

Governing Nature-based Solutions in Small and Medium-sized Cities

for Improved Water Quality and Water Resources Management

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Abstract

Fresh water resources face risks due to urbanisation, economic development, and climate change (CC). Many small and medium-sized cities (SMCs) are particularly vulnerable to these risks due to the lower resource capacity required to mitigate them. Nature-based Solutions (NbS) for water resource management (WRM) are promising to tackle these issues in urban areas while providing extra benefits to society. NbS adoption is growing in the European Union (EU) and in international strategies and agendas. However, SMCs like Rivne in Ukraine face challenges in implementing NbS due to conflicting stakeholder interests and other institutional, organisational, and cultural obstacles, which call for enhanced governance processes. At the same time, the research on NbS governance is dominated by studies from large cities, and the knowledge on effective NbS governance in SMCs remains fragmented. This thesis aims to address this research problem by developing and testing a conceptual framework for NbS governance in SMCs. It does so through a systematic literature review of 60 journal articles, six expert interviews and the empirical application of the framework to four case studies of NbS for WRM in the EU and to the case study of Ustya river in Rivne, Ukraine. The framework for effective governance consists of transformative processes such as adaptability, learning and reflection, six principles including geographical and institutional embeddedness, evidence-based decision-making, inclusivity and equity, collaboration, transparency, long-term perspective, and conditions that influence the capacity to apply those principles. The EU case studies included in the analysis are Ljubljana Connects, Ljubljana, Slovenia; Historic Utrecht Canal, Utrecht, Netherlands; Wupper Stream, Wuppertal, Germany; and Augustenborg Ecocity, Malmö, Sweden. These were chosen as successful examples of NbS governance from the EU-wide database, the Urban Nature Atlas (UNA), and they are therefore instrumental in drawing lessons for the enhancement of Ustya river governance in the Rivne case study.

With Ukraine on its way towards EU membership, such knowledge is particularly beneficial to advance the harmonisation of its legislation and enhance learning on innovative governance, which would improve local knowledge and practice. The data for the Rivne case study was collected via a review of academic and grey literature and six stakeholder interviews. This analysis uncovers existing challenges that slow down the implementation of projects for the Ustya river while exploring opportunities and lessons that could enhance the governance of water resources in Rivne. Lastly, this thesis proposes directions for future research and practical application of its results in WRM.

Keywords: nature-based solutions, small and medium-sized cities, urban governance, water resources management

Executive Summary

Introduction. Cities in the EU and Ukraine face multiple challenges exacerbated by increasing population growth, economic development, and the imminent risk of climate change. Freshwater resource management requires particular attention since it has emerged as a critical urban sustainability and resilience topic. From ensuring access to clean drinking water to mitigating the risks of flooding and water scarcity, cities face complex water-related challenges that demand innovative solutions. The pressure is especially severe in SMCs, which frequently lack the resources to properly reduce these hazards. In that relation, NbS emerge as a promising approach, offering innovative ways to tackle environmental risks while fostering urban resilience (Kabisch et al., 2022; Tozer et al., 2020). Across the EU and on the international stage, there is a growing recognition of the importance of NbS, reflected in various strategies and agendas. However, in cities like Rivne in Ukraine, categorised as SMCs, the implementation of NbS faces significant obstacles (Pol et al., 2022, p.46). Conflicting stakeholder interests and institutional, organisational, and cultural barriers pose obstacles to the effective adoption of NbS, highlighting the need for enhanced governance processes. Addressing these barriers requires learning from past experiences and refining approaches for future NbS projects. The context of environmental degradation in Ukraine further underscores the urgency of finding sustainable solutions to safeguard public health and the environment (Piasecki, 2022).

The literature underscores the importance of flexible and inclusive stakeholder involvement in urban natural resources management, highlighting collaborative governance as a promising approach. However, the theoretical landscape is characterised by diverse and sometimes overlapping forms of governance, such as hybrid, reflexive adaptive governance, and nature-based thinking, each with unique characteristics (Kauark-Fontes, Ortiz-Guerrero et al., 2023; Mercado et al., 2024; Toxopeus et al., 2020; Van Der Jagt et al., 2021). The lack of uniformity in governance modes is attributed to cities' diverse conditions and management structures. The literature also advocates radical changes in city governance structures, emphasising the shift from government to governance to accommodate cities' heterogeneous nature and address diverse interests, agendas, and challenges (Bulkeley et al., 2009). Furthermore, existing research on NbS governance primarily focuses on large cities, leaving a significant gap in our understanding of how to govern NbS in SMCs effectively (NATURVATION, 2017). Despite this complexity, numerous European projects showcase successful governance efforts between public and private entities, leading to transformative outcomes in NbS project execution (Urban Nature Atlas., n.d.). Therefore, the thesis aims to address the research problem by developing and testing a conceptual framework for NbS governance in SMCs. The research problem and objective lead to the formulation of the following research questions (RQ):

RQ1: *Which forms and modes of governance are likely to help NbS realise their co-benefits and lead to sustainable urban transformations?*

RQ2: *What are the fundamental governing principles towards transformative NbS for sustainable water management in small and medium-sized cities?*

RQ3: *How can the governance of water resources in Rivne be enhanced?*

Methodology. The author employed a qualitative approach to achieve the thesis project's objective, examining several snapshot case studies of four NbS projects in the EU using a conceptual framework developed from a literature review and expert interviews. The study followed an iterative approach, starting with identifying knowledge gaps, formulating research questions, and then collecting and analysing data to generate appropriate conclusions. Due to the limited research on the governance of SMCs for NbS projects addressing WRM, a semi-structured method was applied, allowing for the identification of new themes and more nuanced outcomes.

The methodology included a systematic literature review of 60 articles and interviews with 6 experts in NbS development, city governance, or water management to develop the conceptual framework. Following the development of the conceptual framework, it was crucial to validate its practical application through empirical testing. To achieve this, each principle was assessed using various methods to gain insights into their real-world applicability in project implementation settings. This was followed by a thematic analysis and an analysis of four case studies using secondary data from the UNA database and additional grey literature. Lastly, 6 interviews with stakeholders in Rivne were conducted, supplemented by analysing academic and grey materials. The author also ensured research validity and reliability through triangulation and personal reflection.

Results. The conceptual framework consists of several elements developed through a literature review and expert interviews, which are represented in *Figure 0-1*. Firstly, six governance principles include geographical and institutional embeddedness, evidence-based decision-making, inclusivity and equity, collaboration, transparency, and long-term perspective. For implementing NbS projects, the governance should realise transformative processes such as adaptability, learning and reflection throughout all stages, such as strategic planning, implementation, maintenance and evaluation. Moreover, local conditions such as regulations, finances, skills and knowledge, and existing collaborations and networks influence the capacity to apply governance principles.

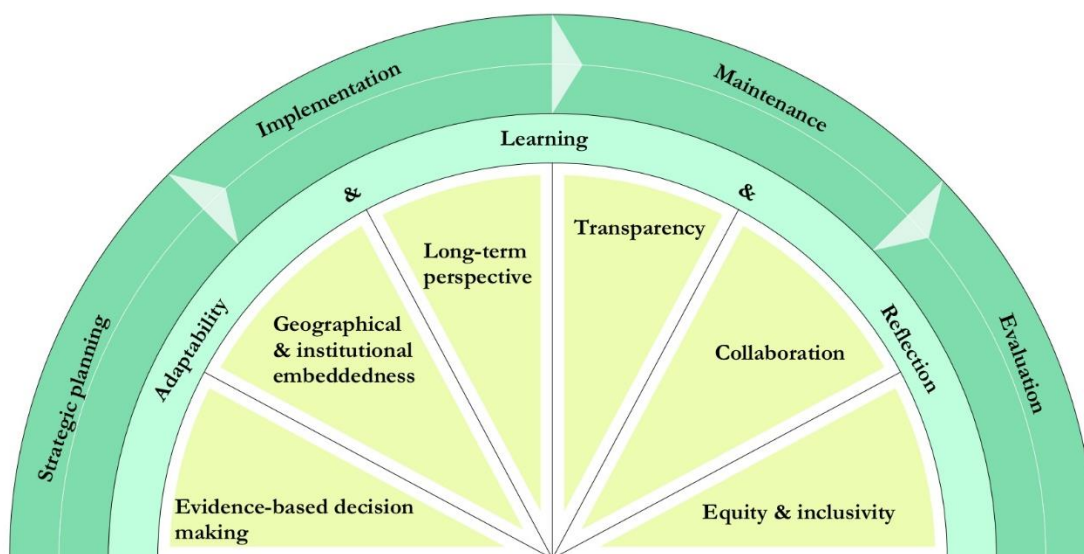


Figure 0-1: Conceptual Framework

The case studies showed that each principle was present, confirming the framework's feasibility. Additionally, it was observed that the extent to which each principle was implemented could vary depending on the project design and the decisions of responsible bodies. This variability was influenced by factors such as project conditions and challenges, which influenced applying these principles.

An analysis of the Ustya river's governance structure exposed the inadequate condition of Rivne's water body management. Firstly, it has been observed that a top-down approach characterises governance in Rivne. There are some collaborations from the different initiatives in the city, but the leading power in decision-making stands with local authorities. Secondly, initiatives that emerge without a systematic framework or strategic planning demonstrate a lack of integrity in WRM. Thirdly, external factors both hinder and present opportunities for

improvement. On the one hand, Ukraine's involvement in a full-scale war directly impacts budget allocation and limits the implementation of projects related to the Ustya river by then. On the other hand, while Ukraine's integration with the EU presents opportunities for alignment with European legislation, it also underscores the urgency for transformations within governance practices.

Conclusion. The governance of WRM in the EU, through the examples of case studies of NbS projects, shows how diverse and multiple problems are addressed and solved. While each context is different and unique, the conceptual framework provides a uniform approach to govern these issues. Moreover, depending on the context, certain principles may be less relevant. However, collaborative mode has become a key driver of transformations, promoting the formation of interdisciplinary teams and enabling dialogue among diverse actors in urban environments. Furthermore, reflexive governance has been essential in managing rapidly evolving conditions and challenges in cities, offering adaptability within administrative departments. Thus, this thesis has made academic and practical contributions by addressing these research gaps.

The challenges Ustya river are multifaceted, necessitating legislative improvements and a thorough analysis of the ecosystem's ecological elements. Such analysis could identify funding opportunities and address resource shortages. Additionally, networking and knowledge sharing would improve local government perception and encourage collaborative governance. Citizens should be well-informed about current Ustya river projects and made aware of the public good that needs protection. Public initiatives can act as catalysts for transformation by fostering participatory approaches, ensuring the sustainability of NbS projects post-completion. Therefore, applying the conceptual framework by stakeholders and governmental structures would improve local practice and knowledge through stakeholder workshops. At the same time, public participation methods could further shape citizens' perceptions of the development of projects for the Ustya river. Moreover, external pressure in the face of EU integration and commitment to Net Zero Cities presented in Rivne pose a potential for urban transformations (Climate-KIC, 2023). Emphasis should be placed on establishing the right conditions and modifying governance structures to address the current state of the water bodies and enable improvements.

Lastly, in a rapidly changing environment, this research offers a nuanced understanding of the effective governance of NbS for water resource management. Focusing on SMCs highlights the unique challenges and opportunities at this scale. This study provides a foundation for future efforts to empower these cities and local governments to build resilience and sustainable development by implementing NbS projects, which offer multiple benefits.

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Abbreviations

AR5 – Fifth Assessment Report

CC – Climate Change

CoM – Covenant of Mayors

DRR – Disaster Risk Reduction

GHG – Greenhouse Gas Emissions

EC – European Commission

EU – European Union

EU ETS – European Union Emissions Trading System

H2020 – Horizon 2020

FE – Freshwater Ecosystem

IUCN – International Union for Conservation of Nature

MLG – Multi-level Governance

MS – Member States

MSFD – Marine Strategy Framework Directive

MinENV – Ministry of Environment

NbS – Nature-based Solutions

NP – National Park

NB-UWS – Nature-based Urban Water Solutions

NUWMNM – National University of Water Management and Nature Management

RBMPs – River Basin Management Plans

SAWR – State Agency for Water Resources

SDG - Sustainable Development Goals

SMCs – Small and Medium-sized Cities

SWA – State Water Act

UN – United Nations

UNEP – United Nations Environment Programme

UNPD – United Nations Development Program

UNFCCC - United Nations Framework Convention on Climate Change

UNA – Urban Nature Atlas

WDF – Water Directive Framework

WHG – Water Resources Act

WWTPs – Wastewater Treatment Plants

WSS – Water Supply and Sanitation

WRM – Water Resources Management

1 Introduction

The introduction (Section 1.1) establishes the framework for the research thesis by explaining the notion of Nature-based Solutions (NbS) in the context of Ukraine and defining the challenges of managing and implementing urban NbS. Section 1.2 changes the attention to the significance and potential implementation of NbS in Europe, highlighting the need to examine diverse governance forms and practices in dealing with climate change (CC). Furthermore, it indicates a gap in the existing literature, influencing the goal and study questions in Section 1.3. Sections 1.4, 1.5, 1.6, and 1.7 discuss the thesis's scope, ethical issues, intended audience, and structure, respectively.

1.1 Setting the Scene

In today's rapid development and expansion, NbS catalyses urban transformations, facilitating changes in infrastructure, economy, and society (NATURVATION, n.d.-a; EC, 2020). Urban NbS, compared to other available technical solutions such as grey infrastructure², can address climate mitigation and adaptation problems by offering cost-effective implementation while simultaneously providing benefits to the environment and society (Kabisch et al., 2022; Tozer et al., 2020). For example, restoring wetlands provides several functions for the city, such as minimising wastewater and pollutant discharge, improving biodiversity, and enhancing the city's livability by offering opportunities for leisure and recreation (Kiss et al., 2020). Also, NbS create a space for the potential to generate fresh economic prospects in specific fields like tourism, conservation management, agriculture and forestry (Xie et al., 2020). NbS include but is not limited to these types of projects: green infrastructures, ecosystem-based adaptation, ecosystem-based mitigation, hybrid infrastructures, ecosystem restoration, or ecosystem protection; there is a uniform definition (Gómez Martín et al., 2020).

From a global perspective, it is essential to note that half of the world's urban population lives in SMCs with fewer than 500,000 inhabitants (DESA, 2015). The largest category of cities in Ukraine, in terms of population residing there, is SMCs, comprising 28 cities across the country (Index Minfin, 2022). These cities play a significant role in climate change as contributors to global greenhouse gas emissions (GHG), presenting opportunities and challenges in today's transformative era towards a sustainable future (Environment, 2017). Cities in Ukraine, including Rivne, are not yet adequately equipped for such transformations. However, the EC has taken a frontrunner position by creating solutions with nature for the cities. This includes funding and implementing NbS research projects like NATURVATION, RECONNECT, PHUSICOS, and ThinkNature, which aim to build sustainable societies (Zingraff-Hamed et al., 2021). An analysis of the Urban Nature Atlas (UNA), the largest database of implemented NbS, revealed that out of 1003 NbS projects in Europe, 463 cases were implemented in 14 countries, specifically within SMCs. These projects addressed city sustainability challenges, such as climate action for mitigation, resilience and adaptation, and water management (Urban Nature Atlas, n.d.). NbS offers significant environmental benefits and fosters social cohesion by engaging with local communities (Tozer et al., 2020).

Nevertheless, the research on NbS has primarily occurred in megacities (NATURVATION, n.d.-b). Many NbS projects implemented in the EU have been governed by various international networks and collaboration between governmental and non-governmental structures (Fila et al., 2023). Municipalities encounter financial constraints, lack networking opportunities, and possess limited knowledge capacities (Borgström, 2019; Fila et al., 2023). On the other hand, there is a typical mindset of the “business as usual” perspective from private actors (developers, businesses), who prefer grey infrastructure over NbS (Monstadt, 2009). Additional issues appear from different levels of government, such as lack of policy integration from national to local

strategy, isolation of the departments, or absence of political will (Borgström, 2019; Kauark-Fontes, Marchetti, et al., 2023). While barriers are described in many kinds of literature mainly by analysing diverse scales and types of NbS, it is vital to acknowledge further analysis on evaluating processes and structures in implemented NbS. Learning from previous experiences is an opportunity to gain new, nuanced knowledge for future NbS projects (Voskamp et al., 2021).

1.2 Ukrainian Urban Landscape

Bridging Europe and the Eurasian Plain lies Ukraine, a country currently grappling with an unstable geopolitical situation, war, and environmental challenges (National Geographics, 2024). Thus, international partners strengthened support and collaboration by including Ukraine in sustainable programs like the LIFE Programme run by the European Commission (EC) and climate policies, the EU4Climate project introduced by the EC, and the United Nations Development Program (UNPD) (UNPD, n.d.; European Commission, n.d.). Different geographical locations, particularly its cities, stand on the frontlines of climate change, contending with issues such as changes in weather patterns, biodiversity loss, and water scarcity (UNDP Ukraine, 2023; Shumilova et al., 2023). The city of Rivne was chosen to participate in the Horizon Europe Programme that supported the European Union (EU) Mission: Climate-Neutral and Smart Cities for enhancing climate change (CC) and adaptation measures (EIT, n.d.). Rive is categorised in the small and medium-sized cities¹ (SMCs) category in Ukraine and exemplifies these challenges, contending with rising average temperatures, recurrent droughts, and notable shifts in precipitation patterns (Pol et al., 2022, p.28). Despite boasting abundant water resources compared to its regional counterparts, Rivne faces a critical need for focused attention on water management (Pol et al., 2022, p.41). This necessity is underscored by the city's future sustainable development concerning water management.

These factors disrupt the natural water cycle, destabilising the city's microclimate and necessitating strategic interventions to ensure sustainable water management practices (Pol et al., 2022, p.46). Moreover, these hazards pose significant threats to the environment, public health, and the well-being of urban populations (UNPD Ukraine, 2023). Currently, Ukraine is considered one of the most environmentally deteriorated areas within the former Soviet Union, with 70% of its population living in regions that present environmental hazards (Piasecki, 2022). Recognising the pressing need for action, an approach gaining traction is Nature-based Solutions (NbS), which is widely applicable in the complex landscape of cities and provides innovative solutions for addressing environmental risks while enhancing urban resilience (EC, 2020). The International Union for Conservation of Nature (IUCN) defines NbS as 'actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits' (IUCN, n.d.). While the benefits of NbS are known, each city has its socio-political context, governing structures, policies and resources that should be considered throughout the governing urban processes. This emphasised that Ukrainian SMCs such as Rivne faced multiple sustainable challenges (Ecoclub, 2023). The local government in Ukraine needs to learn from successful NbS projects in Europe. Such knowledge sharing will contribute to global agendas like the Sustainable Development Goals by the United Nations and facilitate Ukraine's European integration process (UNhabitat, 2022).

¹ Small and medium-sized cities refer to cities with populations between 50,000 and 500,000 inhabitants (OECD, 2024).

² Grey infrastructure refers to artificial structures made of hard building materials, such as dams and barriers (Flood Resilience Portal, 2019).

1.3 Research Problem

The literature suggests that urban natural resources management necessitates a more flexible and diverse involvement of stakeholders, thereby transforming the current urban regime. One such mode is collaborative governance, as highlighted by Van Der Jagt et al. (2021). In this research project, the concept of governance is adapted from Sekulova and Anguelovski (2017), describing the governance of NbS as involving complex interactions among various social and political actors, contexts, and viewpoints. It encompasses the relationships between governmental bodies and civil society, including both formal and informal institutions, regulations, mechanisms, and collective decision-making processes. However, the theoretical landscape is marked by numerous similar and overlapping forms, such as hybrid, reflexive adaptive governance, and nature-based thinking, each with distinct characteristics (Kauark-Fontes, Ortiz-Guerrero et al., 2023; Mercado et al., 2024; Toxopeus et al., 2020; Van Der Jagt et al., 2021). This lack of uniformity is attributed to the absence of universal conditions in cities and the diversity in management structures (Monstadt, 2009).

Across Europe, numerous projects demonstrate collaborative efforts between private and public entities, often facilitated by international organisations and cooperative initiatives, resulting in successful NbS project execution. While the outcomes of these projects may be significant, it is imperative to explore and analyse how multiple actors operate and collaborate through the transdisciplinary approach of NbS (Kauark-Fontes, Marchetti et al., 2023). This is important due to mapping methods that enable implementation of NbS, while also understand how these methods shapes governance mechanisms compared to traditional ones.

The literature frequently advocates radical changes in city governance structures by transitioning from government to governance, particularly in heterogeneous urban environments where multiple interests, willingness, and agendas converge (Castán Broto et al., 2019). This paradigm shift entails moving away from authoritarian regimes and control management methods towards more decentralised systems, where different levels of government collaborate through various mechanisms (Bulkeley et al., 2009.; Colucci, 2022). This model, known as multi-level governance (MLG), involves cooperation between national, regional, and municipal governments in planning, envisioning, and managing urban units (Bulkeley et al., 2009).

In Europe, the urban landscape is closely intertwined with the practice of MLG, often examined through the theoretical lens of its operationalisation (Kabisch et al., 2022; Kauark-Fontes, Marchetti, et al., 2023). However, there is a growing need to address specific questions regarding SMCs and their capacity to transfer and implement policies from national and regional levels (vertical coordination) to address local sustainability challenges (Gustafsson & Mignon, 2020). However, horizontal coordination is also important to delve into urban transformations by creating cross-municipal departments (Bulkeley et al., 2009). These considerations are contingent upon the local resources and capacities of the government, which directly influence the implementation of NbS practices.

In this regard, the literature lacks a systematic review of governing principles in SMCs that are likely to deliver benefits to society and the environment. There are a few case studies analysed in Europe, while no sufficient research on how implemented NbS in SMCs set the processes and structures while overcoming administrative, policy, social and financial barriers (Gustafsson & Mignon, 2020; Monstadt, 2009). Moreover, implemented NbS projects across the EU are highly influenced by policies and regulations from the EC. As such, it would be beneficial to conduct additional research on socioeconomic regions outside of Europe to obtain a more varied perspective on integrating NbS into urban landscapes (Kauark-Fontes et al., 2023).

The literature indicates that urban natural resources management requires a more flexible and diverse involvement of stakeholders, thus transforming the current urban regime. One such mode is collaborative governance (Van Der Jagt et al., 2021). However, many similar and overlapping forms in theory do not have a unified view and character, such as hybrid, reflexive adaptive governance and nature-based thinking (Kauark-Fontes, Ortiz-Guerrero et al., 2023; Mercado et al., 2024; Toxopeus et al., 2020; Van Der Jagt et al., 2021). One reason is the lack of universal conditions in cities and the diversity in management structures (Monstadt, 2009). Numerous European projects illustrate collaborative efforts between private and public entities, often facilitated by international organisations and cooperative initiatives, yielding transformative outcomes in the execution of NbS projects. While the outcomes might be significant, exploring and analysing how multiple actors operate and collaborate through the transdisciplinary approach of NbS is vital. (Kauark-Fontes, Marchetti, et al., 2023). At the same time, most studies aim to investigate different types of projects in NbS and their corresponding governing methods (Kabisch et al., 2022). However, to get a deeper analysis and specific knowledge, it is necessary to study the specifics of one type of project.

