus

As noted in (*Chapter 4 - Research Database*), the UGA cases provide descriptions of the challenges addressed by each instrument. A total of 17 main challenges, derived from previous NbS projects like NATURVATION, are listed, along with the scores indicating how well the 150 analyzed policy instruments tackle each challenge (Figure 10). The distribution of challenges tackled by the instruments is relatively symmetrical, with an average and mode around 6. On average, each policy instrument addresses 6 challenges simultaneously.

The most frequently addressed challenge, accounting for 12% of the policies, is human health, comfort, and well-being, which is tackled by 109 out of the 150 policy instruments. Ecological connectivity is also prominent, featured in 85 instruments (9.2%), followed closely by heat stress and heat island effects in 82 instruments (8.8%), and green space management in 80 instruments (8.7%). On the other hand, landslide risk receives the least attention, being featured in only 6 instruments (0.7%). These results provide insights into the important aspects to consider, indicating that focusing on human well-being and ecological connectivity can be key for successful NbS practices and case outcomes.

Interestingly, the only policy instrument that addresses all 17 challenges is an EFI instrument in Glasgow, United Kingdom (UGA, 2023t). The Green Exercise Partnership (GEP) is a funding scheme launched in 2007 by the Forestry Commission Scotland, Scot Nature (formerly Scottish Natural Heritage), and Health Scotland (part of the Scottish National Health Service). The program finances projects that derive health benefits from exercise and time spent in nature and support turning policy into practice by making green health a key element of the government's

wider physical activity agenda. The GEP also provides a good example of how to give citizens an active role in nature conservation and the implementation of NBS, thereby combining human well-being with ecological benefits.

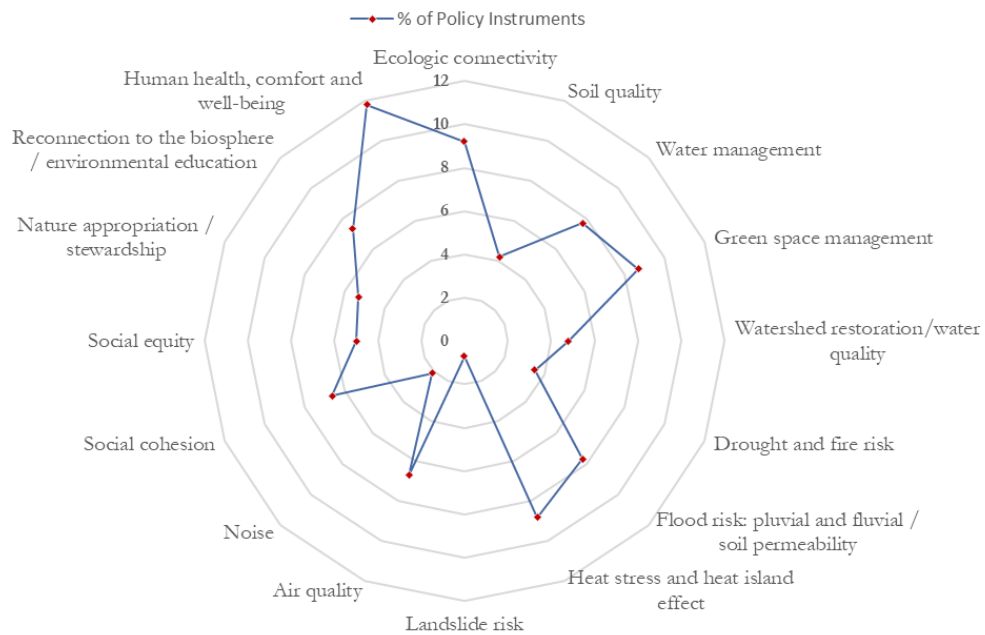


Figure 10 The challenges addressed by the instruments in percentages.

Source: Author-owned visual.

5.1.2 Good Practice Criteria

The distribution of good practice criteria across the 150 policy instruments was analyzed, as mentioned in section *Urban Governance Atlas* (see Box 2). By using these criteria, common characteristics were identified, and the effectiveness of the policies was evaluated. It is worth noting that the majority of cases were from Germany, totaling 26 instruments, followed by France with 19, the United Kingdom with 18, Belgium with 15, the Netherlands with 14, and finally, Spain with 13 (see Annex D for more details).

Figure 11 illustrates that the most frequently mentioned characteristics of the policies are being locally appropriate, featured in 125 instruments (21%), and having the potential to be replicated or upscaled, featured in 118 instruments (19.9%). On the other hand, the provision of a policy business case was the least addressed characteristic, included in only 27 instruments (4.55%). These findings offer insights into the adaptability and transferability of these good practice instrument to different contexts, as well as highlighting the untapped potential to generate business opportunities.

Annex E provides a comprehensive analysis of policy instruments that have achieved full scores in the good practice criteria, using the thesis framework of MLG, modes of governance, and participation. There are four instruments that scored a full 7/7 in the criteria. Notable trends include the association of policy business cases with *EFI* instruments and a significant presence of high-scoring instruments within *AbCI* instruments. Annex E provides detailed information on these instruments, offering them as sources of inspiration. These instruments demonstrate a common insight of being utilized by *both Type I and Type II* MLG, with an enabling mode of

governance. Additionally, they embrace a collaborative participation mode. Each instrument is examined to highlight how they effectively implement these principles to achieve their goals.

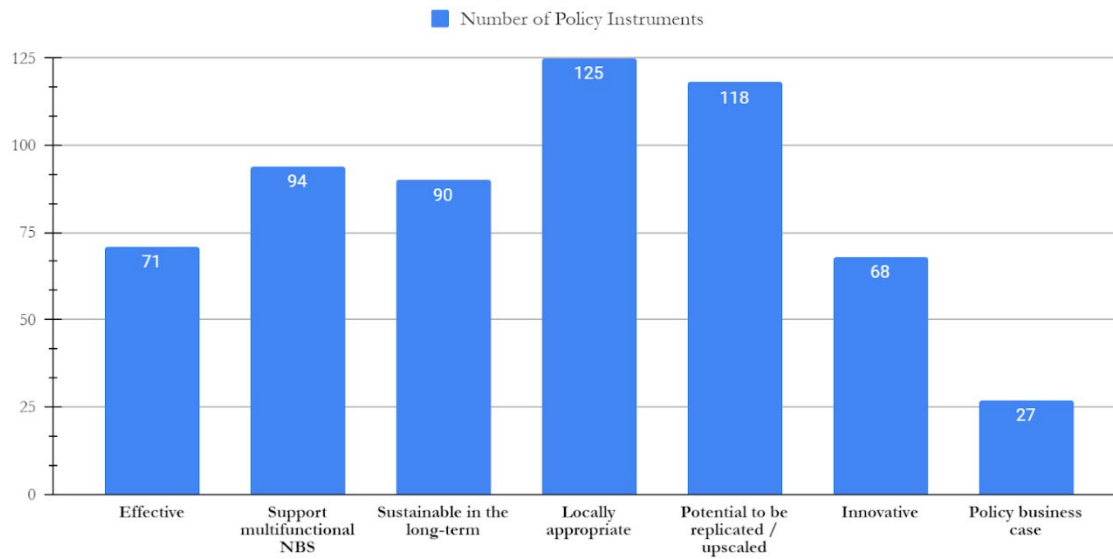


Figure 11 The good practice criteria by the numbers of instruments.

Source: Author-owned visual.

5.2 Governance and Participation

RQ#1: What are the trends and patterns in governance and civic participation of European policy instruments related to NbS in the Urban Governance Atlas?

5.2.1 Statistical Analysis of Trends

The analysis conducted in this study encompassed three primary steps, as outlined in the methodology chapter (*Data Analysis*). Firstly, the cases were classified by utilizing the available information in the UGA's governance sections. Each case was then tagged according to the research framework, which encompassed the multi-level governance type, mode of governance, and participation ladder. Section 5.1 (*Overarching Insights from the UGA*) provided comprehensive insights derived from this analysis. Subsequently, in section 5.2.1.1 (*Network Analysis Results*), the results of the network analysis were presented, aiming to examine the relationships between variables within the UGA cases. Moreover, section 5.2.1.2 (*Multi-nominal Regression Analysis Results*) showcased the results of the regression analysis, which aimed to identify the significant factors influencing the effectiveness of policy instruments. Lastly, section 5.2.1.3 (*Feature Importance Analysis*) featured the presentation of the random forest classifier, utilized to evaluate the importance of decision-making features, and prioritize them accordingly.

5.2.1.1 Network Analysis Results

The network analysis conducted in this study found that a few highly central variables, such as LRSI, governmental initiating body, and collaboration, as well as *type II* MLG variables, have significant power and influence in shaping policy decisions related to urban green areas.

Moreover, variables with high betweenness centrality¹¹, such as LRSI instruments and AbCI instruments, were able to bridge different clusters and informal networks together.

The analysis revealed five informal clusters or networks in the UGA that tend to occur together. Cluster 1 (30% of the network) was concentrated with the governmental body as the initiating body, while clusters 2, 3, and 4 each had 20-26% of the network. Cluster 5 was the smallest, with only 4%. The visualization in Figure 12 indicates that variables in the middle of the network have the most influence, while those that are farther away are less present. The variables that are at the heart of the network include Type II and collaborative modes of governance, as well as governing by enabling and governing by provision.

Additionally, locally appropriate and potentially replicable policy instruments, as well as LRSI and AbCI instruments, were found to be central variables in the network. The highest edge weight was from the governmental initiating body to the collaborative mode of participation and LRSI instruments. Locally appropriate variables had a high weight with LRSI, and the governmental initiating body had a high weight with governing by the provision. These findings suggest that policymakers should consider the network of variables involved in the policy process and their drivers when designing and implementing policy instruments for urban NbS. By doing so, they can better anticipate and manage challenges and opportunities associated with policy instrument adoption and implementation in this context.

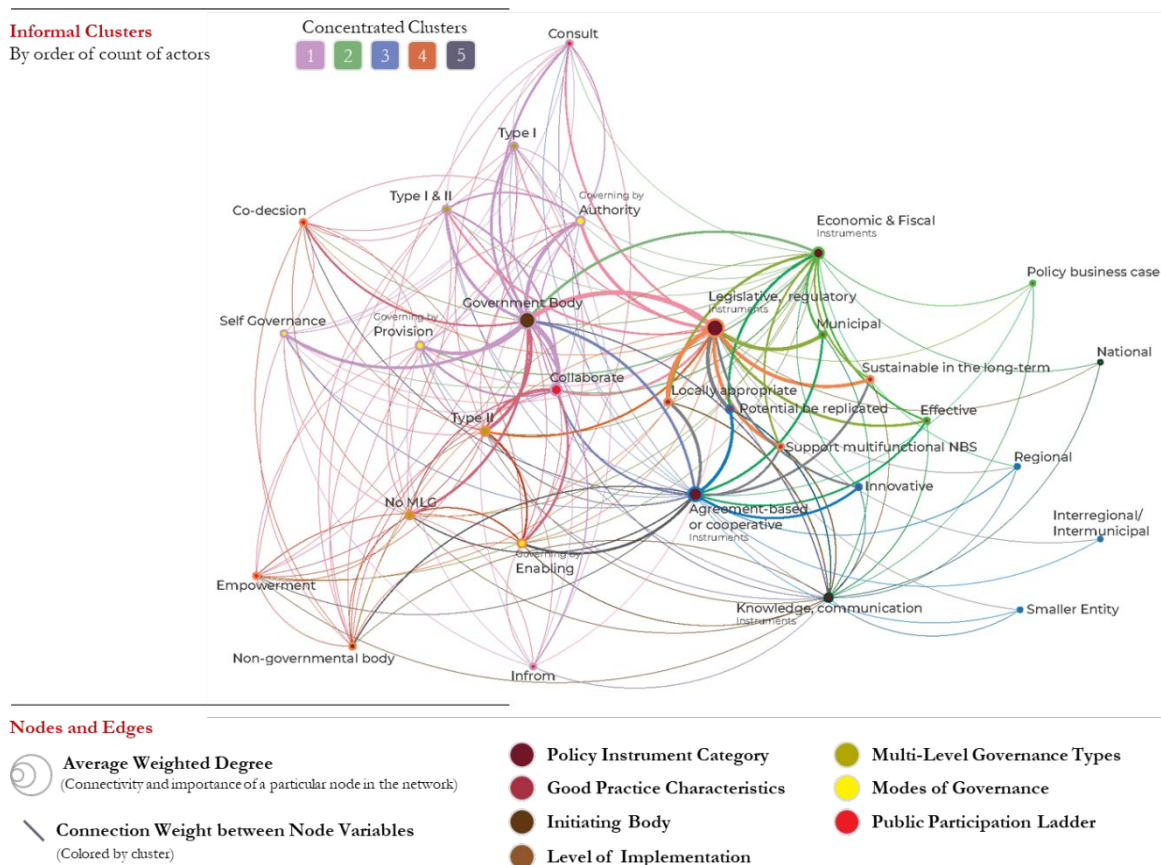


Figure 12 Network analysis showing informal clusters and network of the UGA cases.

¹¹ Means that a node has a significant influence on the flow of information or interactions between other nodes.

Source: Author-owned visual.

5.2.1.2 Multi-nominal Regression Analysis Results

Regression results should be interpreted by considering the coefficient and p-value. The coefficient shows the relationship's direction and magnitude between independent and dependent variables, while the p-value indicates statistical significance. A p-value less than 0.05 is considered statistically significant, suggesting a relationship unlikely due to chance, while a p-value greater than 0.05 implies the opposite.

The analysis of the multinomial regression in Figure 13 helped us understand the significance of variables in instruments effectiveness. The dependent variable categorizes instruments into three levels: Fully Effective (Y=3), Partially Effective (Y=2), and Limited Good Practice (Y=1) (see Chapter 4, Regression Analysis). For Y=3, the regression analysis shows that the *multi-level governance* variable has a positive coefficient of 0.4779, indicating that a higher level of multi-level governance positively (from none to both Type I and Type II) affects the instrument outcome.

Similarly, the *scale of implementation* variable has a positive coefficient of 0.6351, suggesting that a larger implementation scale positively affects the instrument outcome. Interestingly, the *mode of governance* and *participation ladder* variables, with p-values greater than 0.05, indicates no significant relationship with the instrument outcomes when it comes to learning mechanisms. Thus, participation, even if it empowers, does not necessarily lead to higher environmental outcomes, nor do enabling or self-governance modes affect the presence of a monitoring and learning mechanism.