1.4 Aim and Research Questions

This thesis aims to develop and test *a conceptual framework that will contribute to knowledge on more effective governance of NbS in SMCs*. To achieve this goal, the study examines through theoretical perspectives by conducting systematic literature review taken from various interdisciplinary fields (policy, urban planning, and environmental sustainability) and conducting interviews with experts in NbS development, city governance and water management. Then, the conceptual framework is tested through successful NbS projects across different locations in European SMCs, thereby advancing nuanced knowledge from empirical and theoretical perspectives. The research questions (RQ) are presented:

1. Which forms and modes of governance are likely to help NbS realise their co-benefits and lead to sustainable urban transformations?
2. What are the fundamental governing principles towards transformative NbS for sustainable water management in small and medium-sized cities?
3. How can the governance of water resources in Rivne be enhanced?

1.5 Scope

This research focuses on bringing nuanced knowledge to Rivne City in Ukraine by exploring NbS projects in EU SMCs and learning from existing literature on effective governance principles.

Academic literature from Europe was analysed to answer the RQ1. By exploring theoretical perspectives in several fields, such as policy, urban planning, and sustainable urban governance, as well as the available materials of case studies in SMCs. For the RQ2, snapshot cases of four NbS from UNA were analysed. All projects addressed sustainability challenges similar to those of Rivne NbS in terms of WRM and water quality. Such diversity provides a more nuanced picture, allowing the author to explore the main similarities and differences in structures and implementation settings. The number of cases was chosen due to the time limitations and data availability. Lastly, the RQ3 entails conducting interviews with stakeholders, revising literature and materials from the Rivne while also considering external grey literature about laws and regulations in Ukraine.

It should be noted that this thesis focuses on local governance and municipalities and excludes analyses of networks, regional or national targets for CC and how municipalities confront or adapt to them.

1.6 Ethical Considerations

The research emphasised social and political aspects, and collaboration with non-governmental and governmental actors underscored the importance of thorough communication preceding the processing and utilising of relevant information. Before conducting interviews, participants received detailed information outlining the study's purpose, its nature, and their right to withdraw from the research, accompanied by a consent form (Appendix D). Explicit confirmation of their voluntary involvement was sought, and stringent measures were implemented to ensure the confidentiality and anonymity of participants.

Adhering to research standards, any potential risks associated with the information gathered during interviews were transparently acknowledged, and consent was obtained for processing data exclusively for thesis writing, including approval for recording interviews. To safeguard participants' privacy, all materials acquired were securely stored on the author's hard drive, protected by a password designated exclusively for research objectives.

Moreover, the thesis was undertaken independently without any organisational affiliations. While snapshot cases were obtained through the Urban Nature Atlas database developed in the NATUREVATION project, there was no influence from the project's researchers or interviewed stakeholders that may have affected the results. Additionally, contacts with stakeholders in Rivne were established through networking, and none of the individuals were able to influence this research project. It is essential to recognise that the research findings were subject to the author's interpretation and may have been influenced by prior experiences and acquired knowledge. Finally, this study was assessed following the research ethics guidelines of Lund University, and it was determined that a statement from the ethics committee should not be required.

1.7 Audience

This research provides knowledge for various urban actors involved in governing NbS in SMCs, including urban planners, policymakers, non-governmental organisations and city government. Focusing on niche NbS projects to enhance water quality and WRM offers valuable insights for city actors grappling with similar sustainability challenges. Applicable lessons and knowledge transfer from successful European cities to the case of Rivne, Ukraine, could help enhance governance practices. While the findings explore the context of SMCs, it is essential to note that the research does not propose a one-size-fits-all solution for all cities, emphasising the need for further investigations to assess its applicability to other urban settings.

From an academic perspective, this thesis delves into urban governance and sets directions for future research, providing both practical and theoretical perspectives. It contributes theoretical knowledge for stakeholders seeking to apply effective governance principles tailored to specific city contexts. Lastly, *Chapter 7* of this thesis offers more detailed insights for city government, urban actors and practitioners.

1.8 Disposition

This thesis begins with *Chapter 1*, introducing the background and problem, outlining its aims, research questions, and ethical considerations. It then systematically addresses *Chapter 2* (literature review), *Chapter 3* (methodology), *Chapter 4* (conceptual framework), *Chapter 5* (analysis and results), *Chapter 6* (discussion), and *Chapter 7* (conclusion), providing a comprehensive examination of urban climate governance, NbS, and water governance, with a specific focus on SMCs.

2 Literature Review

This chapter provides a comprehensive overview of the research topic, exploring concepts such as urban climate governance, urban nature-based solutions, and governance of water management while also examining connected sub-themes. It compiles and analyses recent literature in these areas, contributing to developing a conceptual framework in Chapter 4. Additionally, based on the reviewed literature, the chapter concludes by identifying gaps and discussing how this research aims to address them.

2.1.1 A paradigm shift to climate urban governance

The historical shift from traditional government approaches to climate governance has been significant. Previously, governmental authorities primarily addressed local challenges through linear processes driven by top-down regulations and command-and-control mechanisms (Colucci, 2022; Heinen et al., 2022; Jagers & Stripple, 2003). However, this shift has pivoted towards addressing global environmental challenges (Betsill & Bulkeley, 2006). In 2015, 195 countries in the international arena designed by the United Nations Framework Convention on Climate Change (UNFCCC), signed the Paris Agreement, committed to confronting CC, recognising it as the main challenge to sustainable development (Coen et al., 2020; Hickmann, 2017; Kronvall et al., 2023).

In essence, there is a pressing need for the national government to transfer global agendas and commitments on CC to actions on the ground (Bulkeley et al., 2009). As traditionally arranged, policies primarily took place at the national and international levels. However, after the Fifth Assessment Report (AR5), the role of sub-national governments was strengthened. Regional and local were marked as necessary due to their goals for addressing global agendas (Pietrapertosa et al., 2021). Consequently, it became apparent that state governments alone could not adequately address such complex challenges (Betsill & Bulkeley, 2015).

Therefore, Bulkeley and Castán Broto's (2013) research discovered that municipalities were the predominant actors in experimentations and advancements across various sectors. As such, municipalities are integrated into a relatively stable framework comprising formal regulations, informal customs, and resource structures, limiting and empowering their actions (Kronsell & Mukhtar-Landgren, 2018). Their role in the experimental CC governance seemed significant (Nieminen et al., 2021). This led to the redistribution and reconfiguration of state authority, granting substate and non-governmental actors access to decision-making (Hickmann, 2017). In particular, the role of the municipality was marked as important. As such, an understanding of this reconfiguration, climate governance was described as “a set of actors, institutions, arrangements, interventions and instruments that together— because of their distinct qualities can be taken to represent the governance of a particular domain that we have come to know as climate change” (Bulkeley, 2015, p.8).

For example, the EU has taken the lead in aiming to achieve climate neutrality by 2050 (EUR-Lex, n.d.). In 2015, the EC introduced the initiative of the Covenant of Mayors (CoM) framework for addressing CC, which is based on three pillars: Adaptation, Mitigation, and Energy Power. Within this initiative, the EC aims to integrate EU climate policies and strategies by supporting local governments in cities through bottom-up governance, engagement with multiple stakeholders, and developing context-specific action plans (EC, n.d.-b).

Furthermore, according to Betsill and Bulkeley (2015), the focal point for climate governance has shifted to cities, serving as a starting point for developing climate measures and policies. As hubs of human activity and development, cities also significantly contribute to CC, accounting for approximately 75% of the world's total (Eichhorn et al., 2021; Ferrini & Gori, 2021). They pose challenges and opportunities, mainly through fostering innovation and experimentation (Castán Broto et al., 2019; Nieminen et al., 2021). Nevertheless, even with such initiatives, decentralisation and policies in place, there is limited action on the ground (Kronvall et al., 2023). It can be marked by the incapacity of governance models to manage the intricate interplay of relationships, competing goals and priorities, varied capabilities, and knowledge assets stemming from multiple stakeholders (Eichhorn et al., 2021).

The studies from the up-to-date literature frequently focus on big cities or the ones that are the frontrunners in climate governance with more than 500,000 residents (Costadone & Vierikko, 2023; Bulkeley & Castán Broto, 2013; Boeri et al., 2022). It can be understood by their significance in economic, environmental and political contexts, representing a dramatic increase in urbanisation and included in living labs and international networks (Bulkeley et al., 2009; Bulkeley & Castán Broto, 2013). They represent centres for innovation, technology development and creative places (Ferrini & Gori, 2021). Therefore, the first actions on CC were taken in leading European and North American cities through local municipalities addressing climate mitigation issues (Bulkeley et al., 2009).

However, several studies point out that SMCs, in contrast to their megacity counterparts, are underrepresented in studies aimed at developing effective governance mechanisms for addressing CC. At the same time, research conducted in European countries has revealed that only 25% of EU cities strive to achieve climate neutrality, primarily due to the cities' sizes (Salvia et al., 2021). The study from Kronvall et al. (2023) explained that one of the reasons for the focus on megacities was high evidence of climate impacts. Such impacts might include frequent extreme weather events and heat waves (Khanh et al., 2023). At the same time, Vedeld (2022) noted limited knowledge from theoretical and empirical perspectives for analysing SMCs. This knowledge might include but is not limited to understanding local circumstances, necessities, drivers, and challenges within the governance processes that occurred in those cities (Colucci, 2022; Kronvall et al., 2023).

Despite the multitude of reasons why SMCs lag, it is imperative to ensure they are adequately equipped to respond to existing and future environmental challenges that might threaten their existence. They represent regional centres for economic growth through job creation and demonstrate innate importance for Europe's environmental and cultural heritage (Szydarowski et al., 2024). Additionally, their potential lies in building future sustainable cities by learning from others' examples and recreating new places in social, environmental, and economic dimensions (Vedeld, 2022).

2.1.2 Understanding urban transformations

Cities represent dynamic systems with constant changes (Hölscher & Frantzeskaki, 2020). Such systems include material, people, and natural flows with various interests, perspectives, and objectives (Castán Broto et al., 2019). Additionally, cities are often influenced by a set of factors such as urbanisation, economy, global events like the Covid-19 pandemic, and social disruption (Hölscher & Frantzeskaki, 2020; Ferrini & Gori, 2021; Rybski & González, 2022; Zhang et al., 2023). As such, cities are not only homes for millions of people but also centres for addressing social inequalities, pollution, and waste generation (Cao, 2023; Castán Broto et al., 2019; Hölscher & Frantzeskaki, 2020; World Bank, n.d.). Meanwhile, the ongoing debate revolves around the execution and integration of holistic approaches for fundamental urban transformations (Borgström, 2019; Glaas et al., 2019). In the academic literature, several

terminologies go under transformation; the ones that refer to city context are presented in Appendix A. Therefore, urban transformations refers to “the process and the outcome of changing the systemic configuration of urban areas, and is mostly studied with a view to its sustainability performance or achievements”(Wolfram et al., 2016).

In studies by Hölscher & Frantzeskaki (2020) and Wolfram et al. (2016), three main viewpoints on urban transformations are identified, rooted in the drive to collaboratively and sustainably alter urban settings. These viewpoints are urban change, system relations and system change. The first viewpoint can be understood as transformations that occur on the ground and are influenced by changes in structures and processes. The second viewpoint suggests that transformations are concurrent system restructuring where new activities, local needs, and interactions appear due to the changing dynamics of cities. The last viewpoint recognises the importance of local urban changes with systems relations to serve the global agendas for CC (Hölscher & Frantzeskaki, 2020; Wolfram et al., 2016). Even though the three viewpoints are conceptualised in codependent and multi-scalar ways, they are driven in a novel and experimental manner (Borgström, 2019). This gives a sense of how complex the nature of urban transformation is while also presenting a need for a shift in human-nature relations.

Urban transformations cause compound governance challenges (Castán Broto et al., 2019; Nieminen et al., 2021). Local authorities are exposed to navigating transformations with a “high degree of uncertainty, as it is not always clear what exactly should be transformed and why, nor how the transformation is meant to happen” (Kronvall et al., 2023, p.2). The complexity of various societal segments sometimes leads to inertia even when change is necessary (Nieminen et al., 2021). In response, local authorities have assumed a leadership role in systematically integrating these changes (Nieminen et al., 2021; Kronvall et al., 2023). Finding innovative approaches to rethinking planning, decision-making processes, and governance models is essential for urban transformations (Gustafsson & Mignon, 2020).

Hölscher et al., 2019 suggest employing the capacity framework to enhance and actualise urban transformation. As such, transformative capacity considers the varied institutions, resources, capabilities, and interactions necessary to empower actors individually and collectively to bring about systemic change effectively (Wolfram et al., 2016). This framework includes four types of capacities: adaptive, regulative, innovative, and orchestration (Kronvall et al., 2023; Wolfram et al., 2016). Local authorities utilise these performance indicators to comprehend the dynamics of transformations, delineate essential conditions, and organise activities in areas where transformations are enacted. According to Kronvall et al., 2023, this method proves particularly useful for practitioners and stakeholders in urban settings and for scholarly research aiming to explain the initial phases of requisite changes. Although this framework evaluates urban transformations within governance processes and activities, it can be universally adapted to different scales of cities and their changes.

2.1.3 Governance choices for urban transformations

Transformations are governed by multiple actors from the public and private sectors and also through different governmental level and its term originates from the EU and is known as multi-level governance (MLG). It examines governance structures involving formally interdependent entities collaborating to handle mutual interconnections (Bulkeley & Betsill, 2005; Heinen et al., 2022). This encompasses activities such as information sharing, coordination efforts, and support each other in addressing climate challenges (Nieminen et al., 2021). In this context, MLG aligns with democratic processes, suggesting that urban transformation endeavours should adopt governance strategies that involve a wide range of stakeholders, including residents and communities (Ferrini & Gori, 2021; Vedeld, 2022).

As such, collaborative approaches are becoming more prevalent, with numerous European cities actively engaging with communities and residents. This involvement includes experimenting with new roles, responsibilities, and methodologies to reimagine the future of cities. Society and residents are cities' primary users, producers, buyers, and proprietors (Boeri et al., 2022). However, despite the emergence of such approaches, a study by Emeis & Fallmann, 2022 suggests that they remain somewhat limited in scope, mainly due to existing regulatory frameworks that exclude these inclusive processes from conventional administrative procedures. Additionally, Brink & Wamsler, 2018 highlighted that citizen participation remains active exclusively in emerging situations as hazard events. Therefore, it is essential to recognise that different cities may face different conditions, possess varying resources, and have diverse capabilities, which can add complexity to implementing collaborative initiatives.

In the research, Nieminen et al., 2021 highlighted that different actors, such as building developers, planners, engineers, and policy analysts, are also involved in the governing. Their role is essential because they interact and operate in the urban system. Thus, they have to consider long-term thinking in equity, justice, ethics and long-term benefits (Wilkes-Allemann et al., 2023). For example, private businesses and organisations can contribute to this process by leveraging additional resources and the opportunity to innovate (Vedeld, 2022). Entities and their actions within their networks can thus become mutually reliant, emphasising the growing significance of collaboration in policy formulation and execution (Nieminen et al., 2021). Each actor, in their way, can engage with others to enhance urban transformations through specific opportunities.

From the legal perspective, municipality governments remain influential in governance processes (Costadone & Vierikko, 2023; Nieminen et al., 2021). It is augmented due to their power and in-place decision-making process (Colucci, 2022; Gustafsson & Mignon, 2020; Nieminen et al., 2021). They are characterised by short-term political coalitions, which influence favourable cities, long-term changes, and urban transformations (Mendizabal et al., 2021). The research from Borgström, 2019 suggested that building partnerships, like with local NGOs, can reshape formal regulations and procedures required to oversee and govern cities (Emeis & Fallmann, 2022). That sense would allow efficient coordination of activities and promote more collaborative forms of governance (Nieminen et al., 2021).

2.1.4 Understanding nature-based solutions

The concept of NbS underscores the strategic and integrated utilisation of natural ecosystems to enhance human well-being cost-efficiently (Toxopeus et al., 2020). Implementing NbS involves deploying goal-oriented solutions to address various urban challenges, including climate mitigation and adaptation, by adjusting existing infrastructure or integrating green and blue infrastructure into urban landscapes (Dushkova & Haase, 2020). Moreover, NbS is poised to significantly contribute to accelerating urban sustainability transitions and resilience initiatives (Adams et al., 2023). For example, the restoration of native ecosystems can fortify soil and vegetation, thereby reducing the risk of floods, droughts, and landslides through improved water infiltration and storage, as well as stabilising slopes and shores while mitigating wave energy (Scolobig et al., 2023). Kauark-Fontes et al. (2023) also emphasised that NbS enhances the urban environment, bolsters social capacity, contributes to place-making, improves physical and mental health, and mitigates economic vulnerability.

The essence of NbS lies in its capacity to deliver multiple benefits across economic, environmental, and social domains (Kiss et al., 2022; Wamsler et al., 2020; Bulkeley et al., 2023). One of the critical advantages of NbS over technical alternatives is their ability to provide these co-benefits, which go beyond addressing specific challenges and enhance various aspects of well-being (Albert et al., 2019). However, there is evidence suggesting that normative

perspectives may lead to an uneven distribution of these benefits (Albert et al., 2019; Toxopeus et al., 2020; Cooper et al., 2023; Hölscher et al., 2024; Voytenko Palgan et al., 2024). Therefore, researchers emphasise the importance of developing effective governance models that ensure fair allocation and equitable evaluation of these benefits among stakeholders while enhancing NbS uptake.

At the same time, implementing NbS involves various actors from both private and public sectors, each with distinct roles determined by their decision-making authority (Sarabi et al., 2019; Zingraff-Hamed et al., 2021). Municipal governments, residents, and NGOs are crucial in this process (Zingraff-Hamed et al., 2021; Kiss et al., 2020). For example, Bradley et al. (2022) and Adams et al. (2023) have identified critical roles based on successful case studies. Enablers initiate NbS projects and provide ongoing support, leaders coordinate the entire process, gatekeepers approve or limit development, and mediators connect isolated actors and enhance project networks. However, it is essential to note that no one-fit-all composition of actors exists for NbS implementation. This composition rather represents the ones in charge of NbS implementation. Meanwhile, from the practical perspective, it offers an opportunity to explain how actors in real situations inform, consult, and get involved through entire phases, from visioning to implementation (Zingraff-Hamed et al., 2021).

Implementing NbS faces numerous challenges, including institutional, organisational, and cultural barriers (Hölscher et al., 2024). One significant issue is inadequate financing, often characterised by short-term funding (Sarabi et al., 2019; Voskamp et al., 2021; Kauark-Fontes et al., 2023). Moreover, Frantzeskaki et al. (2020) highlighted a deficiency in knowledge and skills among various stakeholders engaged in different stages of NbS projects. Van Der Jagt et al. (2023) also pointed out limited policy development, while Kabisch et al. (2022) identified path-dependencies of existing urban systems and a reluctance to change as further challenges. Colucci (2023) and Kabisch et al. (2022) propose that open dialogue among academia, practitioners, and relevant stakeholders is essential for transparent communication during the design and implementation phases. This collaboration facilitates the identification of flexible governance models to prevent or potentially overcome challenges.

2.1.5 Governance of nature-based solutions

NbS, as integral components of urban transformative processes, necessitate novel governance approaches (Wickenberg et al., 2022). While traditional linear and top-down governance models may effectively address immediate environmental challenges, they often fail to ensure long-term viability and equitable distribution of benefits among stakeholders (Kiss et al., 2022; Zingraff-Hamed et al., 2021). For example, the EU emphasised the application of polycentric governance (PCG) for managing public goods. In the context of NbS, PCG often highlights the importance of the local level and its ability to regulate itself (Homsey & Warner, 2015). In that way, PCG aimed to incorporate novel public administration arrangements involving multiple institutional scales and sectors. Moreover, compared to other traditional modes, PCG offers new learning and experiment opportunities (Martin et al., 2021; Cooper et al., 2023). Thus, PCG represents a shift towards more adaptive and collaborative governance approaches.

At the same time, there is evidence from various studies indicating that collaborative approaches show inherent effectiveness in navigating the complexities associated with the implementation of NbS (Voytenko Palgan et al., 2024; Hölscher et al., 2024; Kauark-Fontes et al., 2023; Wickenberg et al., 2022; Kiss et al., 2022; Voskamp et al., 2021; Frantzeskaki et al., 2020). These collaborative methods involve interdisciplinary engagement, multi-stakeholder participation, and cross-sectoral coordination, as emphasised by the research of Hölscher et al. (2023), Toxopeus et al. (2020), and Frantzeskaki (2019). Therefore, their characteristic often lies in co-design, co-production and co-management, reflecting the stages of NbS development. As such,

it means that through ongoing activities and processes, multiple stakeholders commonly integrate NbS into the city context (Kiss et al., 2022; Adams et al., 2023; Van Der Jagt et al., 2023; Adams et al., 2024; Hölscher et al., 2024).

However, challenges arise in how stakeholders interact within governance structures, mainly due to conventional planning methods and segmented governance frameworks (Voskamp et al., 2021). Hence, research by Van Der Jagt et al. (2021) and Kiss et al. (2022) stressed the importance of reflexive governance. It acknowledged the complexity of assessing system dynamics, recognising that actors often differ in their interpretations of system boundaries and strategies for achieving diverse sustainability goals, including climate resilience, biodiversity conservation, and social justice (Van Der Jagt et al., 2021). Therefore, the promotion of reflexive governance underscores the imperative for ongoing reflection and adaptation to address the evolving challenges associated with implementing urban NbS, ensuring that diverse perspectives and strategies are considered to achieve comprehensive sustainability objectives.

Meanwhile, Van Der Jagt et al. (2023) highlighted that citizen involvement could stipulate the long-term liveability of NbS projects. In contrast to governmental actors with brief political tenures, citizens can cultivate enduring commitments within appropriate governance measures and enhance their capacity to act over the long term through the project (Kiss et al., 2022; Colucci, 2023). As such, some NbS projects can fully realise their co-benefits only over a long period (Sarabi et al., 2019). Additionally, the ability of NbS to address current societal challenges implies that NbS transformations should be considered within broader agendas and political debates regarding the extent and magnitude of change, significantly to benefit individuals experiencing deprivation (Mercado et al., 2024).

2.1.6 Introducing freshwater ecosystems

The freshwater ecosystems (FE) form an interconnected network comprising lakes, rivers, ponds, glaciers, and groundwater, acting as conduits that link land and sea, facilitating the transfer of water, substances, and organisms across various systems (Maes et al., 2020; Mubi Zalaznik et al., 2023). River ecosystems are characterised by flowing water, while lake ecosystems feature stagnant water. Riparian zones, floodplains, and lakeshores, which interface with these water bodies and their catchments, play pivotal roles within freshwater ecosystems (Maes et al., 2020). However, human activities, inadequate water management, and the impacts of CC have significantly disrupted their functioning (Mubi Zalaznik et al., 2023).

Furthermore, burgeoning urbanisation trends in urban freshwater ecosystems, such as water shortages, declining water quality, overexploitation of water resources, ageing infrastructure, and concerns about future financing for upgrades and modernisation, underscore the importance of ensuring the livability of cities for both current and future generations (Algaba et al., 2023). In response to these challenges, NbS offer a promising approach to addressing water-related issues (Ramírez-Agudelo et al., 2020). NbS directly addresses these issues and benefits society (Ramírez-Agudelo et al., 2020). NbS for water-related issues can be called nature-based urban water solutions (NB-URS) for this thesis.

By incorporating NbS tailored to address water sustainability issues, such as through hybrid combinations of green, blue, and/or grey infrastructures. A detailed overview of represented grey to green NbS solutions can be found in *Figure 2-1*. NbS, as location-specific interventions, alter the landscape management approach compared to conventional infrastructure projects. This shift is achieved by highlighting the interconnectedness between green (vegetation) and blue (floodable areas, water) spaces, as well as the impact of alterations in land covers and land uses (Ramírez-Agudelo et al., 2020). Given its significance to FE security, water offers society numerous indispensable benefits, often called "ecosystem services." These include access to

drinking water, biodiversity support, food production, well-being, recreational opportunities, and carbon sequestration (NetworkNature website, n.d; Ramírez-Agudelo et al., 2020). Therefore, as noted by Mubi Zalaznik et al. (2023), these NbS represent innovative infrastructure initiatives that aim to achieve a holistic and unified approach to urban transformations in local water management, considering diverse sectors, stakeholders, and requirements.

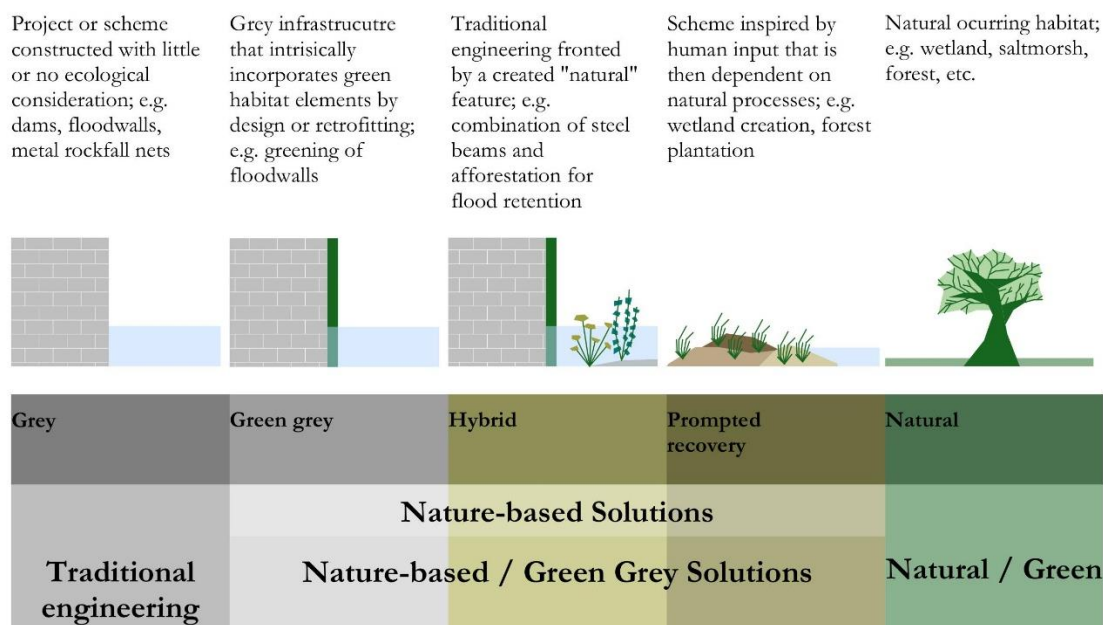


Figure 2-1: The Spectrum of Infrastructure Strategies Ranging from Grey to Green

Source: Author's interpretation. Adapted from Martin et al., 2021

2.1.7 Water governance in the European Union

In the EU, the European Commission has established a robust long-term water management strategy, emphasising the sustainable use of water bodies (European Parliament, 2023). Specifically, examining the Water Framework Directive (WFD), Floods Directive, and Marine Strategy Framework Directive (MSFD) highlights the necessity for improved adherence to their objectives, aiming for full compliance by 2027. This could be achieved by adopting best practices in green infrastructure and reducing pollutants at their sources, indicating substantial potential for Nature-based Urban Water Solutions (NB-URS) to enhance the implementation of these directives (Wilk et al., 2023). However, the study from the European Investment Bank (2023) highlighted that among these policies, the main driver for change remains the WFD, where Member States (MS) are obliged to develop river basin management plans and implement a series of measures to achieve good water quality status (Ryfisch et al., 2023). Even though it seems to play a pivotal role, the information regarding the extent and characteristics of measures is presently unavailable from all MS.

While EU-funded research and projects, such as NICE, have been implemented, their scope is limited as they only involve a few Member States (CORDIS, 2023). When considering other well-known and widely implemented NbS, like community gardens and urban parks, NB-URS appears to represent a niche solution applicable to specific regions where water-related issues are urgent (Suleiman, 2021). Within the EU, 84 NB-URS projects were identified (Wilk et al., 2023). According to the 2021 UNEP State of Finance for Nature report, global investment in

nature has reached EUR 113 billion, with EUR 27 billion allocated to European projects. However, despite this significant investment, less than 1% of total water management financing worldwide is directed towards NbS. The study by Oral et al. (2020) further highlighted that while NB-URS can be designed for water sources with varying characteristics, its adoption in urban settings is expected to increase. Therefore, it is evident that enhancing NB-URS implementation in urban settings necessitates more efficient integration of cross-sectoral approaches and requirements, aligning with holistic perspectives.

NB-URS adoption in urban areas is simultaneously constrained by specific challenges (Oral et al., 2020; European Commission, 2020; European Investment Bank, 2023). The existing trade-off between economic development and environmental protection remains pressing in the EU (European Commission, 2020). In addition, assessments often overlook the trade-offs among various interventions and ecosystem services and differing experiences of the costs and benefits of NB-URS among stakeholder groups (Vasileios et al., 2022). This is further complicated because water resources represent public goods, typically controlled by a single entity, in the case of the EU river basin authorities, which in most cases fund NB-URS projects due to its high implementation costs (European Investment Bank, 2023). Additionally, while several benefits can be designated, the challenge implies that most of them are non-monetary, and thus, it is hard to verify their value (Vasileios et al., 2022). This emphasises the complexity of the water management sector; sustainable adoption of NB-URS relies mainly on cooperation and collaboration among stakeholders, considering the multitude of influences and operational activities involved.

2.2 Summary

In order to address global CC challenges, NbS stands as a promising solution for urban transformations. NbS is an innovative solution that delivers social, environmental, and economic benefits. Despite the urgent necessity for NbS implementation in cities, their adoption faces numerous obstacles, including political, institutional, and knowledge-related hurdles, necessitating a shift within existing socio-technical systems. Given the intricate nature of NbS, several researchers have highlighted the local government's incapacity, currently the primary actor in NbS development, to navigate bureaucratic processes and transition to decentralised governance models. Thus, the starting point would be to catalyse new forms of cross-sectoral, multilevel, and interdisciplinary governance of NBS toward transformative change.

Additionally, up-to-date academic literature suggests that NbS should be well-integrated into cities' visions, strategies, policies, and planning measures. Big cities provide diverse positive examples, as they are more capable regarding resources, knowledge, and available finances. However, specific attention should be given to SMCs, where NbS should be developed far behind.

While researchers Zingraff-Hamed et al. (2021) and Voytenko Palgan et al. (2024) pointed out that a "one-size-fits-all" mode of governance does not exist, the overall tendency is moving towards collaborative, more inclusive modes and practices for NbS development. Therefore, the literature highlights opportunities for future research and implementation in new governance by translating the findings and lessons into practical and replicable tools for other cities. Empirical evidence from implemented projects within similar geopolitical locations and sustainability challenges could serve as a roadmap for the government and all involved stakeholders.

3 Methodology

This thesis aims to explore effective governance principles for water NbS. To achieve the aim, the author adopts an exploratory qualitative research approach, answering three structured research questions through systematic methods (Creswell & Creswell, 2018). This involved conducting a systematic literature review to gain theoretical insights into effective governance modes for NbS, forming the basis for developing a conceptual framework which is further enriched by interviews with experts. Additionally, the researcher selected snapshot case studies from the Urban Nature Atlas (UNA) database in European countries to uncover empirical insights from successful water NbS projects to enhance governance practices in SMCs. Based on theoretical and empirical knowledge, lessons were provided for the ongoing projects in Rivne to improve governance practices further. The structure of this chapter follows a progression from research philosophy (Section 3.1), research design (Section 3.2), case study research selection (Section 3.3), methods for data collection and analysis (Section 3.4) and concludes with considerations of research reliability and validity (Section 3.5).

3.1 Research Philosophy

3.1.1 Research Approach and Research Stages

The research adopts a pragmatic philosophical worldview to address RQ1, RQ2, and RQ3. Pragmatism is chosen for its ability to examine specific topics within political and social realities, recognising the complexities inherent in urban governance (Creswell & Creswell, 2018). By employing a mixed-method approach, researchers can explore actions, situations, and consequences related to the topic, drawing on empirical evidence from literature and real-world projects (Creswell & Creswell, 2018). This thesis employs multiple methods to understand the complexity of the governance for water NbS. It is important to note that the author's experience and knowledge may influence interpretations during data analysis and in the research findings.

3.2 Research Design

Given the limited research available on NbS governance in small and medium-sized cities and considering the complexity of the research questions, an exploratory qualitative research design was chosen (Creswell & Creswell, 2018). This approach was further enriched by integrating snapshot case studies to offer practical insights and deepen comprehension within the water NbS projects. *Figure 3-1* visually outlines the key stages and flow of the study, which are divided into three stages.

| Research Stages | Task | Methods | Research Questions |
|---|---|---|---|
| Stage 1 Literature Review | Understanding theoretical perspective on urban climate governance, NbS governance, water management and water governance | Systematic Literature Review: 60 articles | RQ1: What forms and modes of governance are likely to help NbS realise their co-benefits and lead to sustainable urban transformations? |
| Stage 2 (part I) Development of the Conceptual Framework | a) Map effective factors/aspects for governing NbS; b) Gain practical perspectives on NbS, city governance, water management | a) Systematic Literature Review; b) Interviews with experts (6) | RQ2: What are the fundamental governing principles towards transformative NbS for sustainable water management in small and medium-sized cities? |
| Stage 2 (part II) Testing the Conceptual Framework | Empirically test Conceptual Framework on the Case Studies Analysis from the Urban Nature Atlas database | Database analysis and grey literature about NbS projects (4) | |
| Stage 3 Ustyia River Analysis | In-depth Analysis of the governance of the Ustyia River, Rivne | Interviews with stakeholders (6) from Rivne and grey literature materials | RQ3: How can the governance in Rivne be enhanced? |

Figure 3-1: Visualisation of Research Design

Source: Author's interpretation

3.3 Case Study Research Selection

In this qualitative research endeavour, the selected approach involves employing case studies. Case studies offer a design that enables researchers to analyse a particular case, encompassing events, activities, and processes (Creswell & Creswell, 2018). Also, such a design facilitates exploring multiple data sources through different perspectives (Yin, 2009). As a result, case studies can contribute to developing a comprehensive understanding of a multifaceted phenomenon in real-world contexts (Creswell & Creswell, 2018). Moreover, employing multiple cases can offer a more diverse phenomenon, as findings and conclusions are drawn from a broader range of studies (Yin, 2009).

Case Study Selection

Relevant case studies were identified through the UNA database, arguably as one of the most comprehensive and most extensive publicly accessible databases in Europe (UNA database, n.d). With over 1000 represented NbS projects, the UNA database provided an extensive array of options, making it a valuable resource for selecting suitable case studies. To select case studies for the thesis project, a set of criteria presented in *Table 3-1* was developed (Creswell & Creswell, 2018) by comprising both general criteria and specific criteria focused on niche NbS projects related to addressing similar water-related issues akin to the developing projects in Rivne.

Table 3-1: Selection Criteria for Case Studies

| Case Study Selection Criteria | |
|--|--|
| General Selection Criteria | <i>Geographical Location:</i> Projects located within the European Union. <i>City Size:</i> Projects situated in cities with up to 500,000 citizens. |
| Specific Selection Criteria for Water NbS | <i>Focus on Water Resources Management:</i> Projects addressing water quality challenges and water resources management. <i>Addressed Sustainability Challenges:</i> Water Management Sustainable Development Goal 6 (SDG6); Environmental Quality; Inclusive and Effective Governance Sustainable Development Goal 16 (SDG16). |

Source: Author's interpretation

Furthermore, an additional criterion was added, which was *accessibility*, including case studies from different parts of Europe that are still operating under one jurisdiction of the EU. The rationale for choosing the EU was the advanced research in the NbS and urban governance and Ukraine's close connection and integration into the EU. As NbS projects span different regions in the EU, the research project contributes to a more representative portrayal of governance practices across diverse geopolitical contexts. Therefore, the research project seeks to draw robust conclusions that account for the nuanced differences in European governance approaches.

Lastly, a criterion was established to ensure *diversity* within the research scope. This criterion encompasses different stakeholder involvement in the NbS projects and governance set-up. The rationale behind this decision stems from the project's aim to provide practical recommendations to Rivne based on comparable cities and best practices across the EU.

Ensuring diversity in the selection of case studies allows for a more comprehensive understanding of governance NbS. The final representation of chosen case studies can be found in *Table 3-2*.

Table 3-2: Case Study Selection

| Case | Type of NbS | Scale | Location | Governance Set-up |
|---------------------------------------|---|-------|----------------------|---|
| Ljubljana Connects | Blue infrastructure | Meso | Ljubljana, Slovenia | Private sector and university |
| Renaturalisation of the Wupper stream | Grey and blue infrastructure and parks | Meso | Wuppertal, Germany | Municipality government and public sector institution |
| Greening the Historical Canal | Grey and blue infrastructure and parks | Micro | Utrecht, Netherlands | Municipality government, society |
| Eco City Augustenborg | Blue infrastructure, green areas for water management, nature on buildings, parks and urban forests | Micro | Malmö, Sweden | Municipality government, private actors |

Source: Author’s interpretation is based on the Urban Nature Atlas database

3.4 Methods

Due to the novelty of the NbS governance concept concerning water quality and WRM involving multiple stakeholders, a method combining flexibility and semi-structured interviews was utilised to gather and analyse data. Therefore, such interviews allowed the author to incorporate new insights and perspectives. Triangulation, combining different data sources and methods to confirm results, was used during the case study analysis by collecting data from the UNA database and examining external documents (Creswell & Creswell, 2018). Due to the nature of the research questions, two data analysis and collection stages were adopted. In order to answer RQ1, primary data collection was done through up-to-date academic literature. It served as a fundament for developing the conceptual framework and answered the RQ2, which is situated in the second stages. Additionally, interviews with experts in line with the literature review were integrated to test, validate, and adjust the conceptual framework. At the same time, the thematic analysis allowed the researcher to perceive new insights based on different experts’ perspectives. In the last stage, Rivne's case study was analysed through interviews with stakeholders and academic and grey literature—the outcomes from the third stage, provided answer to the RQ3. Therefore, *Table 3-3* provides an overview of methods for data collection and analysis.

Table 3-3: Methods for Data Collection & Analysis

| Research Stages | Type of Information | Data Collection & Sources | Data Analysis |
|---|--|--|---|
| Stage 1: Literature review | Theoretical literature for understanding different elements of urban transformations, urban governance, urban NbS and governance of NbS and water management | Primary data – relevant academic literature from the researchers for gaining perspective on climate, urban governance, and NbS governance. | Thematic analysis using NVivo. |
| Stage 2 (part I): Developing Conceptual Framework | Experts' knowledge and experience in governing different NbS projects | Primary data – academic literature from the first stage of the research, including topics about NbS governance and water management/governance. Secondary data – 6 expert interviews with expertise in city governance, NbS or WRM. | Thematic analysis using NVivo. |
| Stage 2 (part II): Testing Conceptual Framework | Empirical data from snapshot cases from four NbS projects representing governance set-up, identification of involved stakeholders, activities, policy instruments and delivered co-benefits from NbS projects. | Primary data – UNA database including main information about the NbS projects. Secondary data – grey literature about each project implementation details. | Structuring and categorising based on the conceptual framework. |
| Stage 3: Rivne Case Study Analysis | Single case analysis in Rivne for Ustya river about governance based on the Conceptual Framework | Primary data – 6 interviews with stakeholders directly or indirectly involved in the projects for Ustya river. Secondary data – academic and grey literature, media, and policy documents. | Thematic analysis is based on a conceptual framework using Nvivo. |

Source: Author's interpretation

3.4.1 Methods for Data Collection

Depending on the stage of the research, different types of data collection were applied. During the first stage, a systematic literature review was conducted exclusively. For the development of the conceptual framework, part of the literature review was considered, and six interviews with experts were conducted. The developed conceptual framework was further tested through four case studies of NbS projects from the UNA database, incorporating grey literature to analyse the implementation aspects of each project. Lastly, during the analysis of Rivne, two types of

data collection methods were employed. First, interviews with relevant stakeholders were conducted using an interview guide that included an evaluation of elements from the conceptual framework. Secondly, academic and grey materials were incorporated for a more in-depth understanding of the context in Ukraine and Rivne. Each of these types of data collection is explained in detail in the following sections.

Systematic Literature Review

The literature review referenced above was directed by the research questions and aimed to comprehend the existing knowledge concerning climate governance, urban NbS, governance of urban NbS, and water governance. It spanned from January to April 2024 and entailed an examination of scholarly publications within Scopus, the largest multi-disciplinary database of peer-reviewed literature. The review followed three steps, drawing inspiration from various guidelines for conducting more systematic literature reviews (Okoli, 2015).

Step 1: Initial Publication Identification and Practical Screening. The author established screening criteria to ensure the inclusion of high-quality publications for this review. The initial criteria encompassed "peer-reviewed journal articles" while excluding conference papers, notes, letters, short surveys, editorials, errata, conference reviews, and data papers. Additionally, only publications in English and open access were considered. Primary searching terms can be found in Appendix B, which resulted in 249 articles.

Step 2: Theoretical Screening Application. Aligned with the study's objectives, the author evaluated conceptual and empirical articles' titles, abstracts, and keywords. Additional criteria focused on a clear emphasis on addressing key themes such as nature-based solutions, water quality, water resources management, or governance mechanisms were included. Nevertheless, papers examining NbS governance in small and medium-sized cities were limited but were added to the review. Also, articles that primarily focus on technical aspects of water treatment, engineering solutions, or ecological processes without addressing governance mechanisms or decision-making processes were excluded. Articles focusing on tourism, migration, and economic cost-benefit analysis were excluded. Lastly, articles that primarily focus on governance in non-EU countries were excluded. After this screening, 165 articles were excluded, resulting in 84 articles.

Step 3: Concluding Filtering and Analysis. The subsequent step involved excluding articles appearing multiple times across different search strings, eliminating 24 such articles. This yielded a final list of 60 relevant articles, then subjected to qualitative analysis. As a result, the outcomes from the conducted systematic analysis answered RQ1.

Interviews with Experts

Incorporating interviews with experts was crucial for gaining additional knowledge about NbS implementation and city governance, providing new insights and perspectives to strengthen the theoretical foundation of the conceptual framework. Contacts for experts were obtained through networks in the projects Naturescapes and NATURVATION (Naturescapes, n.d.; NATURVATION, n.d.). Each participant was informed via an email with an invitation letter, which can be found in Appendix C. When an expert agreed to participate, a consent form (Appendix D) was sent, and all agreements were received prior to the planned interview date. A total of 6 experts were confirmed, and the interviews were conducted during April 2024.

These semi-structured interviews with experts, a central element of qualitative empirical research, were conducted (Yin, 2009). The questions were kept broad and general to allow

participants to construct the meaning of a situation, and answers were typically formed through discussions (Creswell & Creswell, 2018). Depending on the expert, some additional questions were asked. To maintain anonymity, the interviewees' names were replaced with codes. A short description of interview details including the nature of the questions asked and aim is located in Appendix G. Lastly, the participants' positions, country locations, interview lengths, and dates, can be found in Appendix E.

Collection of Online Information for Case Studies Analysis

For the case studies analysis, data were thoroughly taken from the UNA database, which served as the primary data source. Additionally, further data collection was conducted by incorporating grey materials. These data not only supported information from the UNA database but also provided more detailed insights into how governance was performed during the implementation of NbS projects. This included the types of stakeholders involved, assessments conducted, types of collaborations, citizen involvement, and alignment with policies and strategies. The goal was to obtain a nuanced picture of how successful NbS projects were implemented. At the same time, the outcomes would demonstrate the applicability and usability of the developed conceptual framework, thereby addressing RQ2.

Data Collection for Rivne Case Study

The data for the Rivne case study involved two types of data. Initially, interviews with stakeholders were conducted. Contacts were obtained through a representative of a local NGO, who assisted in finding appropriate stakeholders from both the private and public sectors. Each participant was informed via an email with an invitation letter, which can be found in Appendix F. When a stakeholder agreed to participate, a consent form (Appendix D) was sent, and all agreements were received prior to the planned interview date. A total of 6 experts were confirmed, and the interviews were conducted during April 2024.

In the same manner as the expert interviews, semi-structured interviews were conducted. The interview guide (Appendix H) was based on evaluating conceptual framework elements in relation to the current governance projects for Ustya river. The aim was to gain a realistic and in-depth understanding of how WRM is implemented (or not) in Rivne through the perspectives and insights of stakeholders involved in the development of the projects or who work closely in that area. Moreover, the outcomes were used to answer RQ3. To maintain anonymity, the interviews were coded, and each participant received a code. A short description of interview details, including the participants' positions, country locations, interview lengths, and dates, can be found in Appendix E.

3.4.2 Methods for Data Analysis

The study employs thematic analysis due to its adaptable nature and straightforward approach to interpreting qualitative data (Creswell & Creswell, 2018). This method involves the "identification, segmentation, categorisation, and summarisation of data" to capture essential concepts governing urban NbS (Creswell, 2018). Thematic analysis was facilitated using NVivo, a computer-assisted qualitative data analysis tool. Data were manually coded, sub-coded, and categorised iteratively in stages 1 and 3, while during the second stage of the research, data followed a structured and categorised approach directly from data sources for integration into the thesis project.