	Instrument Index (Y)=2	coef	std err	z	P> z	[0.025	0.975]
const		-3.7881	1.487	-2.548	0.011	-6.703	-0.874
Mode of Governance		-0.2744	0.214	-1.280	0.201	-0.695	0.146
Participation Ladder		0.3225	0.196	1.647	0.100	-0.061	0.706
Type of Multi-level		0.3157	0.192	1.645	0.100	-0.060	0.692
Scale of implementation		0.0231	0.283	0.082	0.935	-0.532	0.578
Category of Instrument		-0.0303	0.212	-0.143	0.886	-0.446	0.385
Good Practice Index (Continuous)		1.0670	1.190	0.897	0.370	-1.265	3.399
Challenges Addressed Index (Continuous)		1.5491	1.137	1.363	0.173	-0.679	3.777
Relevance to Urban Areas Index (continuous)		3.6967	1.728	2.139	0.032	0.310	7.083
	Instrument Index (Y)=3	coef	std err	z	P> z	[0.025	0.975]
const		-5.6815	1.690	-3.363	0.001	-8.993	-2.370
Mode of Governance		-0.1115	0.251	-0.445	0.656	-0.603	0.380
Participation Ladder		0.2582	0.225	1.148	0.251	-0.183	0.699
Type of Multi-level		0.4779	0.219	2.185	0.029	0.049	0.907
Scale of implementation		0.6351	0.282	2.249	0.025	0.082	1.189
Category of Instrument		-0.1025	0.240	-0.427	0.669	-0.572	0.367
Good Practice Index (Continuous)		1.0481	1.369	0.765	0.444	-1.636	3.732
Challenges Addressed Index (Continuous)		1.9126	1.236	1.548	0.122	-0.510	4.335
Relevance to Urban Areas Index (continuous)		1.8278	1.973	0.927	0.354	-2.039	5.694

Figure 13 Results of the regression models showing p-value and variables coefficients.

Source: Author-owned visual.

5.2.1.3 Feature Importance Analysis

The random forest classifier was used to rank the importance of features in predicting the outcome variable. Figure 14 shows that the Challenges Addressed Index was found to be the most important feature, with a feature importance score of 22%. This suggests that instruments should be designed to address a wide range of challenges and promote multi-functional solutions. The Good Practice Index was the second most important factor, with a score of 14%,

indicating that adherence to the seven good practice criteria can serve as a checklist and navigation tool.

The third most important variable is the type of multi-level governance, emphasizing the crucial role of collaborations across levels and sectors. These findings suggest that addressing challenges and implementing good practices are key factors in predicting the effectiveness of instruments. The mode of governance and participation type also showed importance, with scores of 12% and 11% respectively, indicating that the level of participation and the approach and structure of governance can impact the outcome variable.

Additionally, the scale of implementation, relevance to urban areas index, and instrument category were identified as important features, although to a slightly lesser extent. Thus, suggesting that instruments relevant to the municipal scale are more likely to lead to positive outcomes. These findings can assist policymakers and practitioners in identifying key factors that contribute to the success of policy instruments in achieving their intended outcomes.

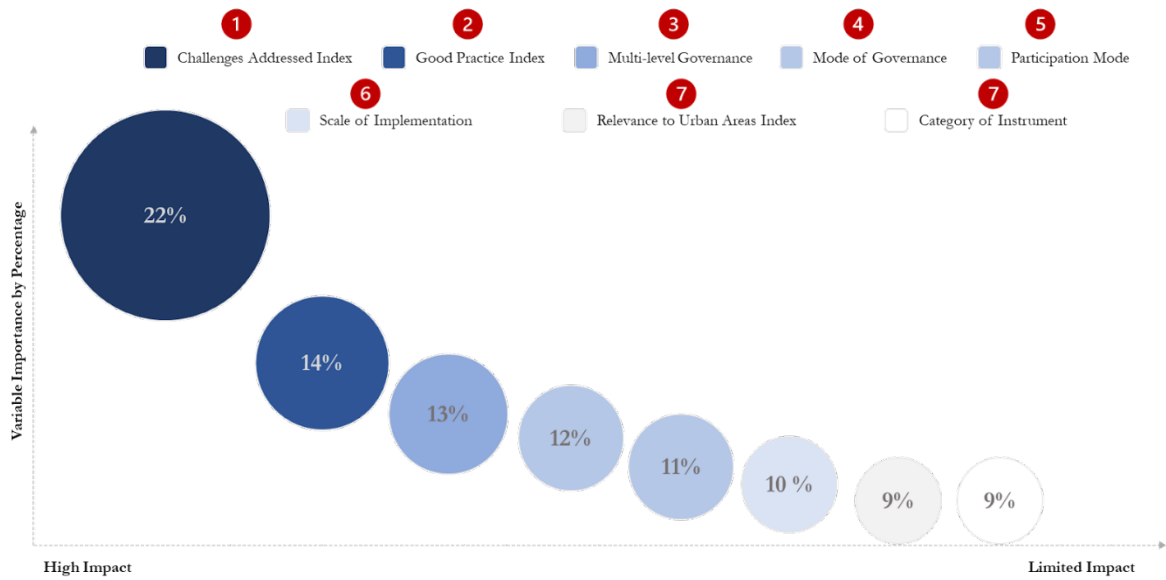


Figure 14 Feature importance by the percentage of variables for fully effective policy instruments.

Source: Author-owned visual.

5.2.2 Multi-level Governance

HP#1a: Effective policy instruments for nature-based solutions in urban areas are more likely to involve vertical and horizontal collaboration among different actors and levels of government.

After analyzing the tagging of 150 policy instruments, it was found that *Type II* of MLG of horizontal collaboration is the dominant MLG type in the design of these instruments. This suggests that not only vertical and horizontal collaborations in MLG are needed, but also, there is significant attention to *Type II*. As per our hypothesis, this proves that MLG utilization is an essential factor in building good practice policy instruments. In total, 77.03% of the instruments were designed while utilizing MLG instruments and collaboration. Table 5 shows that the utilization of *both Type I* and *Type II* accounts for 24.32%, which indicates that there is still a need to strengthen both types, with *Type I* being slightly more utilized (31.08%) compared to *Type II*

(21.62%). It is interesting to note that despite having good practice criteria, 22.97% of the instruments still follow a command-and-control principle.

Furthermore, it was found that the highest MLG value in AbCI instruments is none, which means that they were designed by excluding vertical and horizontal collaborations. Interestingly, in LRSI, no MLG utilization accounted for 4.73%, which can also be seen as positive as it is the lowest value of the MLG components. Moreover, KCII instruments had no instruments that have a vertical collaboration and very low values for both collaborations (1.35%), indicating that this type of instrument may require more strength in vertical collaborations or that this type of MLG collaboration may be needed. Lastly, it was observed that EFI instruments have no specific pattern of the dominant mode of MLG, with all values falling within the same range.

Table 5 Results of a cross-sectional analysis of Instrument types and Multi-level Governance Elements.

Instrument Type	LRSI	AbCI	EFI	KCII	Total
Multi-Level Governance					
Vertical and Horizontal Collaboration	12.84%	6.08%	4.05%	1.35%	24.32%
None	4.73%	9.46%	4.73%	4.05%	22.97%
Type I (Vertical Collaboration)	10.14%	6.08%	5.41%	0%	21.62%
Type II (Horizontal Collaboration)	12.84%	7.43%	4.73%	6.08%	31.08%
Total	40.45%	29.05%	18.92%	11.49%	100.00%

LRSI: legislative, regulatory, and strategic instruments; **AbCI:** Agreement-based or cooperative instruments; **EFI:** Economic and fiscal instruments; **KCII:** Knowledge, communication, and innovative instruments

Sources: Created by the author.

5.2.3 Modes of Governance

HP#1b: Effective policy instruments for nature-based solutions in urban areas may use different modes of governance, but the dominant approach is likely to be enabling governance.

Enabling mode of governance is dominant across the 150 cases, with 32.43% of the instruments governed by enabling, which involves collaboration, partnerships, and experimentation. AbCI instruments have the highest percentage of enabling governance at 16.22% (Table 6). In contrast, LRSI instruments are primarily governed by authority, while EFI instruments are mainly governed by the provision mode. KCII instruments are not governed by authority or self-governance, but rather by provision and enabling.

Interestingly, self-governance is the least prevalent mode of governance, accounting for only 12.84% of the instruments. This indicates a significant shift in urban sustainability trends compared to two decades ago when self-governance was more dominant. Although governing by enabling is the dominant mode, there is only a slight difference compared to governing by authority, suggesting that enabling is emerging while governing by authority remains strong, particularly in instruments promoting nature-based solutions. This is largely attributed to a significant number of legislative, regulatory, and standards instruments.

Table 6 Results of a cross-sectional analysis of Instrument types and Modes of Governance.

Instrument Type \ Mode of Urban Governance	LRSI	AbCI	EFI	KCII	Total
	Governing by Authority	23.65%	2.70%	4.05%	0%
Governing by Enabling	6.08%	16.22%	3.38%	6.76%	32.43%
Governing by Provision	6.76%	3.38%	9.46%	4.73%	24.32%
Self-Governance	4.05%	6.76%	2.03%	0%	12.84%

LRSI: legislative, regulatory, and strategic instruments; AbCI: Agreement-based or cooperative instruments; EFI: Economic and fiscal instruments; KCII: Knowledge, communication, and innovative instruments

Sources: Created by the author

Figure 15 reveals that most of the instruments (84%) were initiated by governmental bodies, while the remaining 16% were initiated by non-governmental bodies and later institutionalized or endorsed by governmental and municipal bodies. It is noteworthy that governing by authority is the predominant mode of governance for the majority of the governmental bodies, with a slight gap with governing by enabling. The majority of governing by-provision instruments come from governmental bodies as well, which shows why public sector is still the main funding actor (Chapter 6.3). On the other hand, self-governance is more prevalent among non-governmental bodies, which can be attributed to the general mode of municipal authorities self-governing as an enabler for non-governmental initiatives. Interestingly, there is a very small percentage of self-governance instruments from governmental bodies, indicating that this mode of governance is being marginalized in favor of more enabling and provisional modes.

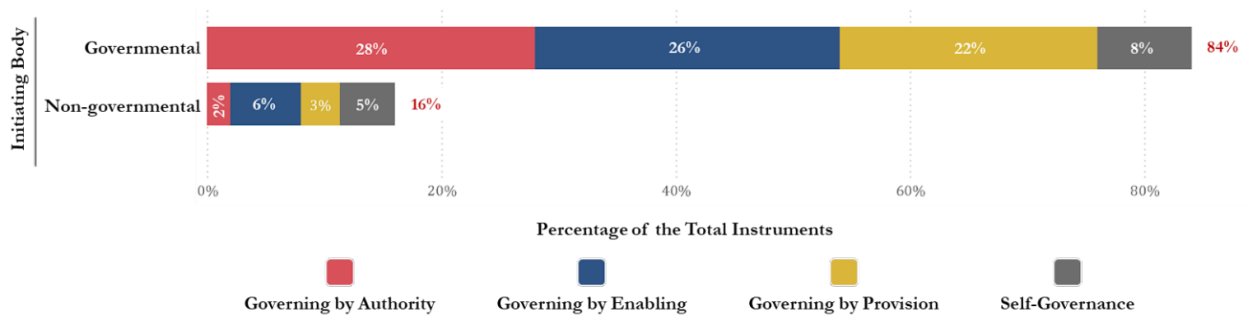


Figure 15 Overview of instruments initiating body and Mode of Governance.

Source: Author-owned illustration

Table 7 provided further insights into the relationship between public participation and modes of governance. Interestingly, most instruments that involve the "inform" mode of participation are governed by authority. Similarly, the "consult" mode is also dominated by governing through authority, indicating that traditional command and control approaches still limit public participation. On the other hand, collaboration and higher forms of engagement are closely correlated with enabling governance, suggesting that collaborative approaches are essential for successful policy implementation. Additionally, the analysis found that empowerment and self-governance modes did not overlap in any of the instruments, which suggests that self-governance is being excluded in favor of top-down approaches. Moreover, it is noteworthy that collaboration was the most frequent mode of participation regardless of the mode of governance, indicating that collaboration is a critical success factor for policy instrument adoption.

Table 7 Correlations between the Public Participation Ladder and Modes of Governance.

Participation Ladder \ Mode of Governance	Participation Ladder					Total
	Inform	Consult	Collaborate	Co-decision	Empowerment	
Governing by Authority	6.08%	9.46%	10.81%	2.03%	2.03%	30.41%
Governing by Enabling	1.35%	1.35%	16.22%	5.41%	8.11%	32.43%
Governing by Provision	2.70%	2.70%	12.84%	4.05%	2.03%	24.32%
Self Governance	0.68%	2.03%	6.08%	4.05%	0.0%	12.84%
Total	10.81%	15.54%	45.95%	15.54%	12.16%	100.00%

Sources: Created by the author

5.2.4 Public Participation

HP#1c: Public participation is crucial for designing and implementing effective policy instruments for nature-based solutions in urban areas. Successful public participation requires collaboration or empowerment approaches.

The analysis in (Table 8) reveals that collaboration was the dominant mode of participation ladder used in the instruments, accounting for 46% of the total. Despite co-decision and empowerment accounting for 15.54% and 12.16%, respectively, they are still relatively low. Inform and consult accounted for more than 25%, indicating that more work needs to be done to engage citizens. Empowerment is still an emerging mode and not yet mainstreamed. Interestingly, LRSI instruments had the highest inform mode (5.41%) and the highest collaborate mode (14.86%). In contrast, AbCI instruments had the highest empowerment mode, with 8.11%. It was also interesting to observe that none of the KCII instruments had a co-decision mode, and almost none had an empowerment mode. Therefore, collaboration is the dominant mode for good practice policy instruments.

Table 8 Results of a cross-sectional analysis of Instrument types and Public Participation Ladder.

Instrument Type \ Public Participation Ladder	Instrument Type				Total
	LRSI	AbCI	EFI	KCII	
Inform	5.41%	0%	3.38%	2.03%	10.81%
Consult	12.84%	0.68%	1.35%	0.68%	15.54%
Collaborate	14.86%	12.84%	10.14%	8.11%	45.95%
Co-decision	6.08%	7.43%	2.03%	0%	15.54%
Empowerment	1.35%	8.11%	2.03%	0.68%	12.16%

LRSI: legislative, regulatory, and strategic instruments; **AbCI:** Agreement-based or cooperative instruments; **EFI:** Economic and fiscal instruments; **KCII:** Knowledge, communication, and innovative instruments

Sources: Created by the author

Based on the analysis, it was found that non-governmental actors, including NGOs and community groups, are leading actors in designing NbS instruments, regardless of the initiating body being governmental or non-governmental (Figure 16) Moreover, the private sector and corporates are also actively involved in the design of NbS instruments, accounting for 29.2% of the instruments. Another interesting finding is the high visibility of researchers and universities in the design of the instruments. Particularly, in instruments that are governed by enabling, researchers have a fixed place, indicating their crucial role in enabling collaborations and partnerships.

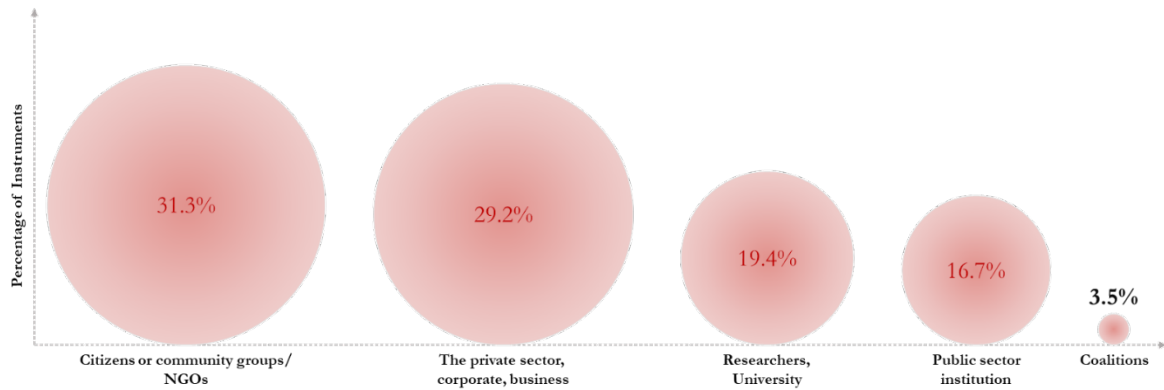


Figure 16 Actors involvement in the policy instrumentalization.