During the first stage, information from academic articles was categorised and synthesised. A set of open pre-set themes was applied, focusing broadly on governance modes and forms, as well as effective factors and aspects for NbS development. New codes within these themes

emerged iteratively during data collection. The resulting analysed data was utilised to better understand concepts for governing NbS projects and introduce correlated concepts, including climate governance, urban transformations, and water governance, which are discussed in Chapter 2.

In the second stage (part I), the base for developing the conceptual framework was established through a literature review, mapping all principles for effective governance; the list of principles and their identification in the analysed articles can be found in Appendix I. Subsequently, interviews with experts were conducted, with participants' approval of the consent form, and audio recordings were transcribed using Fireflies software. Therefore, this stage was characterised by an iterative process, resulting in the conceptual framework through a snowballing data analysis method.

In the second stage (part II), empirical data from UNA and additional grey materials were structured and categorised based on the elements from the conceptual framework into an Excel sheet. This Conceptual Framework offers strengths in testing, revising, and expanding by exploring constructs and relationships within specific settings (Yin, 2009). Therefore, all materials were further organised into groups for each principle from available information for integration into the thesis project.

In the third phase, interviews were coded based on the elements included in the conceptual framework. Similarly, interviews with experts were audio-recorded with participants' approval of the consent form and transcribed using Fireflies software. Grey materials were further analysed on the conditions influencing the capacity to apply governance principles, such as regulations, finances, skills and knowledge, and existing collaborations and networks.

3.5 Research Reliability and Validity

In qualitative research, validity concerns the accuracy of findings, ensuring they authentically represent the phenomenon under study. At the same time, reliability refers to the consistency of results, ensuring they can be replicated under similar conditions (Creswell & Creswell, 2018). To ensure the validity of this research project, several steps were undertaken according to a predetermined protocol for data collection. Triangulation, which involves integrating multiple data sources or investigative approaches to corroborate findings, was pivotal in bolstering the credibility and precision of the research outcomes (Creswell & Creswell, 2018).

Firstly, an extensive analysis of academic and grey literature was conducted through a systematic literature review involving many articles. Secondly, interviews were carried out with external experts and practitioners in urban governance and nature-based solutions. These interviews validated the obtained materials and provided fresh insights for the study. Including expert perspectives added credibility to the research findings (Creswell & Creswell, 2018). Additionally, utilising the UNA, which employs a comprehensive methodology, was an additional step in reviewing materials for several case studies.

Lastly, reflexivity, an integral aspect of qualitative research, aims to detect and observe bias within the researcher's findings. A detailed methodology was developed to achieve transparency and reliability in data collection (Creswell & Creswell, 2018). By adhering to these rigorous steps, the research project sought to enhance both the validity and reliability of its findings, thereby contributing to the overall credibility of the study.

4 Conceptual Framework

This section introduces a Conceptual Framework for governing NbS, as *Figure 4-1* depicts. The development of this Conceptual Framework involved a systematic literature review and insights gathered from expert interviews, integrating several vital elements. Within the context of this research project, governance adapts the definition from Sekulova and Anguelovski (2017) that the governance of NbS entails intricate dynamics involving diverse social and political actors, contexts, and perspectives. This includes the interplay between governmental bodies and civil society, encompassing formal and informal institutions, regulations, mechanisms, and collective decision-making processes. Given the significant correlation and interdependency between governance and urban planning within NbS development (3A), this Conceptual Framework aligns with and adapts the four critical stages outlined by Wickenberg et al. (2021): strategic planning, implementation, maintenance, and evaluation. Planning involves systematically identifying a course of action to achieve objectives by efficiently and cost-effectively utilising available resources. It is commonly described as an iterative, cyclical process consisting of the following essential stages (Marchini et al., 2019). Due to the nature of project implementation, they are presented in circular form, emphasising the rejection of the linearity for the project implementation and moving interactivity between stages (3A; 4A).

Learning, reflection, and adaptation are embedded within this framework, serving as transformative components for urban transformations facilitated by NbS implementation. Six essential governance principles for effective NbS development are outlined, emphasising their application across all stages. These principles include inclusivity and equity, collaboration, transparency, long-term perspective, geographical and institutional embeddedness, and evidence-based decision-making. Their identification of these principles through literature review in the articles can be found in Appendix I.

Furthermore, the Conceptual Framework underscores the importance of considering conditions that influence the capacity to apply these principles, which should be analysed on an individual city basis. Each element is explored in greater detail as a fundamental response to RQ2.

4.1 Conditions influencing the capacity to apply governance principles

The literature and experts emphasise that enabling transformations within NbS projects through effective governance principles relies on various on-ground socio-institutional conditions (1A; 3A; 5A; Kauark-Fontes et al., 2023; Sarabi et al., 2019; Holscher et al., 2024). This research identifies five key aspects: *regulations, finances, skills and knowledge, and existing collaborations and networks*. Each of these aspects is elaborated upon below.

One such condition lies in the *regulations* (3A), encompassing city policies, strategies, and plans (Kauark-Fontes et al., 2023). Additionally, the scarcity of mechanisms and processes for integrating environmental and climate concerns into sectoral planning has hindered translating policies into tangible outcomes (Wamsler et al., 2020). As a result, cross-cutting policies should be integrated into urban governance by appropriately mapping benefits and co-benefits from NbS projects (Kauark-Fontes et al., 2023).

Another influencing condition is *finances* (1A; 3A; Van Der Jagt et al., 2023). The difficulty in allocating budgets for NbS projects stemmed from decision makers' limited understanding of the monetary value of NbS benefits and conflicts with existing local development regulations, such as procurement processes. Sarabi et al., 2019 also pointed out that inadequate resources in finances in municipalities pose significant pressure on these institutions, underscoring the crucial necessity for further exploration of economic opportunities associated with NbS to

incentivise private investment. Specifically, tools offering insights into the long-run expenses and benefits of NbS while quantifying aspects like livability, aesthetic value, and biodiversity in monetary terms could be advantageous (Voskamp et al., 2021).

Frantzeskaki et al., 2020 pointed out that a different set of skills will be required for the development of NbS, as it stands, as an innovative solution for urban transformations. Therefore, 3A and 5A experts insist that familiar professionals operating in the city, such as engineers or landscape architects, work traditionally within urban planning. It means that NbS projects are part of experiments and should look for new perspectives and methods of working (3A). As such, a set of competencies should be developed or incorporated by the professionals who obtain them (3A; Frantzeskaki et al., 2020). In particular, negotiation, collaboration, facilitation and even relational skills are essential (3A; Frantzeskaki et al., 2020). At the same time, depending on the phase of the NbS planning cycle, some of them might be more crucial than others (Frantzeskaki et al., 2020).

At the same time, acquiring *knowledge* about NbS and their implementation requires not only a receptive approach within planning practices but also qualified professionals who can identify pertinent information from various sources and effectively integrate it to suit local contexts and requirements (Sarabi et al., 2019; Frantzeskaki et al., 2020). It encompasses identifying links between NbS projects and urban needs, strategies, agendas, and initiatives (Holscher et al., 2024). Therefore, there is a need to facilitate the replacement of unsustainable practices, assumptions, cultures, and norms that have prevailed in the planning and development of cities (Adams et al., 2024). Additionally, according to Voskamp et al., 2021 providing opportunities for knowledge sharing of best practices in methodologies and guidance tools could promote the effectiveness of the NbS project.

Lastly, *existing collaborations and networks* could sufficiently constrain or enable NbS governance. Given the intricate nature of the urban landscape involving multiple stakeholders communicating, working, and collaborating, the collective determination and pursuit of goals through interactions among these actors constitute a vital component (Dorst et al., 2021). Taking action in interactivities within different networks, such as C40 Cities or Resilient Cities, facilitates mutual comprehension and confidence-building while establishing roles and identities within the stakeholder framework (Dorst et al., 2021). Martin et al., 2021 also highlighted that effective stakeholder engagement and local networks, particularly at the municipal level, were crucial for innovative governance in disaster risk reduction (DRR). This process facilitated the identification of a compromise solution between NbS and traditional measures (grey infrastructure) as part of a co-designed landslide risk mitigation plan. Therefore, these engagement approaches provide an opportunity to integrate NbS projects into traditional urban planning.

4.2 Aspects of transformative governing mechanisms

Learning and reflection

Meaning: promote a culture of learning and reflection within governance frameworks, encouraging continuous improvement and innovation in NbS implementation.

The subsequent governance aspect involves institutionalising reflective and learning-oriented governance structures that connect emerging insights on how NbS are impacted by and impact their surrounding contexts (Hölscher et al., 2023). Learning involves evaluative and reflective processes to acquire knowledge and enhance outcomes, such as making urban NbS systems adaptable, flexible, and capable of learning from implementation experiences (Adams et al., 2023). This is further accomplished by incorporating recent ecological insights, particularly

concerning shifting climate patterns, to expand urban plans, enhance community education and involvement, and reassess processes for implementing new and updated urban strategies (Adams et al., 2024). Such activities nurture trust in decision-making processes and enhance mutual understanding of critical issues, particularly within planning (Kiss et al., 2022).

Considering this, the most effective and meaningful transformative results are expected to deliberately go through a cycle involving visioning, planning, intervention, and institutionalisation, which includes organisational learning through monitoring and feedback into policy processes (Scolobig et al., 2023; Adams et al., 2024). For instance, in the study by Hölscher et al., 2024, cities utilised reflexive monitoring learning sessions to oversee their activities, decisions, and advancements concerning their collaborative processes, develop learning inquiries, and implement subsequent measures. In that way, stakeholders could recognise strengths and find ways to seize opportunities while overcoming challenges. Therefore, learning is related to the ongoing process and how organisations or people work with NbS. Thus, additional awareness of the processes and the outcomes that stakeholders are conducting is required. Such awareness is not always built into the processes. However, it is not necessarily defined or reflected upon when it is in place because there are some monitoring or evaluation systems (2A). The expert 3A pointed out that:

“That is the key question, to be able to learn from what we do and then advance because there is a risk or a challenge we can say today because we tend to work more in silos, we tend to work in our box, and we tend to like to do just the same things.”

While considering sustainability and governance around urban transformations, we should consider these learnings matters for future improvements, which should visualise and capture such interactivity within governance (3A). Lastly, specific emphasis should be placed on the evaluation phase, where opportunities arise to learn from mistakes, consistently assess progress, and integrate those learnings into future actions (1A; Holscher et al., 2024).

Adaptability

Meaning: embrace flexibility and adaptability in governance structures and processes to respond to changing circumstances and emerging challenges.

The adaptation aspect involves shifting away from the linear, hierarchical, and siloed processes typical of traditional urban development towards more collective, flexible, and integrated governance necessary for NbS (Bradley et al., 2022; Kauark-Fontes et al., 2023). In that way, NbS underscores the shifting of rules and norms to govern placed in institutional arrangements and collaboratively undertaken by both public and private entities, facilitating a decentralised system with numerous centres of power (Kauark-Fontes et al., 2023; Van Der Jagt et al., 2021). Involving various actors with diverse skills at different levels in planning, implementing, and managing NbS phases improves the likelihood of achieving urban transformation (Frantzeskaki, 2019; Van Der Jagt et al., 2021; Colucci, 2023). On the local level, their adaptive behaviour in governing public common assets and resources allows various stakeholders within urban environments to collaborate to develop, experiment with, and glean insights from socio-technical innovations (Zingraff-Hamed et al., 2021; Martin et al., 2021). Such flexibility in incorporating new knowledge and learning from others provides an iterative method for reevaluating goals and objectives periodically appearing from the implemented NbS (Van Der Jagt et al., 2023; Martin et al., 2021; Van Der Jagt et al., 2021). This opportunity provides integration to different silos, departments, knowledge, and competencies (3A). Moreover, adaptability improves social interactions and shapes cultural and political considerations by placing all stakeholders equally in governing NbS (Kauark-Fontes et al., 2023).

4.3 Effective governance principles

In order to apply the six principles effectively to cities and engage stakeholders, there is a critical need to establish a shared understanding rooted in the local context (2A). This involves ensuring that all parties, including experts and planners, interpret concepts uniformly by aligning their terminology (3A). This necessity arises because various internal and external factors (2A) shape each stakeholder's perspectives, such as individual mindsets, cultural backgrounds, and personal experiences (2A). For example, private entrepreneurs involved in developing NbS may hold a disconnected understanding of evidence and truth (1A). Hence, it is imperative to recognise that even researchers operating within their domains may lack identical theoretical frameworks. Within urban governance, stakeholders and implementers maintain pragmatic mindsets that warrant consideration when translating research into actionable initiatives on the ground (2A; 4A). Therefore, the author provides a short description of what is meant by using particular principles under each of them.

Geographical and institutional embeddedness

Meaning: ensure that NbS are tailored to a particular city's environmental conditions and social structures.

This principle emphasises the need to tailor each NbS project to its specific environmental, social, and institutional context (2A). NbS acknowledges the potential for multifunctionality right from the outset, designing NbS to tackle numerous challenges simultaneously. This recognition stems from an understanding that sustainability challenges are often interconnected, necessitating NbS interventions that can effectively address multiple problems and opportunities in different geographical locations concurrently (Almassy et al., 2018; Albert et al., 2020; Kauark-Fontes et al., 2023). In practical terms, when developing NbS projects, it is essential to prioritise objectives and goals that align with local priorities and development needs (3A). By doing so, NbS can deliver tangible benefits to local communities and ecosystems while supporting broader environmental and social objectives. This may include promoting local benefits, such as improved resilience to CC impacts, and contributing to the restoration and conservation of valued natural assets at both local and landscape scales (Voytenko Palgan et al., 2024). Furthermore, the successful implementation of context-specific NbS projects relies on establishing appropriate institutional structures and collaborative frameworks (Holscher et al., 2024). This involves fostering awareness among stakeholders about the benefits of co-production and ensuring clear goals for collaborative decision-making.

Evidence-based decision-making

Meaning: base governance decisions on sound evidence and research, incorporating scientific knowledge and local expertise to inform policy and practice.

Given that NBS presents a new urban governance approach, it often integrates various disciplines and knowledge domains (Frantzeskaki et al., 2020; Kauark-Fontes et al., 2023). In order to overcome bureaucratic obstacles, policies should be flexible enough to accommodate these novel approaches to city transformations (Kauark-Fontes et al., 2023). Frantzeskaki et al. 2020 suggested that cities expedite institutional and governance advancements to foster evidence-based policymaking and urban planning. This is achieved by bridging the gap between knowledge regarding NbS and political dedication in decision-making processes. City planners and policymakers should encourage the growing interest in mapping research and evidence-gathering regarding the multiple benefits of NbS (Frantzeskaki, 2019). Concerning different types of NbS, this body of evidence pertains to the health, scope, functionality, and additional benefits that arise from certain types of NbS (Adams et al., 2024).

This data should be monitored, thoroughly analysed, and disseminated through active engagement with higher-level political processes pertinent to the project, involving institutions and potential investors in NbS (Van Der Jagt et al., 2023). Subsequently, a rigorous analytical process should ensue, focusing on the efficacy of implementing these solutions. This analytical phase encompasses understanding and assessing the effectiveness of the decision-making process and its impact on addressing the identified problem with NbS intervention (5A). Even after the materialisation of NbS knowledge into policy agendas, it takes time to apply those evidence-based to new systematic integration for planning approach after learning and experimenting with NbS projects (Wickenberg et al., 2022; Adams et al., 2024; Frantzeskaki et al., 2020).

Inclusivity and equity

Meaning: actively involve diverse stakeholders, including citizens, in decision-making processes while prioritising fair distribution of benefits and opportunities among all members of society.

The systematic integration of NbS demands the involvement of multiple actors to ensure effective design (Frantzeskaki, 2020). Notably, urban planners and policymakers should possess effective communication skills to engage with residents and businesses to develop narratives collaboratively. Acceptance of NbS designs plays a critical role in their adoption (Frantzeskaki, 2019), with municipal governments, in particular, needing to demonstrate political support and a willingness to collaborate (Dushkova & Haase, 2020). Even though bottom-up integration shapes justice and inclusive processes, the leading power in decision-making processes remains within municipal government (Voytenko Palgan et al., 2024). However, designing participatory planning through workshops, collaborative planning teams, shared management of specific project components, and task groups support actors' empowerment (Kiss et al., 2022; Dushkova & Haase, 2020). Such participation opportunities could further promote engagement with various local communities (Kiss et al., 2022).

Collaboration

Meaning: foster collaboration and knowledge exchange among stakeholders, encouraging co-production of knowledge and joint problem-solving efforts.

The inherent multifunctionality, multidisciplinary, diverse forms, and site-specific nature of NbS underscore cross-scale collaboration in governance to facilitate transformative change effectively (Kauark-Fontes et al., 2023). Building and engaging with multidisciplinary teams, governmental cross-departments, and external experts is a starting point for a dialogue to articulate expertise about operating and maintaining NbS in subsequent stages (Frantzeskaki, 2019). Regular dialogue with urban policymakers and planners facilitates knowledge transfer, fostering local solid commitment to protect NbS (Dushkova & Haase, 2020) and generating knowledge regarding the impacts, targets, and actions of a particular NbS on fairness to aid in actor mapping (Hölscher et al., 2024; Adams et al., 2024). Establishing a shared understanding of NbS development can promote smoother integration processes rather than fostering criticism and conflicts (Frantzeskaki, 2019). Furthermore, integrating collaboration into NbS initiatives could represent an initial step toward facilitating the implementation of other governing principles. (2A). Therefore, co-production capacities entail establishing opportunities for collaborative efforts, ensuring inclusivity and legitimacy in decision-making processes, and connecting co-production activities and outcomes to the specific requirements of NbS governance (Hölscher et al., 2024).

Transparency

Maintain transparency in governance processes, provide clear communication channels, and provide access to information to build trust and accountability.

The transparency principle refers to developing a communication strategy for informing, exchanging and consulting data throughout NbS phases in a clear, accountable manner (Hölscher et al., 2024; Kiss et al., 2019). It established several communication formats like newsletters, reports, public presentations, online information, webpages, and interaction field visits (Kiss et al., 2022; Hölscher et al., 2024). Additionally, the provided information should be more straightforward and valuable for all participants (5A). This is necessary because scientific terminology is often not adequately explained for non-experts in the field. As such, urban planners should be able to use skills and tools to engage with citizens and businesses in meaningful communication to co-create narratives and understandings of NbS within contextual framings for its development (Toxopeus et al., 2020). In this way, local governance showcases and disseminates the relevance of the co-production process and results to different target audiences (Hölscher et al., 2024). Therefore, NbS should support mutual learning for city sustainability transitions (Kabisch et al., 2022). At the same time, establishing a formal monitoring system, indicators to use, and reporting would promote and present transparency about the NbS projects (4A; 5A). As a result, presenting and delivering information and appropriate data to different layers of the urban population would notify, enhancing public awareness and NbS acceptance (Kauark-Fontes et al., 2023).

Long-term perspective

Meaning: adopt a long-term perspective in planning and decision-making, considering the sustainability and maintenance of NbS beyond project completion.

In the governance of NbS, adopting a long-term perspective becomes imperative as it necessitates sustained collaboration among various stakeholders, underlining the significance of considering both NbS and its benefits over an extended duration (Sarabi et al., 2019). Politicians, who often represent institutional silos characterised by low interest in NbS projects, encounter challenges due to short-term election cycles (Albert et al., 2019; Sarabi et al., 2019; Voskamp et al., 2021). Moreover, human nature may encounter difficulties thinking with a long-term perspective amidst a rapidly changing world (2A). Thus, establishing long-term commitment and enhancing agency through NbS projects prove crucial (Kiss et al., 2022). This forward-looking thinking is required to appropriate vision and implement NbS, which facilitates efficient decision-making and resource allocation, aligning cities' efforts with long-term priorities (1A). Additionally, NB-URS should be effectively managed to mitigate potential long-term risks. However, given the dynamic nature of changing conditions, it is essential to maintain the flexibility for immediate intervention in response to alterations in WRM projects (6A). Therefore, forming new collaborations and partnerships with diverse stakeholders, including the private sector, emerges as vital for implementing results and facilitating stewardship of NbS (Hölscher et al., 2024; Dushkova & Haase, 2020). Furthermore, engaging with local communities to co-define roles and responsibilities in alignment with NbS goals heightens awareness and enhances urban systems in the long run (Colucci, 2023).

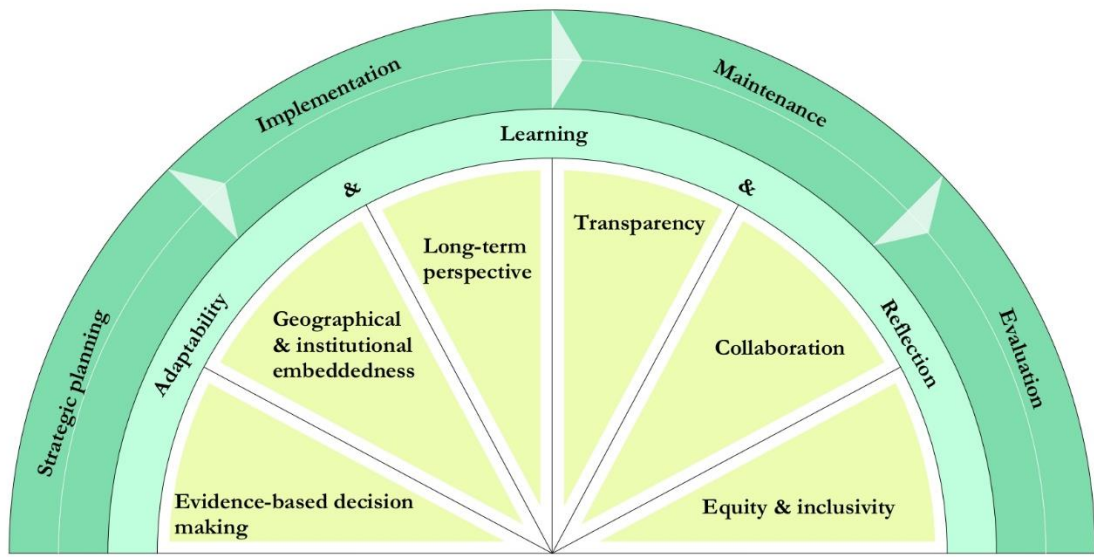


Figure 4-1: Conceptual Framework

Source: Author's interpretation based on the literature review and expert interviews

5 Analysis & Results

In this section, the research project is divided into two primary goals. Firstly, section 5.1 applies a well-established conceptual framework comprising six governance principles to four NbS projects in the EU sourced from the UNA. These projects, namely Ljubljana Connects, Ljubljana, Slovenia; Historic Utrecht Canal, Utrecht, Netherlands; Wupper Stream, Wuppertal, Germany; and Augustenborg Ecocity, Malmö, Sweden; serve as case studies for the investigation. More detailed overview of the case studies including the project duration, scale, type of NbS, management set-up, type of initiating organisation and source of financing can be found in Appendix J. By juxtaposing empirical findings from these case studies, this chapter provides a comprehensive and nuanced evaluation of the practical relevance of the conceptual framework.

Secondly, in section 5.2, the focus shifts to the Ukrainian context for WRM, with a specific emphasis on the ongoing NbS project in Rivne. This section aims to analyse Rivne's governance practices regarding the project for the local Ustya river. This analysis uses perspectives gathered from stakeholder interviews and relevant documentation. Additionally, it aims to provide a broader understanding and perspective on the local context. As a result, this section contributes to answering RQ3.

5.1 Case Study Analysis

To assess implemented NbS projects across the EU, *Table 5-1* presents the evaluation of each principle using practical and feasible methods, serving as a foundation for Case Study Analysis. These methods aim to clarify the information presented. However, responses may vary depending on the available data in the UNA database and other grey literature sources, as each principle encompasses multiple aspects, contributing to diverse answers.

Table 5-1: Methods to Analyse Governance Principles

| Principle | Methods | References |
|--|---|--|
| Geographical and institutional embeddedness | <ul style="list-style-type: none"> • Presence of key sustainability challenge/s within correlation to project objective/s • Mapping of benefits and co-benefits • Correlation to policies: local, regional, national, EU | Almassy et al., 2018; Bulkeley et al., 2023; De Luca et al., 2021 |
| Evidence-based decision making | <ul style="list-style-type: none"> • Assessment tools with data-driven information assessments focused on environmental impacts, climate change impacts, biodiversity, certifications as assessment tools, economic evaluation, social impact assessment, evaluation of social impacts • Presence of impacts: social, environmental and economic | Almassy et al., 2018; Smith et al., 2023; Raymond et al., 2017; Sarabi et al., 2022; |
| Equity and inclusivity | <ul style="list-style-type: none"> • Provide opportunities for participation: workshops, webinars, surveys • Determine the criteria for selection and identify participants through stakeholder mapping, snowball sampling, and event attendance • Participatory approaches: participatory budgeting; working groups or citizen panels; seeking input; shared or cooperative | Wamsler et al., 2020; Holscher et al., 2024; Almassy et al., 2018 |

| | | |
|------------------------------|---|--|
| | management; public oversight; community monitoring or evaluation | |
| Collaboration | <ul style="list-style-type: none"> • Methods for citizen involvement: focus groups; interviews; questionnaires; online discussions; submission of monitoring data by citizens • key actors in multilateral organisations, EU bodies, national or regional or local government, public sector institutions, non-governmental organisations/ civil societies, business associations, private sector/corporate/company, or private foundation, transnational network, researchers/universities, citizens or community groups | Almassy et al., 2018; Mitincu et al., 2023 |
| Transparency | <ul style="list-style-type: none"> • Presence of a communication brand/strategy to demonstrate and distribute the significance of the development processes and outcomes to various target audiences such as PR campaigns, site visits, events • Presence of evaluation: formal monitoring systems, the use of indicators in reporting, the publication of monitoring /evaluation reports, the use of web-based monitoring tools, GIS mapping, and/or the involvement of citizens in monitoring effort | Holscher et al., 2024; 3. 4A; Almassy et al., 2018 |
| Long-term perspective | <ul style="list-style-type: none"> • Evaluate project livability by considering time, maintaining mechanisms and responsible bodies | 3A |

Source: Author's interpretation; references are in the last column

Geographical and institutional embeddedness

The Utrecht NbS project stemmed from the efforts of the local group Greening Singel, which spearheaded its development as a pilot initiative (König, 2016). The project, spanning from 2010 to 2020, was conceived in response to the restoration of the historical canal of Utrecht, with overarching goals centred on enhancing water purity, enriching the visual and cultural heritage, and improving environmental conditions along the Utrecht canal. Simple yet effective measures were implemented to promote biodiversity by creating habitats and breeding spaces for various species, alongside establishing green corridors (König, 2016). Consequently, the project yielded additional benefits, such as improved temperature and air quality (*Greening Historical Canal | Urban Nature Atlas*, 2021). These interventions were aligned with the City Center District Water Plan, thereby transforming the area into a green, sustainable, appealing, and conducive to comfortable living (König, 2016).

Initiated through a collaboration between the municipal administration and the public sector entity Wupper, the NbS initiative in Wuppertal aimed to address environmental and water quality issues while promoting biodiversity along the Wupper river and its surroundings. The project received additional support from local initiative groups, further bolstering its implementation efforts (*Renaturalization Wupper Stream | Urban Nature Atlas*, 2021). Over time, human activities have significantly altered the natural state of the Wupper waters, leading to various disruptions such as contamination, diversion, and habitat destruction (Wupperverband, n.d.-a). Recognising the urgent need for action amidst growing urbanisation pressures, the project adopted a multifaceted approach to mitigate these impacts (Wupperverband, 2016).

In line with the EU Water Framework Directive, the Wuppertal NbS project incorporated ecological considerations. Notably, the Wupper and its tributaries exhibit favourable conditions in 27 per cent of their areas, surpassing the German average of 8 per cent (*Renaturalization Wupper Stream | Urban Nature Atlas*, 2021). These objectives are further supported by legal frameworks such as the Water Resources Act (WRA), the State Water Act (SWA), and the "Guideline for the natural maintenance and development of running waters in North Rhine-Westphalia." This effort involved various measures, including the revitalisation of water bodies, collaboration with agriculture to establish riparian strips, and strategically planting location-appropriate vegetation along riverbanks. Additionally, initiatives such as removing existing cross structures like old weirs and constructing fish routes were implemented to enhance aquatic habitats (Wupperverband, n.d.-b). These activities started in 2006 and are scheduled for completion by 2025, aligning with the objectives outlined in the Wuppertal 2025 strategy (*Renaturalization Wupper Stream | Urban Nature Atlas*, 2021).

At the same time, in the project, Ljubljana Connects, the primary aim was to enhance the ecological integrity of the severely degraded stretch of the Ljubljanica river from the city of Ljubljana to its confluence with the Sava river and extend further upstream along the Sava (University of Ljubljana, 2016). This area is vital as a habitat for fragmented and highly endangered populations such as Roach, Danube Salmon and Striped Chub strategy. The rationale behind the project implementation was aligning with Natura 2000 sites and city strategy 2025 (*Ljubljana Connects | Urban Nature Atlas*, 2021). Through the implementation of restoration measures, the Ljubljanica river corridor reclaimed its significance as a habitat supporting rich biodiversity (University of Ljubljana, 2016). These objectives also contributed to the requirements of the EU Water Framework Directive by advocating for straightforward river restoration measures (*Ljubljana Connects | Urban Nature Atlas*, 2021).

In the case of Malmö, the EcoCity Augustenborg initiative emerged during an urban socio-economic downturn. It marked Malmö's pioneering attempt to tackle various sustainability issues city-wide (Wickenberg et al., 2022). The district of Augustenborg has encountered frequent flooding issues and social challenges (Smart City Sweden, n.d.). The project aimed to revitalise the neighbourhood by integrating open stormwater systems, green rooftops, and harnessing solar power (*Eco-City Augustenborg | Urban Nature Atlas*, 2022). The water systems encompass surface runoff from rainfall, along with canals and ponds (Smart City Sweden, n.d.). The project is unique to its starting year of implementation – 1998 (Månsson & Persson, 2021). The momentum for the change was built by proactive individuals with a shared vision, as concepts with planned measures were relatively novel at the time, and there had been limited prior learning experiences regarding their implementation across various sites or within the municipal organisation. Moreover, specific policies about stormwater management were only beginning to emerge concurrently with the project's advancement (Wickenberg et al., 2022). Therefore, with fewer opportunities, the project is implemented and ongoing nowadays (Månsson & Persson, 2021). Additionally, the project provided multiple benefits to society as the district area experienced a 50% reduction in turnover of tenancies; during the project's implementation from 1998 to 2002, unemployment dropped from 30% to 6%, aligning with the average rate in Malmö, a notable rise in election participation from 54% to 79%, a drop in migration away from the area from 28% to 10%, and the provision of housing for elderly individuals (Kiss et al., 2019; Adaptecca, n.d.).

Evidence-based decision-making

In the Utrecht project, suggestions for measures were initially integrated to align residents' desires and diverse user needs with the preservation of nature, water quality, and the aesthetic appeal of the historic Zocher Park. Considerations for water management, waterway maintenance, and preserving the culturally significant park were carefully undertaken (Konig,

2016). Given Zocher Park's national monument status, close oversight ensured that any developments and interventions adhered to its 19th-century English-style design, including a smooth bank along the water's edge (Konig, 2016).

Mussel crates were mainly utilised as an initial trial, with research conducted by Ecological Consultancy Waardenburg providing valuable insights. Additionally, the Initiative Group Greening the Canal conducted research to identify suitable locations and objects for vegetation in line with the 'wijkwaterplannen' (Neighborhood Water Plans), closely collaborating with the Municipality of Utrecht and the De Stichtse Rijnlanden Water Board (Konig, 2016; *Greening Historical Canal | Urban Nature Atlas*, 2021). Lastly, two types of impacts were identified: environmental and social. With its cultural heritage and a strong sense of place, the canal boasts a lengthy history, and the municipality ensures its proper preservation and maintenance (*Greening Historical Canal | Urban Nature Atlas*, 2021).

In the case of Wuppertal, in order to comply with the WFD, policymakers carried out scientific assessments focused on delivering improved water quality and the overall ecological well-being of the Wupper river. These emphasise the significance of fulfilling regulatory requirements while simultaneously accomplishing environmental objectives. As such, social impacts in the form of improved social justice and cohesion and improving health and well-being were presented in the project (*Renaturalization Wupper stream Wuppertal | Urban Nature Atlas*, 2021).

While undertaking the Ljubljana Connects project, a preliminary study involved conducting various analyses. In order to prevent the deterioration of hydrological and hydraulic conditions within the Ljubljana river's bed, an ecological survey and a hydrological model were carried out. Additionally, there was an assessment of the ecological condition and habitat quality, an examination of the pike, bream, and other fish populations, and a hydrological and hydraulic analysis of both the Ljubljana and Sava rivers. These findings helped identify significant ecohydrological concerns and formed the foundation for detailed restoration interventions planning to enhance ecological coherence and connectivity between Natura 2000 areas (University of Ljubljana, 2016). The outcomes of the projects enhanced environmental aspects while fostering greater community involvement in the management of green spaces and educational objectives (*Ljubljana Connects | Urban Nature Atlas*, 2021).

In the project of Malmö, there was climate analysis for the implementation of an open stormwater system; it was primarily planned to accommodate a rainfall event that occurs once every 15 years, serving the dual purpose of adapting to anticipated increases in precipitation in the future (Adaptecca, n.d.). In 2014, Malmö was shocked by flooding due to rain; the district was not damaged (Smart City Sweden, n.d.). By introducing such a system, the Augustenborg Ecocity reduced carbon emissions and waste generation by 20% (Kiss et al., 2019).

Inclusivity and equity

As a starting point in the Utrecht project, the driver behind that stand in the resident's dissatisfaction with the original municipality's design solution of sharply sloping concrete river banks that led to the formation of the Citizen Initiative Group (*Greening Historical Canal | Urban Nature Atlas*, 2021). This group engaged with residents by providing brainstorming sessions incorporating ideas of adding green elements to the project's design (Konig, 2016). As a result, this engagement influenced the decision-making process and provided satisfactory solutions for addressing citizen needs (*Greening Historical Canal | Urban Nature Atlas*, 2021).

In the case of Wuppertal, the project was authorised by the city of Wuppertal and executed by the public sector entity Wupper. While it is stated that many actors, including official government, public, and private actors, were involved in the joint effort to enhance ecological

and biodiversity aspects, it is still unclear in which way citizens were involved and whether they were able to influence and participate in the ongoing activities (*Renaturalization Wupper stream Wuppertal* | *Urban Nature Atlas*, 2021).

This project initially aimed to raise public awareness about the Ljubljanica river (Sapač & Zabret, 2016). This included a) informing residents about the project and its goals, b) focusing more on the scientific community with a desire to gain new ideas and experiences (Sapač & Zabret, 2016). Two roundtables were organised for the society, where the main problems addressed by the project were presented. Meanwhile, some delays occurred in the equation of tasks due to the strict rules from fishermen that they were not allowed to interfere with the water body during low flows (Sapač & Zabret, 2016). While the implementation concludes with disseminating the information, little attention is given to including citizens in the project's design (Sapač & Zabret, 2016).

In Augustenborg's project, Malmö citizen participation played an essential role in its development (*Eco city Augustenborg* | *Urban Nature Atlas*, 2022). Starting from the planning, the project included comprehensive citizen consultation through systematic meetings, community workshops and other forms of involvement. It is estimated that 20% of residents could participate, while some engaged exceptionally actively in the development (Adaptecca n.d.). However, some difficulties appeared because the project's finances and legislation were limited (Månsson & Persson, 2021). Therefore, as Kiss et al. (2019) pointed out, incorporating more deep forms of participation was essential to the project's success; it should be acknowledged that participatory activities should be incorporated into the project. In the case of Malmö, three forms of participatory processes were identified: trust-building, timing, level of ambition and aims of participation, and creation of a participatory culture within the district (Månsson & Persson, 2021). Each represents a different goal but could serve as a guide for project implementors.

Collaboration

In Utrecht, an extensive form of collaboration was presented. As such, multiple actors from different sectors were involved. In particular, such actors participated: municipal water manager and leader of the City Water Plan, park coordinator for unique parks, including the Heritage advisor, regional manager Utrecht, harbour master of the municipality of Utrecht responsible for navigability relations, civil construction consultant addressed construction aspects, and municipal sewer manager who was part of the foreshore (König, 2016). At the same time, different collaboration methods were used, such as co-planning, consultation, co-implementation, co-management, citizen monitoring, and review. (*Greening Historical Canal* | *Urban Nature Atlas*, 2021).

Throughout the planning and implementation stages of the Wuppertal project, multiple actors participated in its development. For example, governmental and environmental authorities, fisheries representatives, landowners, utility companies, public sectors, and citizens were involved. Each had its competencies and perspectives considered in the project (*Renaturalization Wupper stream Wuppertal* | *Urban Nature Atlas*, 2021).

Three main stakeholders were involved in the Ljubljanica Connects project. The project holder was the Faculty of Civil Engineering and Geodesy of the University of Ljubljana, chosen for their expertise in the field. GEATEH d.o.o. served as the contractor, engaging in various activities related to environmental protection, hydropower, and communal infrastructure. Their services ranged from initial planning to final execution, including project management. On the other hand, PURGATOR d.o.o. specialised in the construction and engineering of wastewater treatment plants (WWTPs), focusing on tasks such as design, construction, and management

within the low-rise construction sector (University of Ljubljana, 2016). Other stakeholders played more informative roles, such as presenting the project at international conferences to the broader professional community (University of Ljubljana, 2016). Also, a series of lessons for the schools were conducted, including thematic presentations and workshops. Additionally, students participated in site visits where traditional teaching methods were transformed into practical workshops (Sapač & Zabret, 2016). The collaboration involved various methods such as conference participation, events, and workshops (LIFE, n.d.).

The Augustenborg Ecocity initiative was led by various municipal stakeholders and dedicated individuals, including personnel from the Service Department in Malmö, the housing company MKB, and to some extent, the municipal water company VA Syd (Månsson & Persson, 2021; Adaptecca, n.d.). Månsson & Persson (2021) emphasise that the transformation in Augustenborg was not guaranteed, given that each department had previously operated within its own established routines, leading to typical institutional silos. Distinguished by its novelty and experimental nature, it evolved into a testing ground where different stakeholders found ways to collaborate and sustain blue-green solutions. Despite none of the municipal stakeholders and municipality-owned companies having experience commercialising such solutions, one of the challenges was discovering new selling methods (Månsson & Persson, 2021). Through collaborative approaches, visioned political leadership, strong partnerships were established, and two residents with relevant knowledge of water systems were engaged to oversee the implemented solutions (Kiss et al., 2019; Månsson & Persson, 2021; Wickenberg et al., 2022).

In 2019, Malmö introduced a new educational concept, ClimateCafé Malmö, which integrated various disciplines and practical applications to enhance capacity in CC adaptation (Boogaard et al., 2020). Building on the experiences gained from the Augustenborg Ecocity project, a two-day workshop was organised with international experts from The Netherlands, Brazil, Norway, and Portugal (Månsson & Persson, 2021). Participants came from China, Indonesia, Sweden, Latvia, The Netherlands, Romania, Belgium, Sri Lanka, and the Czech Republic (Boogaard et al., 2020). In this manner, the city of Malmö underscored the necessity of multidisciplinary collaboration in adapting Nature-based Solutions (NbS) in urban settings, leveraging a comprehensive understanding of their roles, challenges, and potentials while also fostering global recognition of climate adaptation (Månsson & Persson, 2021).

Transparency

In Wuppertal, the Association called Neue Ufer Wuppertal aimed to transform Wupper and its environs into a desirable urban living space and has developed a website that arranges numerous promotions and community-oriented events with the river Wupper (Neue Ufer Wuppertal, 2014; Neue Ufer Wuppertal, n.d.). Additionally, during International World Water Day, the local government capitalised on the occasion by offering information about the diverse facets of water as a vital element of life through various activities, excursions, and educational programs as part of the "Wuppertal Water Week." Consequently, consumers can learn more about clean drinking water and waste reduction, with workshops also conducted at secondary schools (Wuppertalverband, 2024).

The Ljubljana Connects project established a website to provide easy access to all produced documents, articles, brochures, media reports and videos for a wider audience. Additionally, comprehensive technical documentation, including mid-term, progress, and final reports detailing project outcomes, was made available. Furthermore, various technical documents such as models, maps, geodesy, and plans were provided (LIFE, n.d.). Despite encountering unexpected cost challenges with online monitoring, the team constructed monitoring stations, reducing costs and enabling effective river stream tracking (Sapač & Zabret, 2016).

While in the Augustenborg Ecocity project, a communication channel was established between the project and the residents. This involved various activities, including a door-to-door campaign to introduce the concept of Ecocity and actively encourage residents to participate (Månsson & Persson, 2021).

Long-term perspective

Volunteers establish agreements with the municipality in Utrecht regarding maintaining and managing green infrastructure. The initiative group serves as the primary contact and ensures an adequate number of volunteers are available to maintain the sites and remove floating waste (König, 2016). Lastly, one of the voluntary sessions with residents for collecting waste was on 22 of March, 2022 (VergroeningSingel, 2022). By engaging citizen volunteers in maintenance activities, the city ensures the ongoing viability and benefits of green infrastructure beyond its initial implementation (*Greening Historical Canal | Urban Nature Atlas*, 2021).

In Wuppertal, maintenance activities are conducted with the support of Neue Ufer Wuppertal, involving the ongoing participation of citizens and various organisations, including cleaning efforts (Neue Ufer Wuppertal, n.d.). Every interested individual in Wuppertal has the chance to participate by completing a form on the website and paying an annual membership fee, which grants access to all activities (Neue Ufer Wuppertal, n.d.).

In Ljubljana Connects, the After-LIFE Conservation Plan aimed to continue monitoring fish passage through fish passes using an enhanced two-camera system, maintain eco-hydrological monitoring at 17 hydrometric stations and three online stations, and utilise the gathered data for diverse purposes. Additionally, it aimed to disseminate results, raise awareness about the importance of preserving stream health and target fish species, collaborate with similar projects to promote conservation measures facilitating fish migration upstream and monitor the condition of reconstructed structures. For most of the measures, significant financial investment was not necessary; indeed, some activities were incorporated into the routine responsibilities of the beneficiaries (Sapač & Zabret, 2016). The project team engaged students and schoolchildren in various activities and hired young researchers (LIFE, n.d.).

In Augustenborg, the management of blue-green infrastructure has prompted discussions and instigated changes (Månsson & Persson, 2021). Initially, there was a suggestion that citizens would take on the responsibility of maintaining the areas, but this did not come to fruition. During the early stages of the project implementation, various organisations focused on managing their respective territories independently. However, they later recognised the importance of avoiding misunderstandings between residents and different entities. Consequently, VA-market, the Streets and Parks Department, and MKB collaborated and signed a partnership agreement in May 2004. Moreover, the management of Ecocity Augustenborg has accumulated valuable competence and knowledge over time and, therefore, was one of the success factors for this project (Månsson & Persson, 2021).

Summary of Learning Outcomes

The conceptual framework has proven applicable in analysing four case studies of NbS projects across the EU. The summarised results with lessons are presented below in *Table 5-2*.

Table 5-2: Cross-case Comparison of NbS Governance

| Governance principle | Summary |
|----------------------|---------|
|----------------------|---------|

| | |
|--|---|
| Geographical and institutional embeddedness | This principle appeared in each case study, with projects in Malmo and Utrecht standing out for their efforts to address environmental issues and demonstrate tangible social benefits. Furthermore, a close relationship existed between the projects in Utrecht, Wuppertal, and Ljubljana, local plans or policies, and EU initiatives such as Natura 2000 or WTF. Among the most notable examples of leadership during the development of environmental regulations was the Malmo project, which was started in 1998 and was significantly impacted by disturbances in the area. |
| Evidence-based decision making | This principle was evident in every case study, with fundamental analyses conducted for each project design in Wuppertal, Ljubljana, and Malmo. In Utrecht, the assessment was slightly less strict and facilitated by a consultancy company, although local knowledge was also considered. Additionally, the project in Ljubljana integrated hydrological aspects into environmental considerations, enhancing ecological coherence in its execution. |
| Inclusivity and equity | This principle was demonstrated in three cases: Utrecht, Ljubljana, and Malmo. However, while Wuppertal mentioned citizen involvement in project development, no concrete evidence of such participation was found. Conversely, citizens formed an initiative in Utrecht and Malmo; the project expanded the scope of public participation despite facing limitations in finances and legislation. It was also noted that implementation in Ljubljana has slowed down due to strict regulations imposed on fishermen, prohibiting interference in the river. |
| Collaboration | This principle was evident in all case studies. Collaboration with multiple stakeholders was apparent in Utrecht and Wuppertal, whereas in the Ljubljana project, the local university spearheaded implementation in partnership with two private companies. Lastly, the Malmo case was characterised by dedicated governmental actors leading the project's implementation in coordination with various companies. |
| Transparency | This principle was observed in three projects, excluding Utrecht. Malmo undertook a door-to-door campaign as part of an offline strategy, whereas Wuppertal and Ljubljana created websites. Wuppertal's website was mainly used for communication, whereas Ljubljana's website had all of the materials, documents, and assessments needed for the project as it progressed. |
| Long-term perspective | This principle was observed in all case studies. Specifically, the projects in Utrecht and Wuppertal are voluntarily sustained by citizens in Malmo, where the three main stakeholders partnered to hire an external contractor to manage the project. In Ljubljana, stakeholders were also assigned additional responsibilities for certain activities after the project's implementation. |

Source: Author's interpretation

5.2 Rivne Case Study Analysis

This section introduces Ukraine's WRM landscape, including relevant legislation. A practical example from the Rivne city of NbS project for the Ustya river is presented, contextualising governance issues. Subsequently, Ustya river NbS project analysis is provided, drawing on conducted interviews, grey literature, and documentation. The interviews were structured around the six principles and basic context-oriented questions to gather perspectives and

opinions from stakeholders regarding the local context. Finally, the section concludes by offering recommendations for the NbS project for the Ustya river, addressing RQ3.