Source: Author-owned illustration.

The involvement of stakeholders in the design and implementation of NbS instruments took different approaches. Figure 17 illustrates the distribution of these approaches based on the design and implementation phases. Regarding the public involvement in the design, the majority of instruments (42.86%) had a co-planning and co-designing approach. Civil society consultation accounted for 36.73%, and an expert task force consultation for 20.41%. However, it is essential to note that the tagging of these approaches was based on the parameters set by the UGA team, and the actual public participation ladder (Consult) might have been misleading. Thus, some consultations were labeled as empowerment based on the practice followed during these sessions.

Regarding the public involvement in the implementation, six main approaches were identified. The majority of the instruments (43.20%) had a co-implementation approach, which involved co-financing and providing financial means or human resources. Citizen consultations for implementation co-planning accounted for 19.50% of the instruments. Co-designing NbS, citizen oversight, and citizen monitoring and review accounted for 11.80% and 10.10%, respectively. Citizen oversight and citizen monitoring and review shared the same percentage of instruments. In conclusion, this indicates that the role of the public was crucial in co-implementation and in co-designing and co-planning. It highlights the importance of involving stakeholders in the implementation and design of NbS instruments to increase the chances of success and sustainability.

This figure raises a critical question about the significant role of consultation in the cases depicted as good practice policy instruments. I addressed this issue during several expert validation interviews (Interviews C, D, and H, 2023), and it was not surprising to find that several studies they contributed to indicated that higher participation does not necessarily result in better environmental sustainability outcomes, but rather in social sustainability outcomes. However, Interview H (2023) emphasized that this could be an indication that consultation can be effective when implemented in the appropriate context. Additionally, she criticized the limitations of the framework, which I acknowledged and incorporated in *chapter 6* (section 6.2).

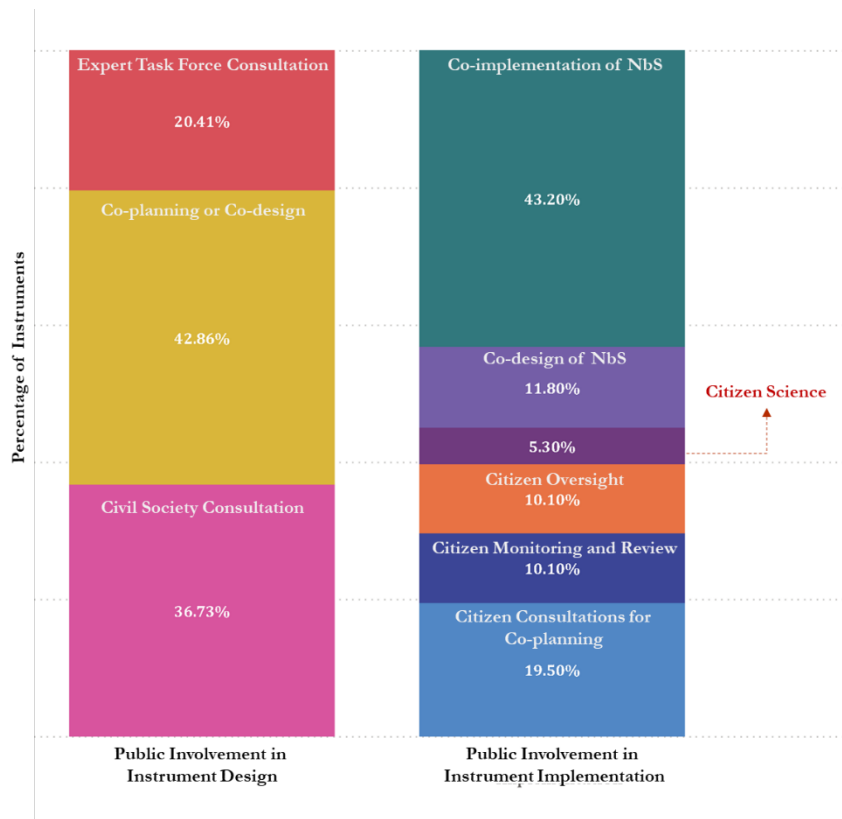


Figure 17 Type of Involvement in the instruments design and implementation.

Source: Author-owned illustration.

5.3 Lessons from Economic and Fiscal Instruments

RQ#2: What lessons can be drawn from the Economic and fiscal instruments based on the data analyzed in the Urban Governance Atlas?

5.3.1 A Glimpse of Sources and Funding

Out of 150 policy instruments analyzed, 29 were Economical and Fiscal Instruments (EFI), including disincentives such as taxes to change behavior, access fees, and market-based instruments to generate revenues, as well as payments for ecosystem services, subsidies, and incentives. The budget for 7 instruments was between € 1-5 million, while 7 instruments had a budget above €10 million, with only 1 instrument having a low budget of € 50-100K and 3 instruments with a medium budget of €500K-1 million. The majority of instruments (74%) involved multi-level collaborations (mainly *type II*), while 52% were governed by provision, 21% by authority, and 18% were governed by enabling, with 10% being self-governed. Disincentives were only governed by an authority, and self-governance was only utilized in financing mechanisms. Collaboration among actors was the dominant mode of participation, accounting for almost 55% of the cases, with "inform" at the higher end, accounting for almost 20% of the cases.

Only two EFI instruments were initiated by non-governmental bodies, and one of them is 'Plan Tree,' a large-scale funding initiative in the Netherlands (2019 - 2024) that aims to plant 10 million native trees to combat climate change and strengthen biodiversity (UGA, 2023b). It is a financial incentive instrument that supports different stakeholders, including residents,

volunteer groups, governments, and businesses, in planting trees. The funding sources are from a wide range of actors, including public national, regional, and local budgets, corporate investment, funds provided by NGOs, crowdsourcing, national postcode lottery, and individual donations. The National Postcode Lottery in the Netherlands contributes €2.25 million to the instrument. It is a cooperation between many different parties and utilizes available space on private land for planting trees. The success factors of the initiative include cooperation between many different parties, flexibility, and the utilization of available space on private land. An online toolbox with information sheets, step-by-step plans, and tips on organizing plant events is provided to individuals. The initiative adheres to best practices such as taking care of new plantings for the first three years, using native trees, and blending into the landscape and environment.

Seven cities and regions have implemented innovative financing mechanisms to fund NbS through instruments that exceed a total budget of € 10 million. In Belgium, the project called "Nature close-by" by the Agency for Nature and Forests (ANB) subsidizes green projects in urban areas, funding 72 projects between 2019 and 2021, and 24 more in 2022, resulting in a total increase of 90 hectares of nature in Flemish cities (UGA, 2023c). The Regional Water Authorities (RWAs) in the Netherlands implemented a tax system in 2009 to fund investments in water management, including NbS resulting in a total estimated revenue of about €2.7 billion in 2017. The city of Wrocław, Poland, has been running a participatory budgeting program since 2013, dedicating part of the municipal budget to fund green areas, with a total of 432 projects realized through the program (UGA, 2023d).

The City of Paris issued the Paris Climate Bond in 2015, raising €300 million to fund adaptation projects, including the creation of new green spaces and corridors, resulting in 20,000 trees planted and 30 hectares of new parks in Paris (UGA, 2023e). In Sweden, the City of Gothenburg issues green bonds to finance sustainability projects, raising €680,693,500 since 2013, with a minor role played by nature-based solutions, such as one project funded to plant trees in the city (UGA, 2023f). These financing mechanisms enable cities and regions to fund nature-based solutions that contribute to ecological sustainability, resilience, and robustness, making progress toward climate neutrality and meeting the European Energy and Climate Plan.

62% of the instrument's sources come from the public local authority's budget, as seen in Figure 18. More interestingly, disincentive instruments were only financed by the local budget. One interesting financing mechanism that was funded by corporate investments and bank investments that exceeded €10 million was the Climate bonds in Paris, the City of Paris committed to providing investors with an annual report on the projects funded by the proceeds of the transaction and has involved various knowledgeable stakeholders (such as independent advisors, sectoral experts in green and climate bonds and bankers) to ensure the sound implementation of the bond. Interestingly, when instruments are only coming from local authority budgets, they often have low-budget instruments, for example, the municipality of Rumia - Poland, implemented a tax system to minimize stormwater recharged to the municipal drainage system. The tax generated savings and income, but its main goal was to encourage citizens to invest in nature-based solutions on their properties (UGA, 2023g).

However, there were challenges due to various interpretations of Polish law, leading to lawsuits and appeals. If successfully defended in court, the policy may lead to new possibilities for other Polish municipalities to create similar policy instruments. Another example is the City of Chemnitz in Germany introduced a funding guideline to subsidize the installation of green facades in urban areas (UGA, 2023h). The guideline provides grants covering 50-75% of the total cost, up to €2,500-€5,000, depending on the location of the new green facade. Private individuals and businesses are eligible to apply for funding. Adopted in September 2021, only

one application was received by August 2022, which was approved and implemented successfully. This guideline aligns with the Masterplan on Urban Nature and serves as an example for future urban greening initiatives in Chemnitz.

In Figure 18, it is evident that public budgets, particularly at the local level, remain the dominant funding source for instruments, with limited contributions from corporate and bank investments. Regional and national budgets also play a visible role in supporting local implementation. EU funding, while limited in terms of the number of instruments, is primarily associated with high-cost instruments above € 1-5 million and above € 10 million. It is notable that local budgets are flowing to all types of fiscal instruments, indicating that cities are seeking to diversify and experiment with their policies using their own resources. Moreover, the content analysis of the instruments revealed six key lessons learned from successful policy instruments, which are summarized below.

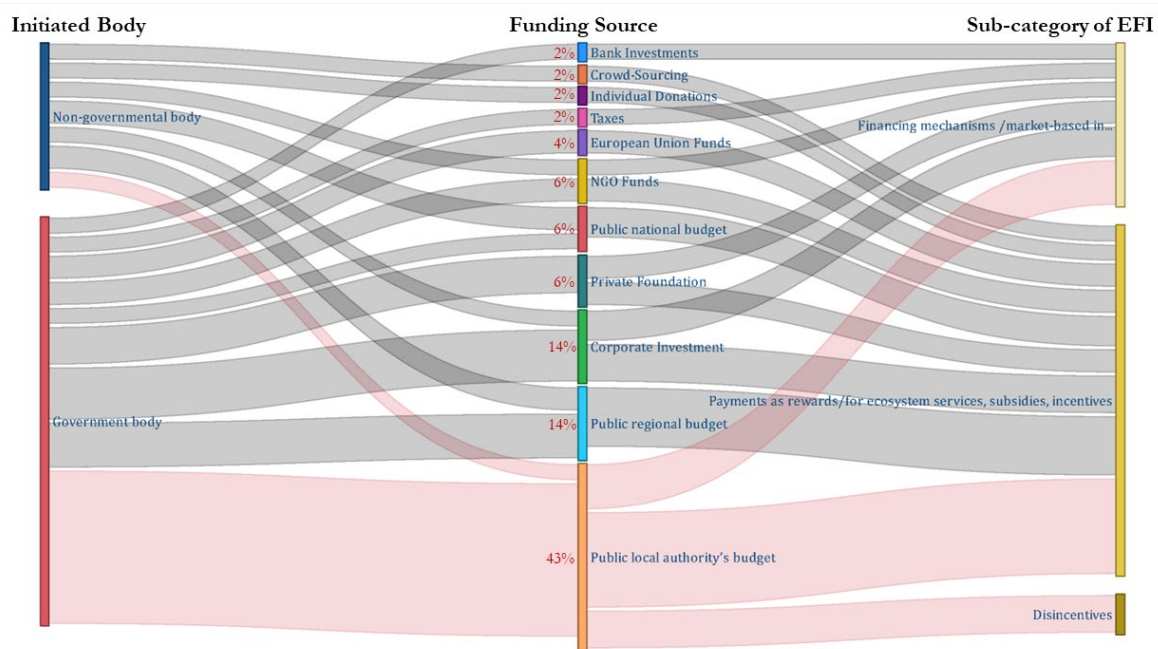


Figure 18 Sankey diagram showing the flow of financing Sources to each EFI sub-instrument.

Source: Author-owned illustration.

5.3.2 Six Key Lessons to Learn

5.3.2.1 Establishing Political Leadership and Visions

Leadership and political vision play a crucial role in the success of economic instruments. The availability of political will and support was evident in the case of the Green Bonds in Paris - France, where the strong political will to pursue ambitious climate policies fostered a burgeoning green bond market. In Nantes, France, the political support since the 1980s was instrumental to the establishment and sustainability of the dedicated municipal budget for green spaces (UGA, 2023i). The same is true for the Rainwater and Snowmelt micro-retention program in Krakow, Poland, where the program is in line with the city's strategy until 2030 (UGA, 2023j).

The Bratislava subsidy scheme to support rainwater management installations is a remarkable example of how low-cost economic instruments can effectively manage water and can be easily

replicated (UGA, 2023k). The political will of the city advised adjusting the subsidy amount to the average cost of the measure to increase the number of projects under the policy. This demonstrates that political leadership can guide the design and implementation of economic instruments to achieve desired outcomes.

Furthermore, providing long-term financing is essential for the success of economic instruments. The dedicated municipal budget for green spaces in Nantes has been renewed every few years, which has implications for the long-term sustainability of the greening strategy. The Rainwater and Snowmelt micro-retention program in Krakow has a long functioning period, making its results very measurable. In contrast, the limited political follow-up action during the Hamburg Stormwater fee instrument highlights the importance of active support and collaboration with policymakers during the project's duration (UGA, 2023l). These lessons emphasize the need for long-term financing and sufficient financing over decades, as well as active collaboration with policymakers for the success of economic instruments.

5.3.2.2 Facilitating Co-governance and Co-creation

The paragraph discusses the governance of environmental programs and initiatives across several European cities. The dominant mode of governance in these cases is through provisions, and there is a high level of collaboration between actors, resulting in a decentralized approach. Co-creation, co-implementation, and co-governance are visible trends among the instruments discussed. The Natural Choices for Health and Wellbeing Programme in Liverpool (UGA, 2023m) and the Plan Tree initiative in the Netherlands are examples of successful co-implementation through partnerships with governmental and non-governmental actors, engaging residents, and utilizing available private land. The Grow Back Greener Fund in London and the green facades project in Sint-Niklaas, Belgium, are examples of successful co-financing and co-governance, respectively (UGA, 2023n). The paragraph highlights the importance of relationship building before project implementation to improve similar programs in the future.

Overall, the examples suggest that collaboration, engagement of residents, and diversified funding and implementation strategies are critical factors for the success of fiscal instruments. Some successful examples of co-decision and co-implementation instruments include the Participatory Budget in Wroclaw, Poland, which allows citizens to allocate part of the public budget to green spaces, resulting in over 432 projects being realized. Another example is Paris's "Parisculteurs" program, which promotes urban agriculture through public tenders and has facilitated over 50 projects (UGA, 2023o). Collaboration between departments and sectoral entities has been key to the success of these instruments. Examples include the Stormwater fee and green roof subsidy program in Hamburg.