Water Resources in Ukraine

Ukraine is characterised by abundant water resources, which nowadays contrasts with the country's high water usage intensity (OECD, 2021). Therefore, the country is segmented into nine river basin districts, encompassing the Dnipro, Dnister, Danube, Southern Buh (Bug), Don, Vistula, Crimea, Black Sea, and Sea of Azov river basins (EUWI+, 2021). Each main water artery originates from small river basins encompassing over 60% of Ukraine's water resources. These water resources are crucial components of the overall water supply, frequently serving as the primary and occasionally sole source for local water users, thus influencing local development and infrastructure placement (Serduk et al., 2017). Despite their abundance, these resources face threats from CC, anthropogenic usage, and the ongoing war in Ukraine. Approximately 20,000 small river basins have vanished in Ukraine, presenting a severe challenge to the country, its citizens' well-being, and the ecosystem (Serduk et al., 2017; Kolodezhna & Vasyliuk, 2022).

Understanding the vital role of rivers in diverse ecosystems is essential, as they provide biodiversity and crucial services for ecological balance (Naka et al., 2022). In the context of Ukraine, small river basins are contaminated. In particular, crops absorb agrochemicals from the agricultural runoff characterised by technological disruption (Serduk et al., 2017). Another contributing factor is water quality issues from releasing untreated and inadequately treated wastewater into its waterways (OECD, 2021). Ruslan Strilets, Minister of Environmental Protection and Natural Resources of Ukraine, highlighted that the country's water situation is concerning: annually, 2 million tonnes of pollutants enter water bodies, with half of Ukraine's regions facing a natural shortage of fresh water. For 80% of the population, drinking water quality is unsatisfactory. Pollution with sewage, heavy metals, and chemicals, along with local authorities ignoring the legislation and insufficient monitoring, plague Ukraine's water bodies (KMU, 2023).

Realising the mentioned challenges, the Ukrainian government has enacted and enforced multiple regulations to manage water bodies. For example, one of the primary laws was the Water Code, which entered into force on June 6, 1995. The Water Code and accompanying administrative, legal, economic, and educational frameworks worked towards establishing regulations governing water and ecological management in Ukraine (FAOLEX, 2023). However, legislative deficiencies persisted, such as a clear definition of "ecological river flow" in water-related laws. Monitoring and regulating pollution remained inadequate, with various sources contributing to contamination. Moreover, persistent challenges are related to access to clean drinking water and sanitation, exacerbated by floods, droughts, and associated health impacts (OECD, 2021).

The shift in regulatory paradigm began when Ukraine signed a series of international agreements (Kolodezhna & Vasyliuk, 2022). In particular, the country ratified the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (EUWI+, 2021). Also, the Agenda for SDGs through 2030 was approved at the UN Summit on Sustainable Development in 2015. While there are 15 SDGs, specific attention in the context of water bodies is given to SDG 6, which aims to promote global collaboration in water provision and sanitation, encompassing water technologies, desalination, effective water management, wastewater treatment, and related initiatives.

Furthermore, improving the condition of water resources is a crucial part of Ukraine's path to EU integration (KMU, 2023). Ukraine signed the Association Agreement with the European

Union in 2014, which required harmonising its "water" laws with six EU Directives (EUWI+, 2021). Where the most prominent is WFD, which introduces two significant improvements: the refinement of processes for developing river basin management plans (RBMPs) and river basin councils, along with the delineation of districts. Along with the State Service of Ukraine for Geodesy, Cartography, and Cadastre (State GeoCadastre), central and local government agencies, and other relevant basin councils, the Ministry of Environment (MinEnv) and the State Agency for Water Resources (SAWR) are responsible for developing these plans and managing their implementation (UNECE, 2022). Currently, Ukraine's water bodies are divided into eight RBMPs. The goals of each basin are to attain and preserve a "good" ecological state in groundwater and surface water systems, as well as a "good" ecological potential in surface water reservoirs that have been artificially created or significantly altered (EU4Environment, 2024; KMU, 2023).

Subsequently, WFD is mirrored in the national, regional, and municipal urban strategies (UNECE, 2022). Cities recognise the intrinsic value of their water bodies, including rivers, lakes, and surface water, as integral components of urban ecosystems (EEA, 2016). In response to the imperative of achieving environmental sustainability and enhancing the quality of life for residents, cities prioritise adopting innovative solutions and measures, such as NbS (NATURVATION, 2017). As demonstrated in the previous section featuring case studies from the EU, NbS have proven effective in addressing water quality and quantity challenges. Nevertheless, despite their proven effectiveness, there are obstacles and difficulties with NbS integration in Ukraine, which could delay their adoption and uptake.

Case Study: Rivne City and Ustya River

The City of Rivne, located in the attractive surroundings of north-western Ukraine, combines history, culture, and environmental treasures (Ukraine.ua, 2023). The Ustya river, often referred to as Rivne's primary water artery (Rivnerada, 2020), originates in Zdolbuniv Oblast, courses through the city centre, and serves as a left tributary of the Horyn river, stretching across 68 kilometres (Pol et al., 2022; Rivne. name, 2022). The Basivkut reservoir stands as the primary water body within the community (Ecological Passport of the Rivne City Territorial Community, 2021:6ff), and two lakes of the Hydropark, formerly swamplands, enhance Rivne's natural attraction (Rivne. name, 2022). Before the Basivkut reservoir, the area boasts a valuable wetland ecosystem known as Basivkutski Plavni, characterised by its rich biodiversity and pristine condition as a natural filter. Acting like a sponge, Plavni effectively purifies the water that flows into the city (4B). The proximity of the Ustya river to the city of Rivne has spurred the expansion of urbanised areas, heightened demographic pressures, and necessitated the establishment of sewage networks as urban and rural areas were structured. While the river's natural filtration and dispersion processes once efficiently managed pollutants, boasting a filtration coefficient of up to 90%, this capacity has since halved, leading to a significant increase in surface runoff pollution (Voytyshyn et al., 2017).

WWTPs are essential components of the sewage management system in the Rivne community, which includes the city of Rivne and the village of Kvasyliv. These facilities are essential to the purification process because they treat wastewater from different sources and eliminate impurities and pollutants before releasing it into the environment. The municipal water utility organisation responsible for managing the water and wastewater systems of the city, Rivneoblvodokanal, is in charge of the WWTPs. However, they provide only 40% of the city's needs for treating domestic wastewater and reconstruction because they were put into operation in 1964. In this regard, the rest of the city's sewage is pumped to the sewage treatment facilities of PJSC "Rivneazot". KOS for the village of Kvasyliv, which is part of the Rivne community, is located in the village of Kvasyliv. The WWTPs for the Rivne are located in the village of Kvasyliv. They were constructed and commenced operations in 1985 (Ecoclub, 2022;

Rivnerada 2021). Notwithstanding WWTPs, the municipality faces difficulties stemming from its antiquated infrastructure, which obstructs the effective handling and processing of wastewater. In addition, a significant part of the private sector of Rivne, including the one located near Basovoy Kut, is still not connected to the central sewage system, leading to untreated sewage being discharged into the environment.

Beyond Rivne's borders, the Ustya river is closely linked to the more extensive Pripjat Basin River system. The Pripjat Basin, which includes Ustya river, is a vast area of wetlands and streams that play an essential role in regional hydrology and ecology (OECD, 2021). Therefore, in line with European integration in Ukraine, the Ustya river, which belongs to the category of small rivers, is subject to compliance with the Water Framework Directive (Grokhovska & Konontsev, 2022). As such, it connects the necessity of long-term management and conservation efforts for Ustya river, whose health directly impacts Rivne and the region's overall natural balance.

Challenges in the Ustya River

In essence, the river of Ustya was listed as the dirtiest river in the whole Rivne region (Rivne.name, 2022). It faces several challenges, with the primary reasons for surface water pollution attributed to human activities, particularly agriculture and urban development (Pol et al., 2022). As such, pollution sources are coming from the industrial sites, such as the Kronospan factory, from fields around the Rivne, and new development sites with private cottages, which do not always connect canalisation to the sewage systems in the city (1B; 4B). Specific attention by the society and local NGO Ecoclub took multiple unauthorised pipes through which leaks occur from the private sector and small enterprises around Rivne (1B; 2B; 4B; 5B). In particular, Ecoclub, with other activists, discovered 17 points in different parts of the city (5B; Pol et al., 2022).

Furthermore, the city of Rivne has seen the effects of CC. Rising temperatures and a trend toward decreasing water levels in river Ustya have slowed the river's flow, resulting in lower oxygen levels (1B; 2B; 4B; 6B). Therefore, several times during the last few years, there were fish losses (2B). Compounding these concerns is the Soviet-era construction of the Basivkut reservoir, which artificially broadened the waters, straying from the river's original characteristics (6B). While the river Ustya reaches the end of its course in the city of Rivne, specifically in Krasyliv, storm sewer facilities are not functioning correctly. This exacerbates the problem as the water becomes dirtier after passing through this area (1B; 4B). This architectural defect exacerbates the problem by enabling water to remain stagnant for long periods, especially during the summer. As a result, the stagnant water becomes overheated, promoting eutrophication and algae blooms in the Ustya river (1B; 6B).

Following the effects of CC, human activities exacerbate the river's challenges. Recreational users on scooters and quad bikes have illegally built a bridge, interrupting the river's natural flow (1B). Furthermore, fishermen contribute to pollution by discarding huge fish that consume more aquatic vegetation (1B; 2B). During the first spring rains, pollutants from winter road surfaces, including poisons and metals from exhaust fumes, wash into the river (6B). Furthermore, visitors to recreational areas like beaches frequently leave behind waste (1B). Lastly, natural territories have been destroyed, mainly by removing old trees along riverbanks, resulting in habitat and biodiversity loss and a reduction in the river's vulnerability to environmental stressors (3B).

In summary, it can be seen that the challenges for the River Ustya are complex (2B). The river represents a complex ecosystem where everything is interconnected, so the solutions to address

environmental and legal issues should be reviewed systematically and holistically (3B). As such, the government of Rivne has initiated several projects to enhance its quality and quantity (Rivnerada, 2020). The following section will present further elaboration in connection with the governance on the Ustya river.

Overview of projects for River Ustya

In 2018, the "Council of the Ustya River Basin" was established under the Rivne Regional State Administration, where the council brought together stakeholders from local government, non-governmental organisations, ecologists, and regional leaders to serve as a consultative and advising body. Their joint objective was to create recommendations and guarantee that the interests of businesses and associations that utilised water were coordinated to preserve and replenish the water features in the basin and bring the surface waters back to a "good" ecological and chemical condition. Under decree N69, this initiative became operative on January 30, 2019. Projects for the river Ustya that were designed between 2018 and 2020 were not carried out. In addition, the start of the war in Ukraine in 2022 made river management even more complicated, aggravating preexisting problems and impeding efforts to find solutions (1B).

Currently, the management of the Ustya river is mirrored in the strategy of the Rivne regional administration until 2027. Moreover, due to the Ukrainian obligation to implement the Water Framework Directive, the basin board for the Pripjat basin is working on creating river basin management plans, where projects aimed to achieve the "good" status of the water bodies are incorporated and revised. As such, in September 2023, the basin board revised a complete list of programs for the area of the Pripjat river sub-basin, including problems associated with the Ustya river, their content, and problems to be solved during 2025-2030. The project of the Action Program for the Pripjat river sub-basin was formed from various current programs and projects based on the proposals of territorial communities, water users, regional offices of water resources in Rivne and other regions (BMWRRPR, 2023).

Based on that, five projects were accepted and considered for addressing pollution in the river Ustya. In Appendix K a detailed description of each project is presented. Although the basin board approved five measures to improve the Ustya river's water quality, execution has been complex. These primarily technical and hydrological projects were created to address the river's significant problems and enhance the waterway's ecological health. Despite the reasonable suggestions and the need for urgent action, none of them have been realised. Some, like the relationship between project acceptance and actual execution, raise concerns about how well Rivne's governance practices for WRM are working.

Despite Rivne's historical reliance on traditional grey infrastructure, such as concrete channels, stormwater drains, and sewage treatment plants, these ageing systems have become inadequate in meeting the city's evolving water needs and addressing current challenges in the Ustya river. Moreover, such grey infrastructure often fails to consider water management's ecological and social dimensions, thereby missing sustainable development and community engagement opportunities. It is essential to recognise the limitations of these outdated WWTPs and explore innovative approaches that integrate ecological principles into future water management projects (World Bank, 2021).

In contrast, the EU has taken a leadership role in transitioning towards improved water bodies, adopting an NbS approach to address complex challenges. As demonstrated in the previous section, NbS projects in four case studies across the EU effectively combined technical and ecological components. The lack of integration with NbS principles in Rivne's WRM limits its ability to adapt to future challenges, including CC and urbanisation.

Given these circumstances, it is imperative to understand the reasons behind the lack of project implementation and assess how well the current governance structure supports the analysis of stakeholder viewpoints and an evaluation of the conceptual framework elements to investigate governance mechanisms in the Rivne case study. Therefore, by examining conditions such as regulations, finances, skills and knowledge, and existing collaborations and networks, this study provides a comprehensive understanding of the challenges facing Rivne's government structures to implement projects for the Ustya river. Additionally, examining six governance principles from the conceptual framework will shed light on the barriers. At the same time, it also provides recommendations for improvements for a more sustainable and resilient future for the Ustya river and its stakeholders.

Governance analysis on Ustya River

Regulations

The discourse surrounding environmental management in Rivne intricately weaves together regulatory frameworks and the pervasive challenges of compliance. During a meeting held in spring 2023, as highlighted by the interviewee from 4B, activists and local authorities convened to discuss pertinent issues. Contrary to the documentation, the Basivkut reservoir is not recognised as a water body despite its considerable length of 6-7 kilometres. This revelation has raised significant uncertainty regarding protecting such an object and determining which activities are permitted or prohibited. Like any other water body in Ukraine, it should have a passport outlining applicable rules and regulations. Only in 2018, when there was a need to create a project for the Basivkut reservoir, was it created (1B; 2B).

Due to the reasons above, a line of activities and developments are not controlled. According to the interviewee from 5B, there have been instances where the responsible entity, Rivnevodokanal, tasked with water treatment and delivery, was approached to address unauthorised pipes. However, they stated they were not authorised to intervene as they were not responsible for their installation. Similarly, when the matter was brought to the attention of environmental inspectors, they also disclaimed responsibility, asserting that removing "pipes" fell outside their jurisdiction. Thus, it can be understood that the capabilities of regulatory bodies are relatively constrained (5B).

Significant developments around the Basivkut reservoir and next to the river Ustya are also emerging (3B). Among many situations, one appeared highly visible. As one of the developers decided to build high-rise apartments, many discussions and opposition were in place against the construction. Even though there were attempts to stop the development, the changes in the status of the territory were approved, and the project was implemented. In a note to that, the interviewee 5B highlighted that:

"...the authorities must have the strength and desire not to go along with those entrepreneurs who would like to build, for example, in these territories. However, the biggest problem is that, in fact, in this case, which has now developed in Rivne, while performing the duties of the mayor, he is directly related to one of the largest construction companies that built an entire neighbourhood and several other buildings. Moreover, perhaps this is also the reason for the current state."

However, another interviewee (6B) noted that certain adjustments have been initiated in alignment with Ukraine's commitment to EU integration. This was underpinned by applying environmental protection legislation. It has been observed that governmental bodies are rustling, all supposed bodies have been divided into water bodies, management plans have been developed and approved, and it is the right direction to use this window with opportunities (European Pravda, 2024). The only question is to be asked of elected local authorities who

posed uncertainty in dealing with and overcoming environmental infractions due to their lack of action (6B).

Finances

The financial component is critical for the successful execution of any project. The development and deployment of advanced technologies for the Ustya river demand substantial investment, posing a considerable financial barrier to progress (3B). The city budget reflects a stark reality: the current financial situation does not allow for significant funding for environmental programs (1B).

Despite facing financial challenges, innovative financing mechanisms have emerged as potential solutions for addressing environmental concerns. One such model is the community-driven approach, which links wastewater fees to clean water consumption. By incentivising conservation while simultaneously generating revenue, this approach can mobilise local resources and foster a sense of ownership and responsibility for environmental stewardship (5B).

The pollution in the river Ustya, caused by unauthorised pipes from the private sector, stems from root causes. One proposed solution involves mapping the territory of Basiv Kut and the Ustya river to the water protection zone, which would prohibit the possibility of illegal dumping. However, the implementation of this mechanism has been hindered by financial constraints, particularly related to hiring specialists to generate the required documentation and a notable absence of political will (5B).

Another potential financial mechanism revolves around the principle of "polluter pays" (2B). This concept suggests that those contributing to environmental degradation should bear the financial responsibility for remediation efforts (Gaur et al., 2022). Interviewee 2B further highlights the potential for leveraging international frameworks from the EU, such as the EU Emissions Trading System (EU ETS), to generate revenue for environmental initiatives (EC, n.d.-c). This multifaceted approach to financing emphasises the need for systematic and comprehensive adaptation strategies, integrating mitigation and prevention measures (2B).

Skills and Knowledge

The National University of Water Management and Nature Management (NUWMNM) is the only water resource management-focused university in Ukraine in Rivne (Wikipedia, 2022). The university has a laboratory, actively participates in scientific research, and works with international organisations. Furthermore, the Rivne city officials started a project in 2018 that was focused on the Ustya river called "Executing measures to rehabilitate and sustain a favourable hydrological state and sanitary status of the Basivkut Reservoir" (Rivnerada, 2020).

Existing Collaborations and Networks

Rivne stands out as the only Ukrainian city to sign up for Net Zero Cities and commit to a 30% reduction in GHG emissions. This program shows that Rivne is committed to tackling climate issues and offers a structure for improving the city's resilience (Climate-KIC, 2023). Alongside this dedication, Ecoclub—one of Ukraine's most prominent volunteer environmental groups—actively participates in Rivne (Ecoclub, n.d.). They led an analysis of the assessment of vulnerability to climate change in the Rivne community in 2022 and brought in several outside specialists. This assessment was approved by local authorities on December 8, 2023, and incorporated into the Rivne community's Action Plan for Sustainable Energy Development and

Climate till 2030. In addition, the Ecoclub has continuously brought attention to the river's declining state (Rivnerada, 2023). In line with that, a notable public initiative led by citizens is the Garden of History, which is acting in the city and aims to green the city by planting trees (Ecoclub, 2016). Furthermore, in Rivne, activists regularly distribute educational materials on biodiversity protection, contributing to the change of Soviet practices in landscaping the city of Rivne (Garden of History in Rivne, n.d.). As such, the renovation involved turning concrete sections in Rivne's public areas into lush landscapes with various plants and trees and building flower beds decorated with perennial plants (Garden of History in Rivne, n.d.).

Geographical and institutional embeddedness

The projects for the Rivne Ustya river and the Basivkut Reservoir aimed to address several sustainability challenges. Primary efforts are underway to restore the river's functionality and mitigate CC impacts, which would increase air humidity and vegetation along the river, which creates a favourable microclimate in the city (3B). Even though the Ustya river is categorised as a small type of river, it is still important to regulate it to create atmospheric processes and subsequent rainfall, as well as the saturation of aquifers (5B).

However, one interviewee noted (5B) that these projects primarily focus on hydrological aspects. While there is recognition of the need to renovate Kvasyliv WWTPs due to their inefficiency in treating water (4B) and removing sediments from the Basivkut (6B), there is a notable absence of ecological considerations in these initiatives (5B). Both 2B and 5B interviewees pointed out that none of the above projects directly addressed the root causes of pollution in the Ustya river, particularly the unauthorised leaks occurring in 17 locations around the city. While improvements in technical solutions such as enhancing river flows or removing sediments may be beneficial, they would not fully address the pollution levels in the river (1B).

They also align with Ukraine's efforts in the EU's WDF, which focuses on enhancing the amount and quality of water. Moreover, as interviewee 1B pointed out, these activities align with Ukraine's green recovery goals and the European Green Deal.

Evidence-based decision making

Analysing the Ustya river project's evidence-based decision-making procedures highlights essential components of informed governance. 1B points out the significance of thorough studies to guide river management efforts, pointing out that no rules or conditions are based on research to help with decision-making (1B). Moreover, the personal perspectives of local authority representatives were emphasised as harming the quality of decisions (1B, 3B). Evidence-based approaches should also be evaluated based on deputies' qualifications and commitment to improving community welfare (1B). Furthermore, interviewee 2B highlighted the importance of qualitative research in addressing current Ustya river challenges and positioned them as vital to a successful project's execution. It was further indicated that although these investigations could cost up to 20% of the project's overall budget, they are essential for comprehending the issue and preventing future harm and expenses.

Simultaneously, 2B elaborates on the obstacles faced by the nation's evidence-based procedures, pointing to a lack of confidence in scientific results and resistance by authorities to take responsibility for their choices. Therefore, finding a common language and bringing complex solutions to the public is essential. Informing the public about the project could build trust and educate residents about the urgency of the execution of the Ustya river (1B).

Inclusivity and equity

2B mentions involving all relevant parties to address complex issues effectively. This includes identifying willing participants and those who might not know their role or impact in finding a solution. Distinct viewpoints frequently cause this disparity, with those directly impacted by the problem being more willing to participate than those contributing to it. This emphasises a fundamental difficulty in reaching all-encompassing solutions since it necessitates reconciling people with opposing goals and interests (2B).

Meanwhile, the community is taking a proactive approach to improving the state of the Ustya river. Before the war, when illegal leaks from pipes in the private sector were discovered, a petition for review received the required number of signatures in a single day, demonstrating the public's protest against pollution in the river Ustya. Interviewee 3B emphasises that, in their own experience, no other problem in Rivne has attracted such quick and broad public attention. However, the authorities have taken no meaningful action to address the issue despite this citizen movement.

However, Rivne still has unrealised potential for greater community involvement. Interviewee 1B emphasises the urgent need for a more organised strategy to educate the public about environmental challenges, even in light of the present lack of interest in river-related issues among residents. It is vital to be aware of the problem as it is severe and has a long-standing history, while it is not a time for finding culprits but rather a time for building a common awareness (1B). Similarly, 2B supports including environmental education in the curriculum from a young age, stressing the value of giving kids the authority to shape their parents' perceptions of and behaviour related to environmental issues.

Integrating enterprises is also a difficult task, but it is needed. The government should present a precise position relative to conserving natural public resources (2B, 3B). Developers actively trying to use the area surrounding the Basivkut reservoir for their purposes should be appropriately informed and engaged in dialogue to ensure that resources are fairly distributed (2B). In light of that, 2B stated:

“Decisions should be simple of their kind, but, unfortunately, the era of such simple decisions has already passed and will never return, and there will be no repetition of such decisions. Difficult decisions await us, and difficult decisions are resolved only at the level of compromises.”