5.3.2.3 Working with Mandatory Requirements and Sustainable Maintenance

A key aspect of the EFI are the technical requirements of the NbS promoted in various instruments. For instance, the Grow Back Greener Fund in London mandates that grant applicants must indicate how their projects will be maintained and how community engagement will be sustained after the end of the project (UGA, 2023n). Similarly, the Nature Close-by program in Flanders obligates applicants to specify a clear societal need that their project will address, which also forms an important element of the evaluation criteria (UGA, 2023c). The call also requires the implementation of a project to last at least 10 years, contributing to a long-term initiative. Plan Tree (Plan Boom) in the Netherlands follows best practices when planting new trees, including caring for new plantings for the first three years, ensuring that trees can

stand for long periods, and planting only native trees that blend well into the landscape and environment (UGA, 2023b).

Another common practice in NbS implementation is mandatory co-financing, focusing on maintaining new or existing projects. The dedicated municipal budget for green spaces in Nantes is an excellent example of this, as it has a dedicated budget for maintenance activities, which is often overlooked in many other budgeting schemes that prioritize implementation over maintenance (UGA, 2023i). In Szczecin's Green Courtyards program, a co-financing requirement has leveraged private funds to create new green areas in the city (UGA, 2023p). The fact that residents are involved in the various stages of the project contributes to the long-term sustainability of the implemented NbS, as residents are more invested in maintaining the landscaping and greenery. Similarly, in the Green Front Yards program, homeowners' associations can apply for grants to plant new vegetation and install urban furniture, with the municipality financing up to 75% of the costs (UGA, 2023p). Since 2008, the programs have created over 144 renovated courtyards and 66 front yards, receiving recognition from the President of Poland and being replicated in other cities.

Another trend in EFI implementation is the involvement of specialized sectors in co-implementation. For example, in Szczecin's Green Courtyards program, the projects are commissioned by homeowners' associations, ensuring that the NbS are tailored to the needs of the residents in the buildings in question. In Greening Hannover in Hannover, Germany, contacting homeowners through their organization "Haus und Grundeigentum Hannover." with its member magazine "WohnArt" and directly approaching large housing associations has proven to be effective in terms of building greening and unsealing (UGA, 2023q). Additionally, digital platforms and standard application forms such as those used in the Subsidy for the Sustainable Use of Rainwater program in Eindhoven have streamlined the application process and reduced the time burden for both applicants and municipalities, making the implementation of NbS more accessible and efficient (UGA, 2023r).

5.3.2.4 Harnessing Evidence and Community Support

The cases highlighted the importance of the science-policy interface in EFI instruments, which involves using digital and computational systems like GIS or digitizing the process while building technical capacities before launching the instrument. Additionally, gaining the community's acceptance of the instrument's long-term benefits and cost-effectiveness is crucial.

For instance, the Subsidy for Sustainable Use of Rainwater in Eindhoven provides tips on creating the right vapor and infiltration system for water storage (UGA, 2023r). The case of Sint-Niklaas emphasizes the importance of having a clear plan before launching the instrument. The Green Roof Subsidy in Rotterdam stresses the need for an interactive online tool to encourage building owners to retrofit their roofs. This tool provides information on load-bearing capacity, costs, potential subsidies, and different options for greening and solar panel installation (UGA, 2023s).

Moreover, the Public Tenders for Urban Agriculture Projects in Paris "Parisculteurs" implemented an innovative approach to encourage feasibility and ensure realistic and appropriate project selection (UGA, 2023o). Finally, both the Green Exercise Partnership in Scotland (UGA, 2023t) and the Green Roof Subsidy Program in Hamburg (UGA, 2023u) emphasize the importance of hiring experts from the environment and health sectors and using GIS-based research to identify suitable locations.

5.3.2.5 Monitoring and Evaluation

Monitoring and evaluation mechanisms play a critical role in EFI instruments' success, although only 60% have such mechanisms in place. These mechanisms differ in innovation, with some relying on external auditors while others engage with citizens and universities. The 'Plan Tree' instrument counts the number of trees planted and evaluates progress annually through a mid-term report (UGA, 2023b). In the Participatory budget in Warsaw, a dedicated website lists successful projects and their stages of completion, and citizens have consulted annually with resulting reports listing their ideas and comments (UGA, 2023d). The Green Bonds in Paris (UGA, 2023e) committed to providing investors with an annual report, while the Green Roof subsidy program in Hamburg is monitored and evaluated by specialized scientific monitoring (rainwater run-off and micro-climate by HafenCity University and biodiversity by the University Hamburg and Zurich University of Applied Sciences Wädenswil) and review of legislation (UGA, 2023u). The City of Gothenburg's green bond framework provides annual reporting on the allocation of proceeds and environmental impact, regularly evaluated by an external evaluator (UGA, 2023f).

Learning and knowledge-sharing are key aspects of the success of each instrument. For example, the Green Roof strategy in Basel collaborated with the Zurich University of Applied Sciences, which shared its expertise and contributed to the project's success (UGA, 2023v). Technical lessons learned from implementing the project, such as maximizing the benefits of green roofs through the right growing medium and ecological requirements, were shared with the academic community. Similarly, the Green Roof Subsidy in Rotterdam identified successful green roof projects that were communicated to other cities to share their benefits (UGA, 2023s). In the case of Green Bonds in Paris, various knowledgeable stakeholders were involved to ensure the sound implementation of the initiative and exchange with other cities (UGA, 2023e). In Wrocław's Participatory Budget, a "School of Leaders" was established, offering publicly available online workshops to help citizens propose and realize successful projects (UGA, 2023d). Lastly, Plan Tree in the Netherlands provides an online toolbox with step-by-step plans and tips on how to start planting trees, organize a plant event, or motivate the neighborhood, making knowledge and learning accessible to all (UGA, 2023b).

5.3.2.6 Branding and Outreach

The instruments emphasized the importance of branding and outreach to promote the instrument within the city and regionally, as well as engaging citizens. Successful branding strategies were used in the Green Bonds Paris, where Vigeo's rating helped attract investors, and in the Green Roof Subsidy in Rotterdam, where the annual The Rooftop Days festival raised awareness of green roofs (UGA, 2023s). The use of Forest Stewardship Council certification for ecosystem services in BIOCLIMA-Lombardy enabled private financiers to communicate the impact of their projects. However, the lack of branding in Funding Guidelines on Greening Facades-Chemnitz resulted in limited applications despite the availability of funds, highlighting the need to better inform citizens about the benefits of green facades (UGA, 2023h).

6 Discussion

This chapter presents the results of MLG and governance modes. The Governing section emphasizes the role of intermediaries, EU cohesion policy, and horizontal collaboration in addition to the role of reflexive and experimentation governing modes. In the Participating section, each framework element is reflected upon using relevant literature and interview insights. The Financing section discusses pathways for innovative financing and upscaling, along with catalysts. Lastly, transparent research limitations and self-reflections are provided.

6.1 Governing

6.1.1 Multi-level Governance

6.1.1.1 Horizontal Collaboration

This study contributes to the ongoing discussion on the increasing irreversibility of the multi-level system of global climate governance, which is attributed to the institutionalization of climate policies, dynamics of change and the emergence of new interests supporting climate action. I also address gaps in research by analyzing the trajectories of urban nature-based solutions policy formation and their drivers of good practice within the context of MLCG. The findings support the literature claims that success in local climate policy requires not only leading cities to take action but also follower cities to emulate their efforts and for binding standards to be imposed on laggards.

This research identified rigorous policy instrumentalization from 20 European countries through the UGA. This research highlights the necessity of adopting collaborative governance as a critical NbS enabler to overcome barriers to NbS adoption and implementation and enable shared risk-taking. Horizontal collaborations, which were the main mode of almost 60% of the good practice instruments, proved vital in overcoming traditional city department structures and their siloed decision-making processes. This is crucial for establishing interactions with strong stakeholders such as other public bodies, housing associations, investors, and developers.

6.1.1.2 Cohesion Policy

The European Commission has been committed to promoting NbS within its Member States, with cities pioneering NbS implementation to drive green innovation, create green jobs, and enhance urban resilience. The EU has made progress in mainstreaming NbS in its policies. Davis et al. (2018) found that 68% of policies¹² established between 2012 and 2018 failed to distinguish between urban and rural areas, but Castellari et al. (2021) showed that urban NbS is now a priority in EU policy frameworks. Local and regional policies are at the core of the new green deal transformation. While progress has been made, there is still work to be done in distinguishing between urban and rural areas and empowering local policy instruments. Nonetheless, the EU has updated and established new policy instruments to establish Europe as a global leader in NbS research, innovation, and the international market.

The EU Green Deal strongly emphasizes empowering citizens, communities, and regions to contribute to the transition, recognizing the vital role that NbS play in addressing both the biodiversity and climate crisis. On the other hand, the EU has established robust biodiversity frameworks, such as the EU Biodiversity Strategy, to support and incentivize NbS in European

¹² EU Biodiversity Strategy (2013), Green Infrastructure Strategy (2013), a Forestry Strategy (2013), Adaptation Strategy (2013), and Urban Agenda (2016).

cities. Transformative change in urban greening plans requires the promotion of NbS through local policy instruments, which is a crucial part of the EU Biodiversity Strategy for 2030 and the larger framework of the European Green Deal. The plan seeks to bring nature back to urban areas and reward community action, highlighting the importance of cross-departmental cooperation and integration of the greening plan with other aspects of urban development.

The EU's rigorous and cohesive policy framework (see Figure 19), combined with the study analysis, shows a strong positive correlation between time and urban NbS policy instrument adoption; the study suggests that there will be an increase in policy instrument implementation in the future, as indicated by the grey zone in the graph. The EU's Restoration Law aims to increase green urban spaces by 3% and tree canopy cover by 10% by 2040 and 2050, respectively. Additionally, the Commission has urged European cities with over 20,000 residents to develop Urban Greening Plans, emphasizing citizen and stakeholder collaboration. The European Commission has adopted a mission approach to address significant global challenges, including achieving 100 climate-neutral cities¹³ in Europe by 2030 and an EU Mission on climate adaptation¹⁴. To support these missions, the Commission has introduced City Climate Contracts (CCCs) as non-legally binding political commitments involving citizens, research organizations, and the private sector to deliver an overall plan for climate neutrality and related investment plans. The use of the term "contract" signifies a commitment to citizens, the European Commission, and national and regional authorities (Shabb and McCormick, 2023).

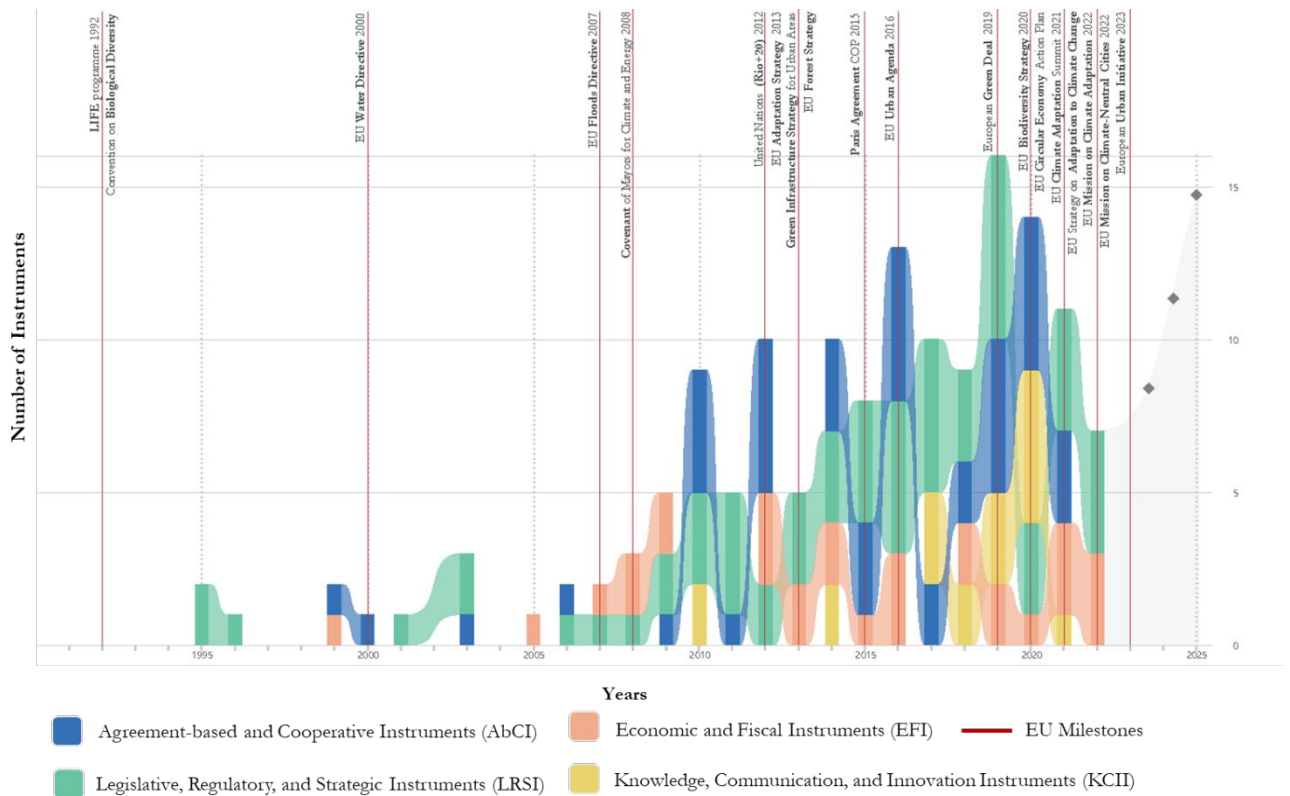


Figure 19 Correlation between Urban NbS policy instruments adoption and EU milestones.

Source: Author-owned illustration.

¹³ https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2591

¹⁴ https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3527

The CCCs can represent a new form of policy innovation that challenges conventional policy categorization. Despite criticisms of the UGA by Interview H (2023) that it follows traditional policy views, the emergence of Agreement-based and Cooperative Instruments (AbCI) in the past seven years is notable and warrants further investigation. This trend could be attributed to both the adoption of more European MLG policies and the increased engagement of citizen science approaches that is evident in the analysis. Additionally, the proliferation of open channels and advancements in communication tools, as well as dedicated funding initiatives like Horizon 2020, may have played significant roles in driving the development of KCII. These observations raise important questions about the drivers and outcomes of environmental governance initiatives and the complex factors that influence them. Continued exploration and analysis of these trends and factors are necessary for a deeper understanding of NbS policy development.

In some interviews, it was highlighted that activating the power of the EU governance in pushing the promotion of the NbS agenda is still yet fully activated. This is due to the European Union (EU) being a complex entity with diverse member states, each with its own interests and priorities. Despite this challenge, the EU has worked towards a more cohesive policy framework through its Cohesion Policy¹⁵ 2021- 2027 regional policy. An interesting finding of this study is that 85% of the instruments were connected to other policy frameworks, whether at national or regional levels. Most commonly, the instruments were part of regional master plans, spatial development plans, national labeling schemes, flood prevention, biodiversity action plans, disaster risk reduction, and mobility plans. Thus, the cohesion of the policy instruments is a vital aspect of maximizing the outcomes, proving that an integrated approach was given in designing the instruments. This can highlight overcoming two main barriers in the NbS adoption, in socio-institutional dynamics, by having inadequate regulations that hinder each other and siloed decision-making due to the integrated approach of the instruments.

Several interviewees highlighted that the EU has yet to fully activate its power to promote the NbS agenda. This is unsurprising given the EU's complexity, with diverse member states, each having its own interests and priorities. However, the EU has taken steps towards a more cohesive policy framework through its Cohesion Policy 2021-2027 regional policy. Interestingly, this study found that 85% of the NbS instruments in the study area were connected to other policy frameworks at the national or regional level. These policy frameworks included regional master plans, spatial development plans, national labeling schemes, flood prevention plans, biodiversity action plans, disaster risk reduction plans, and mobility plans.

The cohesion of policy instruments is vital for maximizing outcomes and indicates that an integrated approach was given in designing these instruments. This is an important finding highlighting how an integrated approach can overcome two key barriers in NbS adoption: socio-institutional dynamics and siloed decision-making. Inadequate regulations and siloed decision-making hinder each other, but a more cohesive and integrated approach can promote better cooperation and coordination among stakeholders involved in NbS implementation. By connecting NbS instruments with other policy frameworks, the study indicated how integrated planning could be a powerful tool to overcome NbS barriers and promote more effective NbS implementation.

¹⁵https://ec.europa.eu/regional_policy/2021-2027_en#:~:text=EU%20Cohesion%20Policy%20contributes%20to,the%20green%20and%20digital%20transition.

6.1.1.3 Role of Intermediaries

Urban climate governance experiments are facilitated by multilevel governance, and municipal networks play a crucial role in shaping the capacity of urban governance. The International Council for Local Environmental Initiatives (ICLEI) and the United Cities and Global Government (UCLG), and EuroCities interviewed in this study are among the national and international city networks established to promote low-carbon development and facilitate sustainable development by creating opportunities for cities to collaborate and share best practices (Jänicke, 2017). Climate governance requires unique approaches for low- and high-income cities to respond effectively to climate change, with effective and political leadership, knowledge, skill, motivation, and the ability to work within networks being critical factors to consider.

"I believe the success of Europe's NbS vision depends on the success of its cities. As local authorities are responsible for implementing more than 70% of EU rules, our role is crucial in strengthening the capacities of cities to respond, act, and implement" (Interview E, 2023)

In interviews B, D, F and G (2023), the city-to-city knowledge exchange approach was considered a key enabler in the successful promotion of adopting of NbS policy instruments and long-term NbS initiatives. This approach involves knowledge sharing, technical assistance, peer pressure, network building, and identifying funding opportunities. Through knowledge sharing, cities can learn from each other's experiences in adopting NbS policy instruments and initiatives. Cities can provide technical assistance to each other in implementing NbS policy instruments and initiatives. Peer pressure is created by seeing other cities successfully implement NbS initiatives, which can motivate other cities to adopt NbS policy instruments and initiatives. City-to-city learning can help build networks of cities that are working together to promote the adoption of NbS policy instruments and initiatives. Finally, city-to-city learning can also help cities identify funding opportunities for NbS initiatives by learning from other cities' successful funding models and strategies for securing financing for NbS projects. By embracing a complementary approach that embraces new ideas and harnessing the dynamic potential of the global climate-related multi-level governance system, efforts can be strengthened at multiple levels.

In this study, several key points emerged regarding the support provided to cities in their climate action planning for mitigation and adaptation from intermediaries in Interview B, G and H (2023). One crucial aspect discussed was the inclusion of NbS in these planning documents. It was highlighted that raising awareness among decision-makers about the importance of NbS is a primary task. Additionally, capacity-building and project preparation support were identified as essential elements in assisting cities. To facilitate the process, cities were encouraged to submit their concept projects, which were then screened to assess their transformative potential. A key role in this process was the matching of opportunities and projects, aiming to identify suitable funding sources. Support was provided to cities in preparing their projects to ensure they were at a stage where accessing finance became feasible. It was emphasized that the bankability of projects was a crucial factor, not only for NbS but for any project seeking investment. To achieve this, incremental steps were taken to demonstrate the feasibility and bankability of the projects. It was recognized that investors require access to reliable data and information to engage in the funding process. Therefore, assistance in finding technical support was provided to ensure that the necessary data and analysis were available.

6.1.2 Modes of Governance

In climate governance, leading cities have emerged as crucial players, but local climate action has no universal solution; rather, lessons drawn from leading frontiers can help inspire prospective cities to advance their actions (Kern, 2019). Although Europe's progress diverges from other regions globally, analyzing Europe's current advancements can provide useful insights for comprehending future global progress. In alignment with the literature and our study, urban experimentation has become a core component of the urban climate politics landscape, with NbS and experimentation as a new climate change governance approach (Kabich et al., 2016). Moreover, governance is no longer exclusively occurring in political arenas but is taking place through experimentation. In the early literature, I observed that the mode of self-governing of frontier cities like Copenhagen - Denmark, and London - UK were the dominant modes in advancing local climate action. However, the results from the research show that the dominant modes of policy instruments promoting nature-based solutions are now governed by enabling and provision, and we observe that the least mode is now self-governance.

6.1.2.1 Enabling by Experimentation

The analysis shows that there has been a clear shift towards governing by provision and enabling modes of governance, which has additional layers of findings on governance modes. Although not discussed in the analysis section, I observed that *governing by enabling* involves creating frameworks that allow citizens and stakeholders to take an active role in shaping policy and decision-making through *experimentation*, investments in *urban living labs*, and *testing solutions*. This approach has been used in various experimental instruments, including four noteworthy cases.

In the first case, the Aarhus City Council held a competition in 2009 to transform Bishorvet Square into a multi-use square with green areas and trees. It involved close cooperation with local communities, ensuring ownership and acceptance (UGA, 2023w). In the second case, River Contracts launched a platform in Flanders in 2017 to engage local stakeholders in addressing water-related issues. They used a participatory approach to gain support and encourage action (UGA, 2023x). The Aquifer Partnership (TAP) was established in England in 2015 to protect groundwater and build resilience to climate change. TAP works with residents, farmers, landowners, and schools to reduce pollution and improve water management (UGA, 2023y). The Green City of the Future is a 5-year research project in Munich, Germany. It focuses on developing integrated solutions for climate change and urban planning. The project involves an interdisciplinary research team investigating how green infrastructure can be maintained and developed for climate adaptation, and it uses real laboratories to develop integrated recommendations for planning practice (UGA, 2023z).

These four cases demonstrate the value of involving local communities and stakeholders in decision-making processes, fostering ownership and acceptance, strengthening support, and building capability and skills. *Governing by enabling* can be a successful approach to creating sustainable and effective NbS policy instruments and initiatives. Furthermore, the analysis results show indications of the literature suggestion by Neij and Heiskanen (2019) that cities can learn to become better at facilitating multi-partner experimentation with time and experience.

Likewise, in the literature and the analysis, it is observed that municipal governments are taking the lead in promoting experimentation, and a new solid financing role for private actors is emerging but not yet mainstream. Additionally, universities and academia play a key role in co-creating and pushing for experimentation. This trend has been attributed by literature to the fragmentation of power and the nature of European cities, as well as the governance structure of the EU. Moreover, the increased urban risks resulting from climate change have accelerated momentum toward experimentation governance beyond land use planning.

According to Bulkeley et al. (2020), experimentation governance has become a dominant governing mode for cities toward sustainability, which is compatible with our findings. Interview C and H (2023) explained that different tax systems of the cities, in which local governments own their local tax collected, have resulted in greater resources and financing for these governments. The provision of EU horizon funds and other direct and indirect funds for cities and their intermediaries, as well as the provision of legal frameworks where this kind of financing is locally appropriate, have mutually increased innovative modes of governance (Interview H, 2023). Still, there are barriers facing NbS governance, as captured in the results of the CLEVER Cities project by Notably, the need to capture multiple benefits, ensure the inclusion of diverse beneficiaries during the design and implementation process, address issues related to maintenance, and increase and maintain political and financial attention.

6.1.2.2 Towards Reflexive Governance Modes

The NATURVATION project in Bulkeley (2019) analyzed fifty-six NbS initiatives and found that there is no one-size-fits-all approach to developing governance for NbS. Instead, local actors must adopt locally fit approaches that prioritize enabling and facilitating governance, as proven to be effective. The analysis identified a variety of 12 proven modes of governance (Annex D), indicating that diversifying forms of governing capacity can be harnessed through multiple agents of change. This approach breaks through the barriers of having no regulatory capacity to govern NbS initiatives by shifting focus on empowering city stakeholders to make decisions (Bulkeley et al., 2020).

In the literature, I captured that successful implementation and management of NbS in urban areas require policy instruments that follow innovative urban governance processes, including multi-level collaborative and reflexive approaches (Kabisch et al., 2016). These approaches should be communicated through policies and to society. Based on the analysis, monitoring, evaluation, and learning are identified as key aspects in the design and implementation of policy instruments, particularly in the context of economic and fiscal instruments. However, the literature also recognizes that monitoring and evaluation should be an integral part of the policy development cycle. This highlights the need for a certain level of reflexivity in governance.

Reflexive governance, as defined by Voß and Kemp (2015), is a mode of governance that requires flexible adaptation through the ongoing pursuit and integration of knowledge about its effects and effectiveness. It is likely to change over time, given the dynamics of socioecological and sociotechnical systems that influence the targets for transformative change. Reflexive governance typically involves bringing together different types of knowledge and perspectives on problems and championing continuous learning to engage with uncertainties and unintended consequences. Kabisch et al. (2016) stress the importance of reflexive arrangements between actors with different epistemic backgrounds to engage in joint knowledge development, planning, and governing of NbSs. Therefore, it is crucial to incorporate reflexivity into governance modes to enable flexible adaptation and continuous learning throughout the policy development cycle.

Furthermore, building institutional capacity is a key enabling aspect of governance capacity, emphasizing how the institutional framework, laws, and regulations facilitate actors in working together to solve mutual problems (Koop et al., 2017). Understanding these modes of governance can help anticipate the results of policy instruments in the pipeline with municipal authorities and comprehend their impact on multilevel climate governance outcomes under the existing system. This knowledge can inspire future cities to learn from previous experiences while also recognizing that every city has its own context, which is one of the biggest outcomes of the UGA's common success criteria.

6.2 Participating

6.2.1 Actors Involvement

The degree of public involvement in the planning, design, implementation, and maintenance of commons is known as citizen participation (Luyet et al., 2012; Wilker et al., 2016; Kiss et al., 2022). While the literature recognizes the increasing demand for stakeholder participation, it also acknowledges that the interests and ideologies of the involved groups in these processes are not significantly impacted (Maier et al., 2014). In fact, participation can give rise to new problems and exacerbate existing ones (Luyet et al., 2012; Maier et al., 2014), and power imbalances between stakeholders can make the process susceptible to manipulation and unfairness (Southern et al., 2011; Luyet et al., 2012; Maier et al., 2014). Warmler (2017) adds that without institutional infrastructure and long-term planning, participatory processes can have negative impacts due to financial and resource constraints and other institutional risks, which will be further discussed in this section.

The findings of this study indicate that the majority of the cases examined involved at least three institutional entities, with NGOs and researchers taking the lead in co-designing policy instruments. These results are consistent with previous research by Kiss et al. (2019), Kiss et al. (2021), and Warmler (2017), which emphasize the crucial role of universities and researchers in enabling and experimenting with governance approaches. Although Kiss et al. (2022) found a negative correlation between high participation modes and sustainability outcomes, Warmler (2017) and Kiss et al. (2022) suggest that citizen participation can still have positive social sustainability outcomes, including knowledge mobilization, social learning, enhanced sense of belonging, and greater motivation for environmental stewardship.

Engaging all relevant stakeholders in the process of policy instrument design is crucial to maximize the benefits, increase awareness, and promote acceptance among actors (DeLosRíos-White et al., 2020; Calvert et al., 2018). The necessary changes to mitigate and adapt to climate change can only be achieved through collective efforts and the involvement of various actors. Our research findings highlight the critical role of collective actor buy-in, as evidenced by the high level of collaboration observed in almost 75% of the instruments analyzed. These results emphasize the importance of fostering cooperation and partnerships among stakeholders to drive effective climate action.

6.2.2 Inform and Consult

In recent literature, there has been much discussion about the "participation myth" or "pseudo participation," which describes a common issue where public authorities offer limited opportunities for stakeholder input in policy formulation merely to fulfill their obligations without actually considering their suggestions (Maier et al., 2014; Scott, 2011). Kiss et al. (2022) argue that this type of engagement, where stakeholders are merely informed or consulted, is considered tokenistic because it only gives the illusion of being heard without any guarantee that their input will influence the decision-making process. These tick-the-box strategies are frequently used to gain public approval for pre-existing plans or to create a platform for stakeholders to voice their concerns without truly taking them into account.

This study's analysis revealed that nearly 25% of the instruments were designed and implemented using one-way communication, mainly through the inform and consult mode. This finding surprised interviewees A and B, as these instruments were considered good practice. However, this result may support the negative correlation found by Kiss et al. (2022) between public participation and sustainability outcomes, particularly about their 58 NbS cases. This also

raises questions for further research on whether consultation levels of engagement can be effective when done respectfully and with proper infrastructure.

The study by Wamsler et al. (2021) reveals that current structures for mainstreaming nature and climate considerations into sectoral planning neglect citizen involvement, resulting in limited sustainable outcomes. Additionally, Kiss et al. (2022) indicate that participation is time-consuming and requires specific competencies that may create exclusion. Similarly, limited access to information and co-creation skills can restrict participation to only those residents who possess particular social abilities and skills. Interviews F, H, and E (2023) suggests that cities should depart from business-as-usual solutions focusing on creating necessary infrastructure through binding and voluntary legislation that can adapt to NbS's social and financial innovation and governance modes.

6.2.3 Collaboration

Under the NATURVATION project, Almassy et al. (2017) analyzed over 970 NbS initiatives in a hundred European cities. They found that public and non-governmental actors jointly led 44% of the NbS initiatives, while public actors and 26% led 30% by non-governmental actors (Almassy et al., 2017). This joint category of NbS initiatives involved the private sector, non-government organizations, and community groups as the most frequent non-state actors. A trend towards co-governance approaches, which take various forms, has been observed in the analysis of this dataset. This trend is evident, with collaboration mode occupying 46% of the instruments. This finding supports Kiss et al.'s (2022) analysis of 58 NbS cases, which identified collaboration as the most common type of citizen participation in NbS.

Collaborative governance has been called for as a critical enabler in supporting sustainability transitions in the past two decades (DeLosRíos-White et al., 2020; Fors et al., 2020; Frantzeskaki, 2019; Klein et al., 2018; Pauleit et al., 2019;). Almassy et al. (2017) suggest that forms of co-governance have become more prevalent in recent years, with an increasing significance of collaboration between public and non-governmental actors in implementing NbS initiatives. This shift highlights the importance of co-governance approaches in promoting sustainability outcomes.