Collaboration

Collaboration emerges as a fundamental pillar for designing paths toward long-term solutions within Rivne's complex patterns of environmental governance. Interviewee 1B emphasises the importance of creating a shared understanding among stakeholders and cautions against making immediate choices that could worsen existing environmental concerns. This appeal for nuanced discourse resonates with the 2B interviewee's advocacy for transparent processes and inclusive interaction. Building trust and fostering open discussion is crucial for negotiating the complex landscape of environmental problems (1B).

Furthermore, collaboration goes beyond communication and includes exchanging knowledge and skills. 5B emphasises the significance of including varied stakeholders for complete decision-making processes. Stakeholders 5B and 3B underline the value of tapping into external expertise and experiences, such as from neighbouring cities or international organisations, to influence decision-making and boost the effectiveness of environmental programs. For example, Warsaw, Leipzig, Lublin and Lviv tackle similar issues that could be referenced for sharing experience and their progress (1B). Moreover, combining diverse viewpoints and

specialities could cause some contradictions while it can help generate higher-quality project' outputs (2B; 4B).

The path toward collaborative governance is, however, contested. 6B recognises the need for political will and coordinated efforts to overcome obstacles to collaboration, especially in areas where vested interests may impede advancement (6B). At the same time, interviewee 1B highlighted the need to choose an administrative body or organisation that could guide the development of the projects for the Ustya river and, therefore, be responsible for decision-making. This opportunity lies in the existing organisation Garden of History, which has already proved efficient in creating and managing park Ostrwica in Rivne. The vision lies in creating National Park (NP) for the territory around Basivkut reservoir. However, such management of the NP in Ukraine is given to local authorities. The goal is establishing regulations and restrictions to manage the area's activities without restricting access for individuals and businesses to participate in the economy (1B).

Transparency

Transparency emerges as a cornerstone principle in the development and execution of the Ustya river project, essential for building trust among stakeholders and ensuring accountability in decision-making processes. 1B emphasises the importance of transparency in governance, advocating for open dialogue and community engagement to promote informed decision-making (1B, 2B). The other interviewee, 3B, highlighted that overall decisions are transparent in Rivne, but the problem lies more in influencing them.

At the same time, 2B explores the challenges and importance of transparency in project management, stressing the need for thorough problem analysis and transparent information sharing to mitigate risks and ensure project success (2B, 1B). Two key obstacles arise in this context. Firstly, certain parties often lack interest in transparency due to differing priorities, prioritising their agendas over collaborative problem-solving. Secondly, information can often be incomplete or insufficient. Therefore, obtaining comprehensive data through preliminary studies is crucial, yet in Rivne, there is a tendency to minimise such studies in terms of time and costs (2B).

Long-term perspective

In considering the long-term perspective of the Ustya river project, interviewee 2B emphasises the need for holistic approaches that extend far beyond immediate results. Another interviewee (1B) underscores the necessity of studying long-term impacts, particularly CC, advocating for restoration efforts prioritising the river's natural state (1B, 2B). While there has not been a developed assessment of possible scenarios for the Ustya river and Basivkut reservoir, it would be beneficial to create a strategic roadmap spanning 10 to 20 years, outlining priority steps to guide sustainable development (1B).

2B further emphasises the importance of long-term thinking in water and nature management, cautioning against short-sighted decisions that may lead to adverse consequences (2B, 1B, 4B, 6B). Moreover, distinguishing the level of intervention from the natural processes should be taken seriously due to its ability to self-regulate (2B). The interviewee critiques past interventions, such as the reservoir construction, which lacked foresight and comprehensive planning. Furthermore, interviewee 2B, with a similar perspective to 1B, advocates for developing the NbS by considering the complex interplay between human activity and natural processes. Compared to the existing concrete blocks, such locks should be removed, and natural and seasonal regulations should be provided (1B).

At the same time, it is understood that the project lives and transforms according to the new conditions and challenges (4B). Currently, no program in Rivne could be applied to observe the effectiveness of new interventions for the Ustya river; therefore, there is no monitoring. However, the project's starting point is identifying the root causes of the pollution, which was lacking in the proposed five projects (5B; 6B). Effective improvements to the river Ustya and the Basivkut reservoir can only be achieved by thoroughly assessing their current conditions and states. This evaluation should inform the establishment of priorities and goals aligned with the available resources for the upcoming time frame (1B; 2B). Lastly, it should be understood that:

“The paradox of such interventions as the entry of natural processes can be rapid and cause fairly significant rapid damage, but reversal is usually quite difficult.”(2B)

Lessons for Transformative Governance of the Ustya River

An analysis of the Ustya river's governance structure exposed the inadequate condition of Rivne's water body management. Firstly, it has been observed that a top-down approach characterises governance in Rivne. There are some collaborations from the different initiatives in the city, but the leading power in decision-making stands with local authorities. Secondly, initiatives that emerge without a systematic framework or strategic planning demonstrate a lack of integrity in WRM. Thirdly, external factors both hinder and present opportunities for improvement. On the other hand, Ukraine's involvement in a full-scale war directly impacts budget allocation and limits the implementation of projects related to the Ustya river by then. On the other hand, while Ukraine's integration with the EU presents opportunities for alignment with European legislation, it also underscores the urgency for transformations within governance practices. As a result, it is imperative to establish the right conditions and modify governance structures to address the current state of the water bodies and enable improvements.

The following section presents an overview of critical points that should be considered to be strengthened within each principle for more effective governance, thereby addressing RQ3:

Geographical and institutional embeddedness

- Local government should advocate for legislative changes to strengthen environmental protection measures and enforcement mechanisms.
- Local government should adopt a broader perspective on the challenges facing the Ustya river, considering both ecological conditions and the impact of human activities.
- Emphasis should be placed on addressing the root causes of environmental degradation rather than merely treating the symptoms.
- Developing a clear and well-defined plan with step-by-step actions is crucial for effective governance of the Ustya river that includes specific criteria for project implementation, resource allocation, and adaptation to changing circumstances.
- Establish a binding mechanism to ensure compliance with governance measures and agreements.

Evidence-based decision making

- Integrate external (unbiased) experts into analysing the Ustya river's current state, ensuring their independence from local authorities.

- Utilize scenario-based planning to identify adaptive strategies for managing the Ustya river under different climate futures.

Inclusivity and equity

- Prioritize environmental justice by ensuring that management decisions for the Ustya River consider the diverse fauna and habitats present in the ecosystem.
- Foster inclusivity by integrating social components from NbS projects into Rivne's overarching strategy, vision, and priorities. By acknowledging the importance of blue-green corridors and other NbS initiatives, decision-makers can enhance community engagement and ensure that the interests and concerns of all stakeholders are addressed.

Collaboration

- Emphasize the importance of education and awareness-raising initiatives to promote transparency in Ustya river management.
- Establish a mechanism for collaboration that leverages existing successful projects in Ukraine to access funding opportunities such as LIFE or Horizon projects.
- Foster networking initiatives to facilitate collaboration and knowledge exchange among stakeholders involved in governance efforts along the Ustya river.

Transparency

- Increase accessibility to the state of the Ustya river by providing regular updates and information to the public regarding the status of ongoing projects.
- Prioritise communication and openness by engaging in meaningful dialogue with stakeholders and the wider community.

Long-term perspective

- Establish a dedicated and accountable body responsible for coordinating and overseeing the implementation of projects along the Ustya river.
- Foster partnerships with local initiatives and organisations to leverage additional resources and expertise in managing the Ustya river effectively.
- Implementation of a comprehensive monitoring system is essential for accurately identifying pollution sources and assessing water bodies' health over time.

6 Discussion

Discussing the research project's results yielded several key findings and reflections, particularly regarding the Conceptual Framework, Case Studies and Rivne Analysis for Ustya river. Afterwards, the author's reflections are presented, on methodological choices for the research project are provided followed by a reflection on research limitations.

6.1 Conceptual Framework for Governance in SMCs

The conceptual framework aimed to enhance understanding of how successful NbS projects for WRM are governed through institutional lenses and research and then to apply this understanding to a practical case study in Rivne, focusing on the Utsya river.

Interviews with experts were crucial part for the evaluation theoretical knowledge into practical framework. Therefore, during the discussion with experts some modifications were applied. In particular, expert 4A emphasised the limitations of analyzing these principles within the UNA context, while 2A and 3A experts highlighted the complexities involved in monitoring them across governance processes. Consequently, the author decided to incorporate them into transformative processes in the governance framework. Additionally, due to the novelty of NbS, the use of six principles would be possible if there in place enabling local conditions. Therefore, conditions influencing the capacity to apply effective governance were added, such as regulations, finances, skills and knowledge, and existing collaborations and networks. These aspects were further identified and reviewed from academic articles, forming the basis for the development of the conceptual framework.

By testing the conceptual framework on case studies from the EU, it was possible to confirm the application and feasibility of developed methods for each governance principle. The rationale behind this stage was a lack of empirical studies focusing on governing NbS projects for WRM in SMCs. While most projects in Rivne are currently in the strategic planning stage, this conceptual framework could be a guiding tool for project development. Thus, it was important during that stage to evaluate conceptual framework on its operationalisation.

Since the conceptual framework is intended for use by initiators and stakeholders involved in governing the development of NbS projects, it is essential to establish a common understanding of each principle. While all principles may seem important, it is crucial first to understand the city's local context, including its resources and needs. Depending on the context, certain principles may not be less relevant. As it was observed with evidence-based decision-making principle, the requirement from LIFE program put stricter obligations for conducting multiple assessments in Ljubljana Connects project, while in case of Utrecht only one local assessment was in place. At the same time, the long-term perspective principle was approached differently. For instance, in the Ljubljana project, nearly all activities were executed in a manner that required no further operationalisation, whereas in Malmo, three parties had to sign an agreement to hire specialists for ongoing activities.

Even though this conceptual framework was based on the literature, it could be further used by academia and scientists to evaluate whether these principles could be used for other types of NbS. From the policy formulation's perspective, this conceptual framework can be used to understand governance mechanisms for integrating NbS projects into local, national, and other policies or strategies. Lastly, while it was primarily planned for the Rivne case study and other NbS projects for WRM, it could apply to countries with similar cultural and socio-economic situations and economies in transitions, but also for the EU context and not limited to SMCs.

The evaluation of governance processes situated in the conceptual framework, such as learning and reflection, and adaptation, was not performed in the case studies due to inability to obtain such information through secondary data but was highlighted as important in the literature. Therefore, further investigation and improvements are needed to create a practical tool to track those aspects of governance. At the same time, this framework did not extensively analyse the aspects of justice and the financial mechanisms applied, which could be relevant for future investigation.

In short, this conceptual framework provides key lessons for WRM initiatives, especially in the context of multiplying NbS projects. Hence, it is essential to ensure that the framework's information is applicable to practitioners in real-world scenarios while also drawing from theoretical perspectives. The practical application of this framework could involve conducting a series of workshops involving key stakeholders engaged in NbS project development. This would be pertinent to city governments, representatives from NGOs, urban planners, and businesses operating within urban contexts. Additionally, effective collaboration would necessitate consultations with community representatives, whose experiences and local knowledge can significantly shape the understanding of the local context. Consequently, such NbS projects could serve as practical responses to urban transitions by challenging dominant ideologies and practices, including a reliance solely on conventional methods.

Institutional and geographical embeddedness should be directly connected to local challenges and needs. Therefore, city strategies and policies for regions, or from the EU level, reflecting global agendas such as the UN SDGs in relation to NbS development. In the case studies, the WFD presents a strong mechanism for improving water quality and quantity, while Natura 2000 focuses on the protection of species. These regulatory pressures were evident in the projects in Wuppertal and Ljubljana. While they are binding regulations, they also present opportunities for securing funding, such as through LIFE projects.

Evidence-based decision-making is a crucial principle of NbS projects, as none of the case study projects progressed without conducting at least one assessment. These assessments were not only necessary to identify needs and challenges but also to communicate the results to the initiating organization or local authorities, who hold the decision-making power. For instance, the project in Utrecht moved forward only after receiving approval from local authorities, and similarly, in Malmo, a climate assessment was instrumental for the initiating organisation to prove the need to improve city district.

The inclusivity and equity principle overlaps with collaboration because both require integrating multiple actors into NbS development. However, the extent to which actors can influence decisions varies. For example, in the Malmo and Utrecht projects, citizens were involved in consultations and could influence decisions. In contrast, the Ljubljana project focused on implementing hydrological interventions, excluded the opportunity to interfere, but faced disturbances when local fishermen restricted interventions in the Ljubljana River.

6.2 Comparative Case Study Analysis

The analysis of four case studies from the UNA database shaped the understanding of how and in which forms of governance were implemented. In line with the literature review section, current case studies for NbS projects have been confirmed to be characterised by new governance modes compared to traditional top-down approaches (Wickenberg et al., 2022). At the same time, the developed conceptual framework has shown its applicability to NbS projects for WRM. All analysed NbS projects were led with a collaborative manner through multi-stakeholder participation and cross-sector collaboration (Hölscher et al., 2023; Toxopeus et al., 2020; Frantzeskaki, 2019). In this regard, it becomes evident that urban transformations through

NbS are primarily driven by actors at the municipal level, whereas policies and strategies guiding NbS implementation originate from various levels of governance.

At the same time, NbS projects for WRM remain to deliver firsthand environmental benefits and reduce climate impacts while also addressing urban activities such as urbanisation. Also, economic benefits were not monetised in three case studies (Utrecht, Wuppertal, and Ljubljana), while only Malmo could create a monetary mechanism for the payment of ecosystem services. Additionally, recreational activities on the water bodies are somewhat limited, and projects like Ljubljana strongly emphasise educational awareness among children and university students. The shift in the perceptions of citizens and stakeholders about water bodies, which are natural ecosystems, is an essential aspect of protecting and sustaining the excellent quality of water bodies. This also emphasised creating a sense of place among populations and building trust (Kauark-Fontes et al., 2023).

Formal organisational approaches such as the creation of citizen initiatives have been developed in Utrecht and Wuppertal and have shown opportunities for the involvement of the local community in different forms of participation. Therefore, public participation was influential in shaping the understanding of the projects while also building trust among the population. However, as presented in the Malmo project, collaboration requires additional financial support and approval from legislative bodies. Thus, public participation plays an essential role in shaping public perception of NbS projects while also building trust among citizens. However, decision-making remained unclear as to which extent was possible.

As mentioned in the study by Costadone and Vierikko (2023) and Nieminen et al. (2021), it was observed that the government remains the primary enabler for NbS development. Compared to mentioned typical institutional silos as a challenge in the literature, the case of Malmo showed a leadership position that motivated representatives from the governmental side characterised. In the same way, local citizens in Utrecht not only presented dissatisfaction with solutions from the government but were able to run their initiative with dedicated individuals with expertise in emerging issues. At the same time, in the Ljubljana project, a new significant entity emerged to facilitate the development of NbS. In contrast to what was found in the literature by Zingraff-Hamed et al. (2021) and Kiss et al. (2020), who emphasised including municipal government, residents, and NGOs, Ljubljana showcased the importance of the local university in facilitating this change.

In essence, present risks concerning environmental aspects, habitat or social disturbance in cities were the main drivers for the development of NbS projects. Thus, climate assessment and analysis of each case study confirmed and built the foundation for finding appropriate solutions. At the same time, external pressure from the EU policies such as WDF or Nature 2000 was explicitly important for WRM. Moreover, available funding for complying with those policies, like the LIFE program allocated to Malmo and Ljubljana, not only helped move the project, but also provided opportunities for networking in international conferences while supporting knowledge exchange.

The maintenance of NbS projects for WRM remains not fully uniformed. In Utrecht and Wuppertal, the main tasks of managing NbS project are assigned to citizens who are actively involved in initiatives. This confirms the studies by Kiss et al. (2022) and Colucci (2023), where citizens played a pivotal role in maintaining NbS in a long-running timeline. Conversely, in the case of Ljubljana, the project was implemented so that no further interventions were needed; however, some activities were allocated to the project's beneficiaries (*Ljubljana Connects | Urban Nature Atlas*, 2021). Therefore, considering the aspect of maintenance from the very beginning of the project development would require decisions from responsible bodies. As such, the

Malmo case presented an innovative method of commercialisation and maintenance for the provided ecosystem payment by signing a partnership agreement with an external contractor.

6.3 Analysis of Ustyá River

The governance structure for the Ustyá river and Rivne City is characterised by a top-down approach, with the primary decision-making power residing with the local government. At the same time, limitations in the long-term sustainability visions and transformations are hindered by short election cycles, confirming the research by Mendizabal et al. (2021). Moreover, despite decentralisation attempts in Rivne observed in the study by Kronvall et al. (2023), local administrations lack the political will to confront the current situation on the river Ustyá. Such incapacity comes from multiple strategy goals and limited knowledge in uptaking transformations (Eichhorn et al., 2021).

Furthermore, municipal administrations operate in a disorganised style of governance. Although Rivnevodokanal is a public utility company responsible for delivering water services to the community, it is not well-positioned to address issues like improper disposal of leaks from the private sector due to a lack of funding and leadership. These illegal disposals are the leading root causes of the pollution in the river Ustyá. Meanwhile, companies are not involved in developing projects for the Ustyá river. There is no available mechanism to leverage additional resources from them; thereby, opportunities from the private sector are not used (Vedeld, 2022). Moreover, the top-down governance approach in Rivne further underestimates the long-term perspective of designing solutions for the Ustyá river that could bring a wide range of benefits (Kiss et al., 2022; Zingraff-Hamed et al., 2021; 2B).

At the same time, local NGOs and public organisations proactively engage in climate adaptation measures. Their position provides a bottom-up approach by utilising community ideas and local resources to set up awareness among the community. By attracting attention through their activities and conducting research, they balance the dominant view of local governments on how NbS projects should be developed. This underscores the outcomes from Emeis & Fallmann's 2022 research by indicating that in the case of Rivne's other projects, their responsibilities and power are somewhat limited to the regulatory pressure and obtained power by local governments. However, Hölscher & Frantzeskaki (2020) and Wolfram et al. (2016) outlined that city transformations were started through collaborative efforts involving multiple actors.

Local conditions have significantly influenced the development of projects for the river Ustyá and have further hindered its implementation. As Hölscher et al. (2024) mentioned, these conditions refer to institutional, organisational, and cultural aspects. Moreover, several factors, including a lack of finances and the ongoing war, have contributed to these challenges. Additionally, the phenomenon known as "free riding," where residents exploit the ecosystem of the Ustyá river as a public good without contributing to its maintenance or investing in its protection, poses a significant risk to its viability (Investopedia, 2020). Also, the existing trade-off between economic development, manifested in the form of constructing private apartments in ecologically essential areas following the river Ustyá, reflects the realities in Rivne that the government does not fully control, a situation also experienced in the EU (1B; 5B; European Commission, 2020). In this context, it becomes evident that the problem is complex and requires interdisciplinary collaboration to address its various aspects effectively. The study by Kauark-Fontes et al. (2023) highlighted that collaboration is important and can effectively drive transformative change by integrating multidisciplinary teams and cooperation with cross-sectoral departments.

EU integration in Ukraine offers a window of opportunity for cities in Ukraine, including Rivne, to advance the implementation of projects for the Ustya river. Specifically, binding harmonisation with EU legislation for water bodies such as the WFD puts pressure on local authorities to act. As the EU stands as a frontrunner in implementing NbS solutions, it is also strongly committed to addressing global agendas (Hölscher & Frantzeskaki, 2020; Wolfram et al., 2016). Thus, the EU coordination for improving Ukraine's water bodies also opens opportunities for fund-raising, improving networks and building capacities for delivering transformations in cities.

In Rivne case, structured administrative bodies for WRM have been formed, and public participation events have been conducted. However, considering that projects were designed in 2020 to meet current obligations under the WFD, questions arise regarding the adequacy and timeliness of the solutions proposed and whether they have been sufficiently studied. Despite the numerous events and decisions taken, there is a risk that proposed projects may not be thoroughly analysed, potentially leading to ineffective solutions or failures. Creating appropriate conditions in Rivne is crucial to facilitating progress and sustaining projects for the Ustya river.

6.4 Reflecting on the Research

This research project has encompassed several methodological aspects, which will be reflected in the following text. Given the project's aim to develop a practical framework for governing NbS projects in Rivne and other SMCs, it was decided to initially develop a conceptual framework based on theoretical knowledge from up-to-date literature representing effective governance modes and forms conducive to implementing NbS projects. Alternatively, the transformative capacity framework could have provided a more comprehensive understanding and assessment of how urban visions and strategies in SMCs contributed to transformative changes by implementing NbS projects (Castán Broto et al., 2019). This approach would involve evaluating each project using a set of criteria from various perspectives, including governance modes, justice, policy implications, strategic considerations, as well as educational and reflective aspects. Such an evaluation would not only enhance the understanding of the strengths, weaknesses, and opportunities of each NbS project in the future but also scrutinise the city system itself and its capacity to integrate social, environmental, and economic dimensions through NbS projects.

Subsequently, while interviews with experts provided crucial information to enrich the conceptual framework, gathering perspectives from Ukrainian experts or experts from countries with economies in transition and experience implementing NbS would have been valuable. This would have provided more nuanced practical recommendations for governing NbS projects due to the different socio-economic contexts compared to the EU cities. Theoretical perspectives were then applied to NbS projects in SMCs, explicitly focusing on challenges similar to those in Rivne. The largest database of NbS projects was utilised to select relevant projects, and the results from the case study analysis were proportional to the selected projects. While the project would have benefited from selecting more NbS projects to identify patterns and trends in SMCs, resource limitations may have constrained this aspect.

When the conceptual framework proved its applicability to NbS projects for WRM, it allowed for analysis of a real-case scenario under development in Rivne City for the Ustya river. Interviews with stakeholders from Rivne were conducted and facilitated through an NGO representative who shared contacts with the author. The conceptual framework served as a basis for creating questions for the interview guide. While the revised information from stakeholders provided enough material to conduct the analysis, the additional review was enhanced by relevant and up-to-date strategies and policies that directly influenced the development of

projects in Rivne. However, the research project could have been enriched by gaining perspectives from a wider audience, such as residents and politicians.

Exploring the complexities of urban transformation, especially concerning NbS, offered a fruitful chance to expand knowledge in this field. This focus increased the author's understanding and provided insight into the complex interactions between actual projects in the real world and scientific research conducted in urban settings. However, there were some difficulties even in the most satisfying parts of the research process. As such, the research design's frequent modifications necessitated constant adaptation and flexibility. For example, some initial case studies from SMCs were eliminated due to a lack of materials and the absence of contacts in the implementation projects. Moreover, the literature on water governance and management was limited and mainly presented data about technical solutions or connections to the policies. Therefore, it posed some difficulties in the development of the conceptual framework for the governance of NbS for WRM, but this has been overcome by reviewing the examples from NbS governance, and then evaluating through interviews with experts and applying conceptual framework to case studies focused on WRM in the EU.