The overarching Figure 20 show the results of the thesis hypotheses that clearly demonstrate the dominant role of collaboration as an intersection of the three framework perspectives. In *both*, *Type II* and *Type I* cases, collaboration is necessary across various levels of actors and sectors, accounting for nearly 75% of the cases. Regardless of the mode of governance, all cases exhibited a form of collaboration with the local government. It is worth noting that all the cases included in the UGA met the filter criteria of being endorsed by the local government.

In terms of *enabling*, as previously discussed, collaboration emerged as the predominant mode, indicating that the local government played a facilitating or provisional role. Furthermore, when examining the stages outlined in Figure 17 collaboration remained the dominant mode both in the design and implementation phases. This underscores the significant power and importance of collaboration, not only as an enabler as suggested in the literature (see Table 2), but also as a starting point for driving societal change.

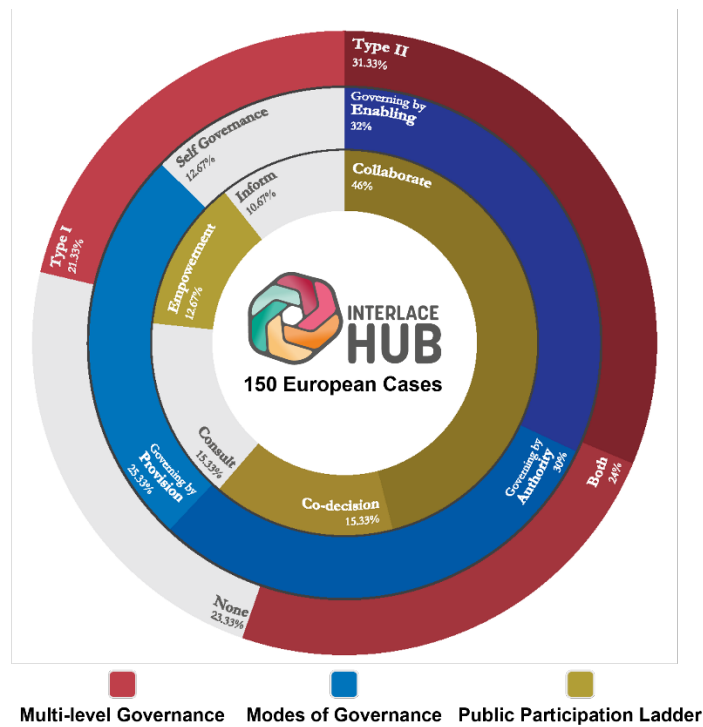


Figure 20 Overarching results showing the dominate of collaboration in the UGA European cases.

Source: Author-owned illustration.

6.2.4 Co-decision and Empowerment

In our study, co-decision-making (15%) and empowerment (13%) emerged as a trend and common modes of engagement in a wide range of European countries, including Poland, Spain, the Netherlands, the UK, Belgium, Germany, and Denmark. Scholars such as Wamsler et al. (2020) argue that more substantive forms of participation, such as co-decision-making and empowerment, that signify democratic processes are needed to ensure that NbS initiatives generate co-benefits across social groups. The adoption of citizen engagement and the emergence of new and transformative narratives in NbS governance is critical for cities, particularly through co-decision-making and empowerment, as emphasized by Wilker et al. (2016) and Kiss et al. (2021). Creating diverse arenas and urban platforms for dialogue and discussions is essential for these participatory approaches.

Several scholars have identified limitations in current nature-based solution (NBS) approaches, particularly in integrating urban biodiversity governance more comprehensively (Xie and Bulkeley, 2020). Wilker et al. (2016) highlight the importance of recognizing the valuable resource of local stakeholders' knowledge in planning green infrastructure holistically as a nature-based solution. Integrating modes of participation into flexible governance processes that encourage discussions on power dynamics, policy tools, and institutional frameworks is also crucial (Kiss et al., 2022).

Kiss et al. (2022) argue that deeper levels of citizen participation in NbS do not necessarily enhance ecological sustainability outcomes but can strengthen and diversify both expected and unexpected social sustainability outcomes. Reflexive governance, which engages actors with diverse and divergent views, is proposed as a means of giving citizens real control through "co-decision" and "empowerment." If applied authentically, reflexive governance could lead to

deeper forms of engagement and a more just and sustainable urban development (van der Jagt et al., 2021).

Moreover, it has been suggested that existing theories, policies, and guidelines must be revisited to support the need for change across current participation approaches (Wamsler, 2017; Interview H, 2023). She also highlights the necessity for critical investigations of the role and limitations of stakeholder involvement and transdisciplinary in facilitating change, as well as the comparative importance of these factors to other aspects like ownership. The focus of change should not be limited to the ability to learn in the context of the adaptive capacity process but should instead prioritize improvements to stakeholders' effective ability to adapt and influence issues such as the legal and political systems, decision-making, and operational processes (Wamsler, 2017). Interview H (2023) highlighted the need for more innovative frameworks and definitions in policy development and participation to achieve better results. According to her, the participation ladder framework, which was developed in the 1950s, is still being used today despite the significant changes that have occurred since then. Therefore, there is a need to develop new frameworks that can capture more results and drive innovation toward achieving sustainable and just outcomes.

6.3 Financing

As captured in the literature, financing is a critical aspect of implementing urban NbS. While the benefits of NbS are well recognized, funding for their implementation remains a significant challenge to ensure long-term sustainability. Moreover, the literature examines the finance domain separately from other structural fields of urban development and regulatory functions, creating a siloed understanding of finance (Dorst et al., 2022). In cities, densification strategies exacerbate the challenges of financing NbS, as noted by Toxopeus et al. (2021), Mayor et al. (2021), and Hagedoorn et al. (2021). These challenges can be linked to management change, partnership working, monitoring and evaluation, and government policy. This study confirms that public funding, such as government grants, tax incentives, and subsidies, remains the primary source of financing for NbS instruments.

Figure 21 illustrates the flow of funding sources for each instrument category. The data shows that the European Union Funds have taken on a more significant role in funding NbS projects than the EFI diagram (*A Glimpse of Sources and Funding*). The increased demand and necessity to upscale NbS projects and private sector investment have become increasingly important in financing such initiatives. Still, the study finding shows that corporate investment in NbS has accounted for only 10% of the 150 instruments, indicating that private sector engagement in NbS financing still requires further encouragement and support.

Private investors increasingly recognize the potential long-term financial returns of NbS projects and their social and environmental benefits. Effective policy instruments, such as strategies, regulations, and incentives, are therefore essential for promoting investment in NbS in urban areas. The analysis of Economic and fiscal instruments revealed six critical lessons learned. These include the need for political leadership and long-term vision, as well as the provision of solid financing. Furthermore, the adoption of co-governance and co-creation approaches and the inclusion of sustainable thinking across policy cycles and NbS physical solution cycles are critical to achieving sustainable maintenance. In addition, the importance of utilizing community support, monitoring, evaluation, learning, and building buzz and outreach is increasingly evident.

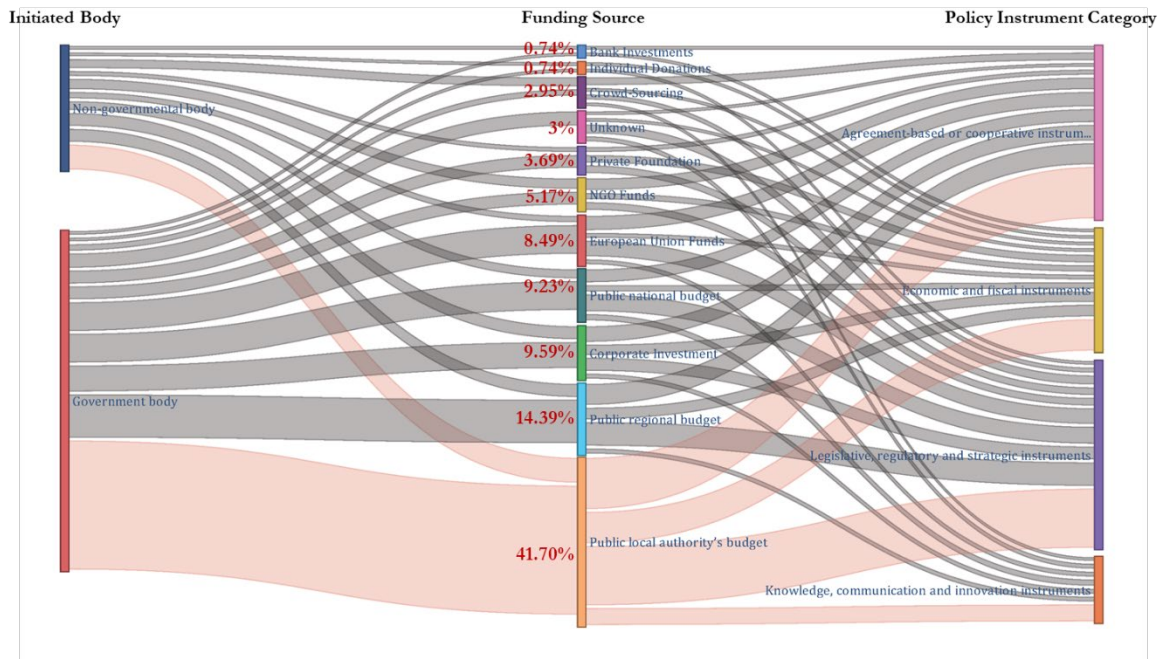


Figure 21 Sankey diagram showing the flow of financing sources to each UGA instrument category.

Source: Author-owned illustration

However, it is important to note that these guiding lessons learned should be adapted and customized based on the specific context and problem being addressed. As Borrás & Edquist (2013) emphasize, each policy instrument is unique and requires careful consideration of the overall social, political, economic, and organizational context in which it is applied. Thus, the implementation of systemic innovation policy depends on the extent to which the instruments are defined, customized, and combined into appropriate mixes that address the complex and multi-dimensional nature of the problem at hand. Even if some policy instruments are similar in their ways of defining and approaching a problem, there will always be substantial differences in terms of how they are chosen and designed. Therefore, policy instruments are not systemic unless combined into mixes that address the complex and often multi-dimensional nature of innovation challenges.

6.3.1 Innovative Financing

Through the analysis of this study, a diverse range of innovative Economic and Fiscal Instruments (EFI) were identified. It is noteworthy that incentives were found to be the dominant mode of instruments, as opposed to disincentives, indicating the continued need for incentivizing the adoption of financial policies. These incentives are often co-implemented by the public through co-financing arrangements.

Innovative financing mechanisms, like green bonds and public-private partnerships (PPP), are being used more frequently to fund NbS projects (Droste et al., 2017, Kabisch et al., 2017, Ershad Sarabi et al., 2019; Frantzeskaki, 2019). Our analysis confirms their emergence but not their mainstream. PPPs allow collaboration between public and private sectors to finance and implement NbS initiatives, leveraging the strengths and resources of both sectors for long-term support (Interview G, 2023). Green bonds provide environmentally conscious investors the opportunity to invest in sustainable projects, including NbS, while PPPs involve public and

private sectors in NbS planning, financing, and implementation, ensuring public oversight and accountability (Frantzeskaki et al. 2014; Graham and Ernstson 2012).

Crowdfunding and outcome-based financing are two untapped innovative financing approaches. Crowdfunding involves raising funds from many individuals through online platforms, making it useful for NbS projects with a strong community or social component as it builds support and engagement for the initiative. Outcome-based financing, mentioned in Interview F (2023), links financing to specific targets or outcomes like reducing carbon emissions or improving biodiversity, ensuring effective NbS projects that attract long-term financing.

The Green Climate Fund (GCF) is a crucial tool for mobilizing finance and investing in innovative business models, particularly for projects that are considered too risky for other banks. Our analysis highlights the low contribution of development banks, making GCF an even more critical player. With access to various financial instruments and over 200 partners, GCF promotes a blended finance approach that combines different financial tools to fund NbS projects sustainably. This approach involves partnerships between multiple financiers to fill financing gaps, making it useful for financing climate and biodiversity impacts over large areas and long periods of time (Glemarec et al., 2023). By blending different types of financing, organizations can create a sustainable financing structure that can support long-term NbS initiatives, even when carbon credits or other sources of financing may not be sufficient on their own.

The systematic review by Toxopeus and Polzin (2021) identified two key aspects regarding reported strategies for upscaling urban NbS and financing. Firstly, while numerous studies are on valuing NbS benefits, there is still no widely accepted framework for practical use by financiers, hindering upscaling efforts. Secondly, strategies for coordinating public and private finance often focus on cost and risk-sharing with parties who benefit from NbS, but this raises concerns about socioeconomic justice when vulnerable populations cannot afford to pay. Private finance for NbS development targeted at affluent urban citizens risks neglecting socioeconomic benefits for the wider population. (Toxopeus and Polzin, 2021)

Furthermore, the literature highlights that economic opportunities from implementing NbS are being recognized at multiple levels of government and by various actors. For instance, EU-funded projects are collaborating with research institutions, corporates, and intermediate organizations to explore long-term financing options and new funding opportunities through pilot projects, as reported by Wilk et al. (2020). This field of research is advancing significantly, and the funds available for delivering NbS are constantly evolving, as noted by Mell (2018). NbS financing can be supported through various channels, including public funding, private investment, and innovative financing mechanisms such as green bonds and public-private partnerships. It is crucial to continue exploring and leveraging these financing options to ensure the successful implementation of NbS projects and realize their potential benefits for both the environment and society.

6.3.2 Upscaling Financing

Scaling up financing for NbS faces several challenges, including lack of awareness among investors and financial institutions, absence of standardized metrics, unclear ownership and management, high upfront costs, long-term commitment, and policy and regulatory barriers. These challenges can be addressed through various means, such as raising awareness about the benefits of NbS, developing standardized metrics, establishing clear legal frameworks, creating innovative financing mechanisms, implementing long-term financing strategies, and developing

supportive policies, and enabling regulatory frameworks. Collaboration among governments, investors, financial institutions, and civil society organizations plays a crucial role in achieving these solutions, as they can collectively promote awareness, strengthen policies and regulations, and develop innovative financing mechanisms to unlock the potential of NbS in addressing environmental and social challenges.

Furthermore, insights from experts in the field suggest that collaborative finance in urban NbS involves trade-offs. While private sector involvement is important for the success of NbS projects, it may have negative implications for social justice outcomes (Fathi, 2021; Interview D, 2023). However, experts argue that private investments should not be discouraged, as NbS solutions have the potential to generate value, create green jobs, and provide new opportunities. To ensure fairness, it is essential to accompany these investments with a comprehensive social plan that grants local communities access to employment opportunities. Recognizing the potential winners and losers and engaging in transparent communication and awareness-raising among stakeholders are crucial steps in effectively addressing these trade-offs. By considering the social implications and involving all relevant parties, the long-term success of NbS projects can be achieved while also prioritizing equitable outcomes for communities (Nelson et al., 2020; Toxopeus et al., 2020).

6.3.3 Catalysts of Financing and Knowledge Sharing

Access to knowledge and technical information is vital for urban capacity building. Collaborations between different governance levels and non-state actors enhance this aspect (Pierre, 2019). Creating tools to map NbS benefits, identifying sectors where their value is not established, and fostering knowledge communities within the government are recommended (Bulkeley, 2020). NbS knowledge platforms play a crucial role in mainstreaming lessons learned. The European Commission has invested in platforms like EKLIPSE impact evaluation framework (Raymond et al., 2017); the knowledge marketplace OPPLA (showcasing the latest thinking on ecosystem services, natural capital, and NbS); the community-building actions of NetworkNature and now also NetworkNature; and databases and tools provided by specific projects and initiatives (such as UNA)

Other platforms are also inspirational in terms of financing such as the OECD's Policy Instruments for the Environment (PINE). It is a valuable database platform that offers information on over 3900 economic and market instruments implemented in over 130 countries worldwide. It notably includes 234 biodiversity-related taxes across 62 countries. Likewise, the IEA's Policies and Measures Database provides access to information on 7260 public climate policies and measures, covering various instruments such as regulations, taxation, and payment and transfer mechanisms. These databases serve as valuable resources for understanding global environmental policy efforts (Glemarec et al.2023).

Additionally, it is crucial to recognize that there is no universal solution that applies to all situations, as the effectiveness of NbS depends on local contexts. These knowledge platforms play a significant role in showcasing exemplary NbS projects that can serve as models of good practice. By highlighting these projects as "rock stars of NbS" or flagship projects, they can be effectively communicated to various stakeholders such as city officials, local entrepreneurs, investors, community groups, and residents (Kabisch et al., 2016). Lastly, it is essential to ensure the inclusion of case studies from the global south to capture a diverse range of experiences and perspectives.

6.4 Research Reflections and Limitations

The research design had several elements, including the examination of city-scale data from 150 policy instruments and the bridging of academic and applied research methods through partnerships with the Ecologic Institute. Expert validations and discussions also provided valuable insights. However, the study also had limitations that need to be acknowledged.

Firstly, due to the wide scope of the research, comprehensive insights were sought from the UGA knowledge platform, but this may have constrained the depth of analysis. Secondly, limitations existed in the research methodology, as the tagging of the key concepts in the analytical framework (*Multi-level Governance*, *Modes of Urban Governance*, and *Public Participation*) relied on the researcher's understanding of the cases that are collected from various sources and disciplines. The quality assurance conducted by the Ecologic Institute primarily aimed to standardize technical languages, but it is important to acknowledge that biases from primary contributors may have emerged. Furthermore, it is crucial to pay special attention to potential biases in the good practice criteria index, as contributors were directly involved in ticking the characteristics boxes.

The outcomes of the study were proportionate to the number of cases rather than accurately reflecting the impact on the ground, making it challenging to quantify or provide an accurate representation based on the available information. The expert validation step played a crucial role in providing a broader scope and insightful concepts. However, the extent of insights obtained was highly dependent on the status of each expert and interviewee. It was concluded that a survey would have provided more comprehensive insights if the experts or researchers had sufficient time to reflect and provide further critique. It is important to mention that practitioners received a presentation with questions and research results, while researchers only received questions and an overview via email. This means that the validation process lacked systematicity in this regard. Furthermore, the focus was on fostering interactions rather than mere communications and facilitating discussions to gain further insights from experts in this field.

Lastly, due to the limitations of the master's thesis size and scope, the statistical analysis insights could only scratch the surface in providing overarching trends and patterns. However, this also leaves room for further exploration, particularly in the areas of network analysis and regression. It is especially important to examine the weight of linkages between nodes/variables in the network analysis and how they relate to the regression variables. Furthermore, I endorse the opinions of experts in Interview H and G (2023) who expressed that the study framework was simplistic and would benefit from the inclusion of a more in-depth analytical framework. This could involve delving into aspects such as multi-level governance, exploring principles, actors, and processes, and identifying the actors that bridge these collaborations, beyond simply categorizing them as *Type I* and *Type II*. Additionally, further reflection on whether learning has occurred and what type of learning is best to acquire would also enhance the study's insights.

7 Conclusion

The primary objective of the study was to contribute to a better understanding of policy instruments that promote the deployment of NbS in urban areas. By examining 150 European good practice instruments from the UGA and analyzing key patterns and trends, valuable insights have been gained. Specifically, the study examined the public involvement and governance arrangements, levels of collaboration, and the role of municipalities in institutionalizing and implementing NbS. The findings indicate a growing trend in frontier cities, where local policies and instruments are being adopted at a rapid pace. Furthermore, the discussion argues that these instruments will be accelerated not only due to the urgency to act and mitigate climate change implications but also because of comprehensive EU frameworks and policy mix that promote the urban NbS agenda with binding targets. This is expected to drive the transformation and expedite the deployment of NbS instruments, particularly those based on agreements, cooperation, and economic and fiscal mechanisms.

Understanding urban modes of governance is crucial for effective decision-making, policy implementation, and collaboration among diverse stakeholders, ultimately shaping the sustainable development and resilience of cities. Multi-level governance, with a focus on horizontal collaborations between sectors and departments, emerges as a key factor in achieving successful outcomes. Intermediaries play a vital role in advocating for urban interests, accessing financing, providing expertise, and facilitating learning, bridging gaps and promoting effective governance. Transitioning towards a reflexive mode of governance, building upon enabling and experimentation modes, is critical for changing implementation course in addressing complex urban challenges and in adopting novel solutions like NbS. Moreover, this transition necessitates the development of institutional capacities and infrastructure that foster innovation in financing and engagement, enabling cities to adapt and respond effectively to evolving needs.

Public participation is a critical element in shaping sustainable urban governance as well as delivering and maintaining urban NbS interventions. The study argues that consultations with proper implementation can lead to better outcomes, by ensuring that diverse perspectives are considered in decision-making processes. The study also argues that social engagement becomes paramount in urban NbS, by focusing on knowledge mobilization, social learning, fostering a sense of belonging, and promoting environmental stewardship within communities of intervention. Understanding the tipping point at which public engagement influences collaboration is crucial to avoid unintended consequences in policy development and marginalization, highlighting the profound impact of the public awareness in involvement and in enhancing co-creation and governance mechanisms.

Furthermore, the study emphasizes the importance of innovation in financing approaches, particularly the legal infrastructure that can facilitate this innovation. Such innovation opportunities can foster a more sustainable financial system and promote the scaling-up of NbS deployment. Drawing on cases in frontier cities like Paris, Hamburg, and Gothenburg, as well as the discussion chapter, the study highlights promising avenues for NbS financing and bonds. These include blended financing, integration with academia and partner cities, and applying for EU grants such as Horizon. Additionally, outcome-based approaches, crowdsourcing, PPPs, and the potential interaction of ESG stewardship funds and investments have been identified as potential drivers to accelerate the pace of transformation and widespread adoption of NbS. Achieving this would involve bringing NbS into all sectors and focusing on reintegrating nature into our lives and cities. The study also recognizes the need for large-scale implementation today, which necessitates reevaluating investment valuation and returns.

Based on the in-depth results and discussion of this study, a set of key recommendations is provided for audiences in academia, practitioners, and city leaders. Researchers in academia should focus on conducting comprehensive ex-ante assessments of policy instruments with full-score good practice characteristics to further explore the lessons that can be drawn and gain in-depth insights into the systems processes surrounding instrument development. Furthermore, they should investigate the impact of multi-actor collaboration on decision-making and delve into the emergence and mainstreaming of alternative modes of governance for NbS, particularly reflexive governance. Another important area that remains untapped is the development of standardized tools for NbS quality assurance and reporting. Additionally, it is important to validate the research on the degree of involvement in terms of processes regarding sustainability outcomes.

Further research on NbS financing innovation, statistical correlations in policy landscapes, and comparative studies of NbS cases in the UGA between European and CELAC cases are also encouraged to generate valuable insights for future NbS implementation. Practitioners are urged to leverage the study's results as inspiration for developing and implementing NbS urban policy instruments. They should focus on designing instruments that attract financing without greenwashing, sharing lessons learned, collaborating with relevant actors, and integrating horizontal collaborations. City leaders should prioritize collaboration, reflexive governance, and vertical collaborations, foster city twinning and partnerships, and establish networking channels to promote knowledge exchange and resource sharing through city intermediaries.

In conclusion, this study highlights the imperative of implementing urban NbS policies as a means to accelerate the pace of change in addressing the wicked climate change catastrophe while strengthening adaptation, resilience, and social justice. The interconnected challenges of climate change necessitate a profound societal shift, underscoring the significance of policy development, engagement, and governance. While the thesis analysis primarily focuses on Europe, this research can serve as an inspirational stepping stone for other prospect cities and feed the literature on urban governance.

The overarching role of multi-level governance, effective governance mechanisms, inclusive participation, and sustainable financing is crucial for all sectors, extending beyond NbS and prompting a reevaluation of policies. It is essential to rethink the valuation of nature and policy outcomes, moving beyond conventional cost-benefit analyses and traditional approaches. By promoting cooperative and collaborative approaches within sensitive sectors of the built environment, I can demonstrate the potential for transformative change and significant acceleration towards a sustainable urban future.

8 Recommendations

8.1 Researchers

1. Ex-ante assessment of policy instruments: Conduct a comprehensive ex-ante assessment of the four policy instruments, further investigate their lessons (outlined in Good Practice Criteria, Annex E).
2. Comparative study on UGA cases: Undertake a comparative study to identify commonalities, challenges, and successful strategies among UGA cases in Europe and CELAC. Pay special attention to cases from the global south, ensuring their inclusion and analysis. Identify commonalities, challenges, and successful strategies across these cases to inform future NbS implementation.
3. Developing a standardized matrix tool for NbS quality assurance: Develop and communicate a standardized matrix tool for assessing and assuring the quality of NbS. This tool should enable effective communication of the quality standards and performance metrics associated with NbS projects.
4. Evaluating consultation and participation processes: Further investigate the effectiveness of consultation as a form of good practice actors participation. Assess whether consultation alone is sufficient or if additional empowerment measures are needed. Verify the accuracy of the statement that successful engagement can be measured by indicators of empowerment.
5. Research on NbS financing innovation: Conduct further research on innovative financing mechanisms for NbS. Specifically, explore the interests and involvement of corporates and development banks in funding NbS initiatives. Identify potential avenues for leveraging private sector investments to scale up NbS implementation.
6. Exploring statistical correlations in policy landscapes: Uncover the untapped potential of statistical correlations among variables in the policy landscapes. Analyze the relationships between different policy factors and their impact on NbS outcomes. Identify any synergies or trade-offs that may exist and leverage them for more effective policy design.
7. Advancing frameworks for multi-stakeholder interactions: Advance existing frameworks to enhance multi-stakeholder interactions within NbS initiatives. Emphasize the inclusion of non-public actors, such as private entities, in the decision-making processes.
8. Research on learning from processes and experimentation: Conduct further research to identify the types of learning required from NbS processes and further investigate the learning and experimentation cases of the UGA. Furthermore, utilize UGA cases as a steppingstone for refining NbS approaches and enhancing their effectiveness.

8.2 Practitioners

1. Utilize the results of the study as inspiration when developing, designing, and implementing urban policy instruments for NbS projects. Ensure alignment with best practices identified in the study.
2. Channel projects and instruments into a typology and language that make financing more viable and attractive, while ensuring there is no promotion of greenwashing. Develop clear and transparent mechanisms to demonstrate the environmental integrity of NbS initiatives.

3. Prioritize collaboration and reflexive governance with citizens and relevant stakeholders. Mainstream participatory approaches to ensure effective engagement, decision-making, and implementation of NbS initiatives.
4. Learn from the fiscal and economic instruments used in previous projects as a source of inspiration. Focus on effective monitoring, evaluation, and learning to continuously improve.
5. Share both failures and successes openly, as they provide valuable learning outcomes for prospective cities. Foster a culture of learning and knowledge exchange within the NbS community.

8.3 City Leaders

1. Prepare institutional frameworks and legislative frameworks that facilitate access to international financing and adapt them to promote social innovation in NbS projects.
2. Emphasize vertical collaborations as essential allies for local actions, integrated planning, and sectoral cooperation. Foster coordination and cooperation among different levels of government to maximize the benefits of vertical collaborations.
3. Establish networking channels with intermediaries who can support advocacy efforts, facilitate access to financing, provide expertise, and facilitate learning exchanges. Leverage city-to-city sharing and collaborate with other cities to enhance the implementation and impact of NbS projects.

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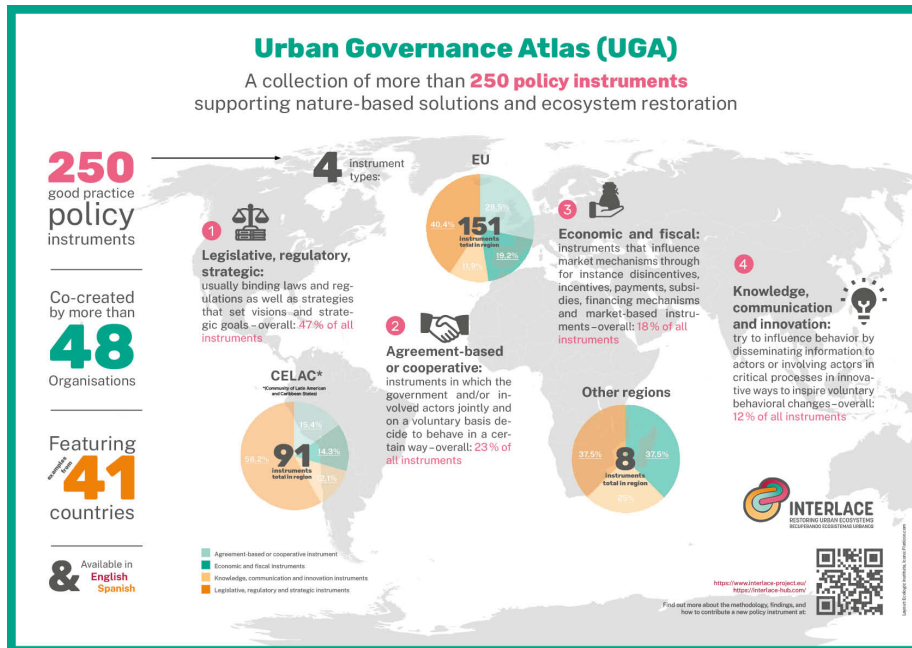
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Appendix A

Figure 22 Screenshot of the UGA and visual illustration of summary of its content and its creation

Source: Adopted with written approval from (UGA, 2023a)



Appendix B

Table 9 UGA policy instruments typology of main and sub-categories with examples

Category	Sub-category	Definition
Legislative, regulatory and strategic instruments	Dedicated strategy, plan or law	NbS, green infrastructure, urban forestry or green space strategy or plan
	Overarching/cross sectoral strategy, plan or law	circular city, smart city strategy or plan; masterplan, integrated plans; action plan on (innovation/green) public procurement
	Sectorial strategy, plan or law	adaptation, biodiversity, climate change, mobility
	Urban planning mechanisms	spatial (zoning), infrastructure or socio-economic development plans; green space factor restrictions on development of green areas; targets (regulation and planning) standards; scoring
	Standards	green public procurement standards
Economic and Fiscal Instruments	Disincentives	taxes and charges/fees, tariffs; trading of permits for using a resource or trading
	Payments as rewards/for ecosystem services, subsidies, incentives	subsidies or payments to landowners/ private actors for practices; public financing/grants; payments for insurance covering the risk associated with newer green technologies
	Financing mechanisms /market-based instruments	'green finance' or debt-based instruments; blended finance; payments for ecosystem services (PES); public-private-partnerships (PPP)
Agreement-based or Cooperative Instruments	Community based agreement with the support of the government	Citizen assemblies, neighborhood development plans
	Public private community-based agreement	Participatory budgets, Partnerships for ecosystem restoration or climate action; local networks of stakeholders that promote NBS and biodiversity action.
	Public private business agreement	Public private collaborations for improving urban greening.
	Public- community agreement	Community management of green spaces on public lands, community asset transfer, citizen science programs.
	Private business agreement with the support of the government	Business parks and biodiversity investments.
	Joint regional planning between municipalities	Inter-municipal exchange platforms, Inter-municipal plans for environmental management and restoration

Category	Sub-category	Definition
Knowledge, Communications, and Innovative Instruments	Communication/awareness raising	targeted educational programs; certification (labelling) or ranking; awareness raising campaigns
	Knowledge and innovation	communities of practice; living labs; creating workshops; pilots; constructing business cases or land use plans; green hu

Source: Adopted with written approval from (Davis & Burgos, 2022; UGA, 2023a)

Appendix C

Table 10 *Naturvation project categorization of 12 Modes of Governing for Nbs*

Governing Approach	Definition
In-house (municipality)	NBS is designed, implemented and financed within the municipal organisation.
Public provision	NBS is provided by a public authority or public agency: it is designed, implemented and financed by (one or more) public authorities/agencies.
Public-private provision	NBS is provided by group of public & private authorities, agencies and organisations that are linked through a formal institution or legal agreement (e.g. they form a consortium, a partnership with legal standing). The NBS is designed, implemented and financed through this consortium (i.e. there are no other organisations who work in partnership with this entity but remain external to it in formal/legal terms).
Regulation	The design and implementation of NBS is undertaken by a private sector organisation/civil society group in response to a regulatory requirement provided by a public authority or agency (at any level of governance). Financing could be provided by the initiating actors or another source (public/private/civil society).
Incentives	The design and implementation of NBS is undertaken by a private sector organisation/civil society group in response to an incentive provided by a public authority or agency (at any level of governance). Financing could be provided by the initiating actors or another source (public/private/ civil society).
Enabling & supporting	The design and implementation of the NBS is undertaken by a private sector organisation or civil society group in response to enabling and supporting measures – such as support with developing knowledge about NBS/their potential, signposting to relevant sources of financial or other support, the provision of access to resources or land, donation of some resources - provided by a public authority or agency (at any level of governance). The financing of NBS could either be provided by the initiating actors or come from another source (public/ private/civil society).
Partnership – public sector led	The design, implementation and financing of NBS is undertaken in partnership, where different authorities, agencies, organisations and groups contribute towards a joint undertaking but without becoming constituted as one entity in legal or institutional terms. Partnership initiated and led by a public sector authority, agency or group (at different levels of government).
Partnership – civil society led	The design, implementation and financing of NBS is undertaken in partnership, where different authorities, agencies, organisations and groups contribute towards a joint undertaking but without becoming constituted as one entity in legal or institutional terms. Partnership initiated and led by a civil society organisation/group (i.e. composed of actors from civil society and operating on a not-for-profit basis).
Partnership private sector led	The design, implementation and financing of NBS is undertaken in partnership, where different authorities, agencies, organisations and groups contribute towards a joint undertaking but without becoming constituted as one entity in legal or institutional terms. Partnership was initiated and led by a private sector organisation or group.

Governing Approach	Definition
Private-sector led	The design and implementation of the NBS is undertaken by private sector organisations or civil society groups, where the initiation of the NBS is driven by a private sector organisation and it provides the enabling conditions/support required for its implementation. The financing of NBS could either be provided by the initiating actors or come from another source (public/ private/civil society).
Philanthropic/Notfor-profit	The design and implementation of the NBS is undertaken by private sector organisations or civil society groups, where the initiation of the NBS is driven by a philanthropic or not-forprofit organisation and it provides the enabling conditions/support required for its implementation. Financing could either be provided by initiating actors or from another source (public/ private/civil society).
Community driven	The design and implementation of the NBS is undertaken by civil society groups, where the initiation of the NBS is driven by a community group and it provides the enabling conditions/ support required for its implementation. Financing could either be provided by the initiating actors or another source (public/private/ civil society).

Source: Adopted with written approval from (Bulkeley et al., 2020)

Appendix D

Table 11 Summary of each policy instrument type and European countries and Cities.

Country	City	AbCI	EFI	KCII	LRSI	Total
Austria	Vienna				1	1
Austria Total					1	1
Belgium	Regional	1	1			2
Belgium	Antwerp				1	1
Belgium	Flemish Region	4	2		1	7
Belgium	Genk	2			1	3
Belgium	Ghent	1				1
Belgium	Sint-Niklaas		1			1
Belgium Total		8	4		3	15
Croatia	Zagreb	1				1
Croatia Total		1				1
Denmark	Aarhus	1				1
Denmark	Copenhagen				3	3
Denmark	Høje-Taastrup	1				1
Denmark Total		2			3	5
France	Aix-en-Provence				1	1
France	Île-de-France			1		1
France	Lyon				2	2
France	Marseille	1			1	2
France	Montpellier	1			1	2
France	Nancy				2	2
France	Nantes		1			1
France	Paris		2			2
France	Saint-Etienne	1				1
France	Seine-Saint-Denis			1		1
France	Strasbourg	2		1	1	4
France Total		5	3	3	8	19
Germany	Regional			1	2	3
Germany	Andernach			1		1
Germany	Berlin	2		2	2	6
Germany	Bremen				1	1

Country	City	AbCI	EFI	KCII	LRSI	Total
Germany	Chemnitz	1			2	3
Germany	Dortmund, Essen, Duisburg, Gelsenkirchen	1				1
Germany	Dresden		1			1
Germany	Essen	1				1
Germany	Hamburg		2		1	3
Germany	Hannover		1			1
Germany	Leipzig				2	2
Germany	Munich			1	1	2
Germany	Todas las ciudades alemanas				1	1
Germany Total		5	4	5	12	26
Greece	Athens			2		2
Greece Total				2		2
Ireland	Dublin				2	2
Ireland	Dublín				1	1
Ireland Total					3	3
Italy	Bolonia	1				1
Italy	Isola Vicentina				1	1
Italy	Lombardy region		1			1
Italy Total		1	1		1	3
Norway	Oslo			1	1	2
Norway	Oslo, Grefsen District	1				1
Norway Total		1		1	1	3
Poland	Krakow	1	1		1	3
Poland	Krakow Metropolis	1				1
Poland	Rumia		1			1
Poland	Szczecin		1			1
Poland	Various				1	1
Poland	Warsaw		1	2		3
Poland	Wroclaw	1	2		2	5
Poland Total		3	6	2	4	15
Portugal	Lisbon	1			1	2
Portugal Total		1			1	2
Romania	Timișoara				1	1
Romania Total					1	1

Country	City	AbCI	EFI	KCII	LRSI	Total
Scotland	Glasgow	1				1
Scotland Total		1				1
Slovakia	Bratislava		1			1
Slovakia Total			1			1
Slovenia	Ljubljana	1				1
Slovenia Total		1				1
Spain	Barcelona	1			3	4
Spain	Bilbao	1				1
Spain	Granollers	1			1	2
Spain	Granollers, Les Franqueses del Vallés and Canovellas	1				1
Spain	Madrid				1	1
Spain	Málaga			1		1
Spain	Mollet del Vallès, Santa Perpètua de Mogoda, Palau-solità i Plegamans, Parets del Vallès, Lliçà de Vall y Montcada i Reixac				1	1
Spain	Terrassa				1	1
Spain	Vitoria-Gasteiz				1	1
Spain Total		4		1	8	13
Sweden	Gothenburg		1		1	2
Sweden	Malmö				1	1
Sweden Total			1		2	3
Switzerland	Basel		1			1
Switzerland Total			1			1
The Netherlands	Regional		2			2
The Netherlands	All municipalities in the country can participate			1		1
The Netherlands	Amsterdam	2			2	4
The Netherlands	Breda			1		1
The Netherlands	Eindhoven		1	1		2
The Netherlands	Rotterdam	1	1		1	3
The Netherlands	Utrecht	1				1
The Netherlands Total		4	4	3	3	14
United Kingdom	Brighton and Hove	1				1
United Kingdom	Bristol				1	1

Country	City	AbCI	EFI	KCII	LRSI	Total
United Kingdom	Doncaster	1				1
United Kingdom	Glasgow		1		2	3
United Kingdom	Liverpool		1			1
United Kingdom	London	2	1		2	5
United Kingdom	London and Essex County	1				1
United Kingdom	Manchester	1				1
United Kingdom	Sheffield				2	2
United Kingdom	Sunderland				1	1
United Kingdom	Wakefield				1	1
United Kingdom Total		6	3		9	18
Grand Total		44	29	17	60	150

Source: Author owned table, 150 European cases from the (UGA, 2023a)

Appendix E

Table 12 Framework analysis of the four instruments that have full score of good practice criteria.

Instrument Category	Name	Contextilization	Reference
<p>Economic and Fiscal Instrument</p>	<p>stormwater fee - Hamburg</p>	<p>The city of Hamburg in Germany implemented a stormwater fee in 2012 to incentivize the restoration of ecosystems and increase permeable surfaces initiated by the city department of Hamburg Wasser. The EFI instrument design included both MLG types I and type II in the form of vertical and horizontal collaborations between governmental bodies and actors. Hamburg Wasser introduced the cost-recovery wastewater charge with approval from its board of governors and participating municipal boards. To address the fragmented stormwater management, Hamburg Wasser and the State Ministry for Environment and Energy initiated the 'Rain InfraStructure Adaption' (RISA) project, establishing a stormwater runoff fee and coordinating actors responsible for stormwater management.</p> <p>The instrument was governed by the authority of the local government. Four co-planning working groups were formed, and a Hamburg-wide GIS system was established (including traffic planning, urban and spatial planning, urban draining departments, etc.). The fee is based on the property's impermeable area and degree of connection to the sewage network, and it is calculated through the GIS system created. Property owners were consulted on the permeability mapping of their properties through remote sensing and data surveys. The stormwater charge is aimed at cost recovery of €0.73/m² sealed area per year, while the sewage charge is based on a cost recovery principle and amounts to €2.11/m³.</p> <p>The success factors of the project include being an integrated planning project with a matrix structure covering concerned departments, collaboration with university research and private companies, and integration of economic and legal topics into the technical responsibilities of the Department for Stormwater Management. Despite limited political follow-up activities during the project's duration, the Hamburg stormwater fee serves as a good practice example of incentivizing sustainable stormwater</p>	<p>(UGA, 2023l)</p>

Instrument Category	Name	Contextilization	Reference
		management through integrated planning and stakeholder engagement	
Agreement-based or Cooperative Instruments	Emscher Future Master Plan - Northrhine-Westphalia, (Germany)	<p>The Emscher Future Master Plan was implemented from 2006 to 2020 in Northrhine-Westphalia, Germany, to restore the heavily polluted Emscher River. The instrument design followed types I and type II MLG and was developed through a two-year regional dialogue involving stakeholders and political actors using a bottom-up approach. The plan complemented existing formal planning procedures and provided a framework for informal coordination across sectors and municipalities. The local government adopted the Master Plan by enabling, which served as the backbone of the regional restoration process, facilitating the involvement of the 11 cities along the Emscher River in the restoration and creating impetus for new projects (including Dortmund, Essen, Duisburg, Gelsenkirchen). The unique AbCI instrument followed a co-decision approach with actors.</p> <p>The restoration succeeded due to ongoing government support and significant investments from public and private sectors, including the European Investment Bank. In 2021, the Master Plan was declared an internationally recognized good practice example for large-scale river restoration, with the Emscher being declared free of sewage water for the first time in 170 years. The plan is an example of a flexible and adaptive planning instrument for large-scale restoration projects that were jointly developed by stakeholders. However, a lack of a monitoring framework and overlapping competencies between the two water boards remain weaknesses of the plan.</p>	https://interlace-hub.com/emscher-future-master-plan
Legislative, Regulatory, and Strategic Instruments	Grey to Green - Sheffield	Sheffield City Council's 'Grey to Green' scheme, launched in 2013, transformed 1.6 kilometers of road space into a sustainable, linear green route for pedestrians, cyclists, and public transport through self-governing. The project addressed the need to reconnect the Castlegate area (Sheffield - UK), reuse redundant highways, and mitigate flood risks. Its four-phase implementation allows for continuous improvements. In 2018, an open consultation was conducted with all relevant stakeholders and occupiers to gather their feedback and insights regarding the proposed improvements. This consultation was	https://interlace-hub.com/grey-green-sheffield

Instrument Category	Name	Contextilzation	Reference
		<p>essential to ensure that the next phases of the scheme aligned with the needs and expectations of those directly affected by the development. The completed phases have already boosted economic development, improved biodiversity, and surface water management.</p> <p>The instrument is based on Type I MLG collaboration between the municipal departments. The project is now part of the Sheffield City Region Net Zero Work Programme, initiated after the Mayoral Combined Authority declared a Climate and Environmental Emergency in 2019. The Grey to Green scheme's Phase 1 budget was €4.06M (£3.4M) and was funded by Sheffield City Region, the European Regional Development Fund, and Sheffield City Council. Phase 2, with a budget of €7M (£5.8M), was funded as part of the local government and the EU's call for proposals of large-scale NbS interventions.</p> <p>The scheme has had a significant impact on the urban regeneration area, including a 561% increase in biodiversity value, reduced heat island effects, and new office and residential developments. Collaboration between the city, universities, businesses, and local communities was key to the project's success, and the approach is now being developed further in future phases. The comprehensive and coordinated vision of the actions, programming, and management of urban regeneration can be greatly useful to other cities.</p>	
<p>Knowledge, Communication, and Innovative Instruments</p>	<p>Map of opportunities and city safari - Breda</p>	<p>The Map of Opportunities is a citizen-driven knowledge and innovation instrument created in collaboration with local stakeholders and experts around the GreenQuays project area in Breda, Netherlands. The project involves daylighting the river Mark and restoring it to a more natural state to address the lack of urban green space and climate change impacts. The GreenQuays project was co-financed by the European Union's Urban Innovative Action and included Type I and Type II collaboration between actors, with Breda municipality as one of the partners. The tool is now included in the municipality's approved participation guidelines for new projects and was governed by enabling.</p> <p>The map identifies problems and opportunities for improvement from a citizen and local stakeholder</p>	<p>https://interlace-hub.com/map-opportunities-and-city-safari-breda</p>

Instrument Category	Name	Contextilization	Reference
		<p>perspective. The map was developed in co-creation workshops with local stakeholders and experts and has been used as a supportive tool for urban planning and other departments of the municipality, as well as planning and actions of the regional health service and the regional water board. The instrument began as a bottom-up innovation instrument to collect local knowledge and perspectives and was formalized by the local government upon completion. The instrument raised awareness of the benefits of NbS for experts, urban planners, citizens, and local stakeholders. It revealed new insights and identify opportunities that expert knowledge alone would have missed. The instrument generated new ideas, such as hidden opportunities in courtyards, large roofs, and streets where the sewer had to be replaced. Other success factors included the respectful treatment of laypersons, the willingness of experts to learn, and the feeling of ownership.</p>	

Source: Author owned table.