Overcoming these challenges and capitalising on opportunities for growth and learning were proven to be critical components of the research process. Despite the hurdles encountered along the way, the excursion provided a better understanding of urban transformation and the critical function of NbS in this dynamic setting.

6.5 Limitations

Conceptual Framework. While the conceptual framework includes several elements, the processes (i.e. learning, reflection, and adaptability) were not possible to track in the case studies from UNA or Rivne Case Study. This limitation was present due to the complexity of governance processes, which are difficult to monitor with specific tools. Thus, this limitation hindered insights into the evolutionary processes of NbS projects and their capacity for learning and adaptation over time.

Case Studies from UNA. Employing a conceptual framework for evaluating each principle, the enrichment of outcomes was limited due to the absence of interviews with project implementers from four case studies. Also, reliance on static and secondary data from the UNA database and the available but still limited number of grey materials hindered the ability to thoroughly assess each case, underscoring the need for more diverse data sources. Additionally, temporal constraints associated with the UNA database further impacted the research, as the limited availability of project documentation hindered the thorough analysis of specific projects. This constraint underscored the importance of considering the timeliness and comprehensiveness of data sources in future research endeavours. Moreover, the research project was restricted by including limited case studies. This limitation may have constrained the scope of analysis and the generalizability of findings, indicating the necessity for a larger sample size in future studies. Therefore, incorporating multiple examples of NbS projects from large cities, in contrast to SMCs, could enrich the understanding of similarities or differences in governance practices.

Rivne Case Analysis. Efforts to secure interviews with government representatives were hindered by a lack of response, highlighting potential communication barriers within governmental structures. Additionally, conducting a site visit to Rivne and Ustya river was impossible due to the ongoing war in Ukraine, which restricted the possibility for participant observation and collecting data from other sources than formal interviews.

7 Conclusion

The final chapter emphasises the study's main findings with reference to the three research questions. These findings are used further to present recommendations to city governments and practitioners and identify future study opportunities.

7.1 Key Findings

The research project aimed to provide a nuanced understanding of governing NbS projects addressing WRM in SMCs, focusing on the Ukrainian setting and the Ustya river case study in Rivne. The systematic literature review served as the primary data source for mapping governance modes and forms likely to deliver transformative changes, laying the groundwork for developing a conceptual framework to address RQ1. Specifically, it revealed that the EU agenda promotes a polycentric mode, empowering local governments to regulate their needs and challenges through experimentation and innovation. Additionally, collaboration emerged as a significant driver of transformations, fostering interdisciplinary teams and facilitating dialogue among multiple actors in urban settings. Lastly, reflexive governance proved crucial in addressing rapidly changing conditions and challenges in cities, providing adaptability within administrative departments.

In the second phase of the research, the conceptual framework was tested and refined following a two-stage process. Firstly, the evaluation and perspectives of experts on the conceptual framework were collected, drawing on their experience and knowledge in NbS implementation and city governance. As a result, the developed conceptual framework encompasses six governance principles: geographical and institutional embeddedness, evidence-based decision-making, inclusivity and equity, collaboration, transparency, and long-term perspective. Additionally, it has transformative processes such as adaptability and learning and reflection, and conditions influencing the capacity to utilise these principles for governance as regulations, finances, skills and knowledge, and existing collaborations and networks.

Secondly, due to the project's aim, it was essential to empirically test the conceptual framework. Subsequently, the conceptual framework was applied to the four case studies on NbS projects from the EU in SMCs such as Ljubljana Connects, Ljubljana, Slovenia; Historic Utrecht Canal, Utrecht, Netherlands; Wupper Stream, Wuppertal, Germany; and Augustenborg Ecocity, Malmö, Sweden; addressing similar issues to those faced by the Ustya river. This empirical application demonstrated the framework's applicability to real-world settings and answered the RQ2.

In analysing the Rivne case, interviews with stakeholders were conducted using a guide constructed to assess the presence of elements from the conceptual framework. Additionally, grey literature, such as policies, strategies, and other materials, was incorporated into the analysis to deepen the understanding of the Ukrainian context. Consequently, it was established that the Rivne case study necessitates enhancements and modifications in the current Ustya river governing. As a result, an answer to RQ3 was provided through lessons aimed at enhancing transformative governance arrangements in the city of Rivne.

In short, the challenges presented by the Ustya river are complex, requiring improvements in legislation and a more comprehensive analysis of ecological elements for this ecosystem. Moreover, such analysis could help identify opportunities for funding and overcoming the lack of resources. Additionally, networking and sharing knowledge would enhance the perception of local government and promote more collaborative forms of governance. Lastly, citizens should be carefully informed about existing projects for the Ustya river while simultaneously building awareness of the present public good that needs to be protected. Public initiatives could work

as catalysts for such transformations by creating participatory approaches that could support the livability of NbS projects after their completion.

7.2 Recommendations for City Governments

In the section below, recommendations tailored to city governments are presented. These recommendations are particularly relevant to SMCs, encompassing both the context of Ukraine and the EU. Additionally, insights drawn from these recommendations may provide valuable inspiration for countries undergoing economic transitions.

1. Prepare evidence-based documentation, such as climate assessments or other types of analysis, to facilitate high-quality project execution.
2. Create partnerships with local initiatives and NGOs that act as environmental advocates and actively maintain a range of solutions
3. Explore the available funding opportunities in relation to binding policies and utilise these networks to learn about best practices and examples from successful projects.
4. Develop a practical tool representing relevant and essential skills and knowledge for stakeholders facilitating NbS development.
5. Engage with a broader audience in a meaningful manner by establishing communication channels to inform about ongoing projects and activities.
6. Conduct dialogues with private sector actors to explore engagement opportunities in addressing environmental challenges.
7. Evaluate the presence of local expertise and resources to apply and use for the development of NbS projects.
8. Implementing monitoring and evaluation mechanisms can help practitioners assess the performance and impact of NbS projects, identify areas for improvement, and inform future decision-making.

7.3 Recommendations for Practitioners

Meanwhile, this section highlights five recommendations intended for practitioners operating within SMCs, such as urban planners, policymakers, representatives from NGOs, and local green initiatives.

1. Policy advocacy: Advocating for supportive policies and regulations at local, national, and international levels can create an enabling environment for NbS implementation and scale-up
2. Encourage innovation and experimentation in NbS design, implementation, and monitoring can help practitioners explore new approaches and technologies to address complex environmental challenges.
3. Integrate adaptive management approaches into administrative processes to enhance flexibility and iterative learning. This ensures that stakeholders can effectively respond to evolving environmental conditions and stakeholder needs over time.
4. Provide opportunities for public participation through established agendas and goals, allowing society to contribute local knowledge. Employ participatory mapping exercises to facilitate meaningful public involvement in NbS project planning, implementation, and evaluation.

5. Develop educational campaigns to increase environmental awareness about available public goods and their benefits to society and advance understanding and support of NbS initiatives.

7.4 Recommendations for Future Research

As the number of NbS projects continues to rise, it becomes crucial to address implications for future research directions. By integrating both theoretical and practical perspectives, NbS can enhance its implementation and deepen understanding across diverse urban contexts.

Therefore, it would be beneficial to delve into the relevance of governance principles across different stages such as strategic planning, implementation, maintenance, evaluation of NbS projects. By dissecting the applicability of these principles throughout various project phases, researchers can gain a deeper understanding of their effectiveness and inform more targeted interventions.

A comparative study between megacities/big cities and small and medium-sized cities could provide valuable insights into governance practices related to NbS. Understanding whether urban scale influences governance approaches or if overarching principles remain consistent across diverse contexts could yield valuable insights for policy formulation and implementation.

Given the potential variations in governance mechanisms across urban scales, there is a pressing need to analyse a greater number of case studies in small and medium-sized cities. Examining NbS implementation in diverse urban settings can help evaluate the effectiveness of governance mechanisms and identify best practices for sustainable urban development.

It is crucial for future research efforts to prioritize the analysis of NbS projects in developing countries or economies in transition, such as Ukraine. These contexts often face unique challenges related to resource constraints, institutional capacity, and environmental degradation. Understanding how NbS can be integrated into policy frameworks within these contexts is essential for promoting sustainable development and resilience in these geopolitical contexts.

Moreover, further analysis is needed to explore how NbS projects can be effectively integrated into policy frameworks in developing countries. By identifying barriers to integration and examining successful policy interventions, researchers can provide actionable recommendations for policymakers seeking to mainstream NbS into national and local policies.

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Appendix A – Variations in Urban Transformation Terminology

| Concept | Reference |
|---------------------------------|---|
| Sustainability initiative | (Borgström, 2019; Costadone & Vierikko, 2023) |
| Intervantion | (Boeri et al., 2022) |
| Urban climate transition | (Glaas et al., 2019) |
| Urban sustainability transition | (Nieminen et al., 2021) |
| Grassroot innovation | (Colucci, 2022) |
| Urban intervention | (Bulkeley and Castán Broto, 2013) |

Source: Author's interpretation; references are in the last column

Appendix B – Initial search results and filtered publications according to search terms and screening criteria.

| No. | Search string | Total publications |
|-----|---|--------------------|
| 1 | (TITLE-ABS-KEY (city OR urban AND area OR municipality) AND TITLE-ABS-KEY (governance, AND urban AND governance, AND climate AND governance, AND sustainable AND urban AND governance)) | 94 |
| 2 | (TITLE-ABS-KEY (city OR urban AND area OR municipality) AND TITLE-ABS-KEY (multi-level AND governance, AND modes AND of AND governance)) | 7 |
| 3 | (TITLE-ABS-KEY (climate AND change, AND mitigation, AND adaptation) AND TITLE-ABS-KEY (governance, AND multi-level AND governance)) | 12 |
| 4 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (collaborative AND governance)) | 17 |
| 5 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (hybrid AND governance)) | 4 |
| 6 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (adaptive AND governance)) | 18 |
| 7 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (nature-based AND thinking)) | 25 |
| 8 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (government)) | 13 |
| 9 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (polycentric government)) | 5 |
| 10 | (TITLE-ABS-KEY (nature-based AND solutions, OR NBS) AND TITLE-ABS-KEY (experimentation)) | 9 |
| 11 | (TITLE-ABS-KEY (nature-based AND solutions, AND NBS, AND water AND NBS) AND TITLE-ABS-KEY (water AND management, AND governance)) | 24 |
| 12 | (TITLE-ABS-KEY (nature-based AND solutions, AND NBS, AND water AND NBS) AND TITLE-ABS-KEY (water AND management, AND governance)) | 21 |
| | Total number | 249 |

Appendix C – Invitation letter for experts

Subject: Invitation to Participate in Interview for Thesis Research on Governance of Nature-Based Solutions for Water Management

Dear [Research Expert's Name],

I hope this email finds you well. My name is Alisa Horbachevska, and I am currently pursuing my master's thesis in Environmental Management and Policy under the supervision of Dr. Yuliya Voytenko Palgan.

I am reaching out to you because of your expertise in the field of Nature-Based Solutions (NbS) and city governance. My thesis research focuses on exploring the governance of NbS to improve water quality and water resources management in small and medium-sized cities. To achieve this, I have developed a conceptual framework with governance principles.

Dr Yuliya Voytenko Palgan has suggested that I conduct individual interviews with experts like yourself to present my conceptual framework and validate it with professionals in the NbS and city governance domains. During the interview, I will present the framework and then proceed to ask several questions to gather your opinions and perspectives.

Your expertise and insights would be invaluable in ensuring the robustness and relevance of my conceptual framework. Therefore, I would like to invite you to participate in a 30-45 minute interview via Zoom.

Before the interview, I will provide you with information and consent forms that follow LU ethics guidance.

Would you be available for an interview between April 12th and April 26th? Please let me know your availability during this period, and I will do my best to accommodate your schedule.

I truly appreciate your consideration of this request and look forward to the opportunity to discuss my research with you. If you have any questions or need further information, please feel free to contact me at al0827ho-s@student.lu.se.

Thank you very much for your time and consideration.

Best regards,
Alisa Horbachevska

Appendix D - Consent Form

This form is intended to verify that you have received information about the ongoing research project and to allow you to confirm your willingness to participate in this research endeavour. Please indicate below which of the following statements applies to you:

| | |
|--------------------------|--|
| <input type="checkbox"/> | I have been briefed on the thesis project, had the chance to pose questions, and received satisfactory responses. |
| <input type="checkbox"/> | As a research participant, I am cognizant of my right to withdraw from participation at any juncture. |
| <input type="checkbox"/> | I consent to the interview being audio- and video-recorded, transcribed, and analysed. |
| <input type="checkbox"/> | I understand that the research findings will be disseminated in a manner that precludes the identification of my personal information. |
| <input type="checkbox"/> | I agree to the recording of my interview being securely stored for reference in the researcher's thesis project. |

Attention: Your participation in this research is voluntary. As an interviewee, you are not obliged to respond to all questions posed; you retain the right to decline or discontinue your participation in the interview process without providing a reason and may request the confidentiality of certain materials.

Please affix your signature below to indicate your consent:

| | Participant(s) | Researcher(s) |
|---------------------|----------------|---------------|
| Name(s) | | |
| Signature(s) | | |
| Date(s) | | |

For any questions or concerns about this research, please reach out to:

Alisa Horbachevska

MSc Student in Environmental Management and Policy

International Institute for Industrial Environmental Economics

Lund University

Email: al0827ho-s@student.lu.se

Appendix E - List of Interviewees

Table: Interviewees of experts for a conceptual framework

| No. | Participant code | Position | Medium | Time Length | Date of Interview |
|-----|------------------|---------------------------------------|--------|-------------|-------------------|
| 1 | 1A | NbS Practitioner, Ukraine | Online | 32 min | 12.04.2024 |
| 2 | 2A | Researcher, Sweden | Online | 54 min | 17.04.2024 |
| 3 | 3A | Practitioner-based researcher, Sweden | Online | 73 min | 18.04.2024 |
| 4 | 4A | Researcher, Hungary | Online | 44 min | 18.04.2024 |
| 5 | 5A | Ecology Expert, Ukraine | Online | 34 min | 19.04.2024 |
| 6 | 6A | Practitioner-based researcher, Sweden | Online | 54 min | 26.04.2024 |

A: Experts

Table: Interviewees of stakeholders in Rivne

| No. | Participant code | Position | Medium | Time Length | Date of Interview |
|-----|------------------|---|--------|-------------|-------------------|
| 1 | 1B | Deputy | Online | 63 min | 15.04.2024 |
| 2 | 2B | Professor at the University of Water Management | Online | 74 min | 16.04.2024 |
| 3 | 3B | Representative of the Ecocenter of the Palace of Children and Youth | Online | 54 min | 17.04.2024 |
| 4 | 4B | Associate Professor Urban Planning | Online | 68 min | 22.04.2024 |
| 5 | 5B | NGO Project manager | Online | 60 min | 23.04.2024 |
| 6 | 6B | Hydraulic engineer | Online | 75 min | 28.04.2024 |

B: Stakeholders from Rivne

Appendix F - Information Form for Stakeholders in Rivne

I want to express my gratitude that you decided to become part of this thesis project. The goal of this research is not only to contribute to the existing body of knowledge in urban governance within small and medium-sized cities but also to provide stakeholders with valuable insights and fresh perspectives for the ongoing Nature-based Solutions (NbS) projects in Rivne. The following section aims to provide all the necessary details to assist you in making an informed decision about participating in the research.

Project Description

This thesis research is part of my completion requirements for the Environmental Management and Policy Master's programme at Lund University's International Institute for Industrial Environmental Economics (IIIEE). Undertaken out of personal interest, this project operates independently without any external support or influence. The research aims to investigate governance modes and principles of NbS for sustainable water management, focusing on their potential to realise co-benefits and facilitate sustainable urban transformations.

Given the complex nature of cities as socio-technical and ecological systems managed through diverse processes and activities, enhancing collaboration and learning is crucial for urban governance. Small and medium-sized cities, often lacking in transformational capacities, resources, and available data, require specific analysis. Acknowledging the unique sustainability challenges faced by each city, this thesis concentrates on cities striving to address water quality and water resources management through NbS development.

While challenges exist in NbS governance, numerous European small and medium-sized cities have implemented NbS to tackle water-related issues. Analysing a few NbS projects across the European Union and conducting a systematic literature review, this project identifies eight fundamental governance principles for NbS and learns from empirical NbS perspectives.

In addition, it is crucial to highlight that interviews with practitioners from Rivne are an integral part of gaining a real-world perception of the on-ground situation for the projects on the Ustya river. Your insights and experiences will provide invaluable contributions to understanding and enhancing governance practices associated with NbS implementation in Rivne.

I want to assure you that any data collected during this research will be handled with the utmost care and confidentiality. To this end, all data will be securely stored on a cloud platform specifically designed for the thesis project. Each participant's data will be anonymised, and a unique numeric identifier will be assigned to ensure complete confidentiality. Rest assured that your data will only be used for the purpose of data analysis for this project and will not be shared with any third parties under any circumstances.

Furthermore, I would like to emphasise that the data will be stored only until the end of June 2024, which coincides with the completion date of the thesis. Throughout the duration of the research project, participants retain the privilege to access their personal data, request its amendment, deletion, or limitation of processing, and voice concerns regarding the handling of their personal. Lastly, it is important to note that the thesis will be made publicly available and available to everyone. This is done to promote transparency and facilitate the dissemination of the research findings to a wider audience.

Appendix G – Sample Interview for Experts

This interview guide was meticulously crafted to engage experts in the fields of city governance, nature-based solutions (NbS), and water resources management. Its primary objective is to explore experts' perspectives on governance principles and their intersection with the advancement of NbS in small and medium-sized cities. Each interview session delves into various thematic areas crucial to the understanding of governance in NbS development. These themes include the exploration of proposed governance principles along with adaptability to changing circumstances, fostering learning and reflection aspects.

Question guide for experts was following:

1. What do you think about the governance principles in the framework?
2. Which governance principle is most important for NbS projects?
3. Are there any principles that are difficult to understand? If yes, how can it be addressed in the framework?
4. How could the framework be improved?
5. Are certain principles more important during specific phases of NbS development?
6. Do you think any of the mentioned governance principles play out differently or similarly in large and small and medium-sized cities? Why?

Lastly, the interviews serve a dual purpose of both testing and validating findings derived from existing literature, which in turn informed the development of the conceptual framework.

Appendix H – Sample Interview Guide for Stakeholders in Rivne

This interview guide was specifically crafted to conduct interviews with various stakeholders involved in the ongoing development of an NbS project in Rivne. The guide aims to explore stakeholders' perspectives on fundamental governance principles and their alignment with the NbS project. Through structured questioning, the guide seeks to gather insights on *equity and inclusivity, collaboration, transparency, long-term perspective, geographical and institutional embeddedness, and evidence-based decision-making* in NbS development. The information collected will contribute to a comprehensive understanding of the NbS project's governance dynamics and inform strategies for effective project management and stakeholder engagement.

Introduction:

Q1. Can you provide an overview of the NbS project that is currently under development?

Q2. What is your role and responsibility in the NBS project?

Geographical and institutional embeddedness:

Q3. What are the primary objectives or goals of the NbS project?

Q4. How does the NbS project aim to address environmental challenges or contribute to sustainability in the area?

Inclusivity and equity:

Q5. How are stakeholders from diverse backgrounds and sectors engaged in the planning and decision-making processes of the NbS project as it continues to develop?

Q6. How will the NbS project address equity considerations to ensure that benefits will be distributed fairly among all community members, including marginalised groups, once implemented?

Collaboration:

Q7. Can you describe potential opportunities for collaboration among different stakeholders as the NbS project progresses through its development stages?

Transparency:

Q8. How is transparency being maintained in communicating the evolving goals, processes, and potential outcomes of the NbS project to stakeholders and the wider community?

Long-term perspective:

Q9. What considerations are being made to ensure the sustainability and long-term maintenance of NbS interventions as the project moves towards implementation?

Evidence-based decision-making:

Q10. How are scientific evidence and local knowledge being used to inform governance decisions and guide the ongoing development of NbS interventions?

Governance processes within Rivne:

a) Adaptability:

Q11. How is the NbS project demonstrating flexibility and adaptability in response to emerging challenges or new insights during its development phase?

b) Learning and reflection:

Q12. Can you discuss how lessons learned from the ongoing development of the NbS project are being captured and reflected upon to inform future planning and decision-making processes?

Concluding questions:

Q13. What do you consider the biggest challenges/problems for this NBS project?

Q14. Based on our conversation, do you have any recommendations or suggestions for enhancing governance practices within the NbS project?

Q15. How do you envision the NbS project's future in terms of governance and sustainability?

Q16. Is there any additional information or insights you would like to share regarding governance aspects of the NbS project?

Appendix I – Governance Principles Identified from Literature Review

| Name of the principle | Reference to the literature |
|---|--|
| Geographical and institutional embeddedness | Almassy et al., 2018; Albert et al., 2020; Kauark-Fontes et al., 2023; Voytenko Palgan et al., 2024; Holscher et al., 2024 |
| Inclusivity and equity | Kiss et al., 2022; Wamsler et al., 2020; Voytenko Palgan et al., 2024; Van Der Jagt et al., 2023; Hölscher et al., 2024; Frantzeskaki et al., 2020; Cooper et al., 2023; Zingraff-Hamed et al., 2021; Kauark-Fontes et al., 2023 |
| Collaboration | Martin et al., 2021; Kiss et al., 2022; Hölscher et al., 2024; Frantzeskaki et al., 2020; Voytenko Palgan et al., 2024; Kauark-Fontes et al., 2023; Voskamp et al., 2021; Hölscher et al., 2023 |
| Transparency | Martin et al., 2021; Kiss et al., 2022; Hölscher et al., 2024; Toxopeus et al., 2020; Kauark-Fontes et al., 2023; Kiss et al., 2019; Adams et al., 2023; Kabisch et al., 2022; Adams et al., 2024; Frantzeskaki 2019; Kauark-Fontes et al., 2023 |
| Long-term perspective | Albert et al., 2023; Van Der Jagt et al., 2023; Kiss et al., 2022; Hölscher et al., 2024; Kiss et al., 2019; Sarabi et al., 2019; Voskamp et al., 2021; Dushkova & Haase, 2020; Colucci 2023; Wickenberg et al., 2022; |
| Evidence-based decision making | Adams et al., 2024; Frantzeskaki et al., 2020; Frantzeskaki 2019; Van Der Jagt et al., 2023; Frantzeskaki et al. 2020; Kauark-Fontes et al., 2023; Wickenberg et al., 2022 |

Appendix J – Overview of Case Studies

Case: Ljubljana Connects in Ljubljana, Slovenia



- *Duration:* 2012-2015
- *City population:* 279624
- *Scale:* Meso-scale
- *NbS:* Blue infrastructure
- *Management set-up:* Led by non-government actors
- *Type of initiating organisation:* Private sector/corporate actor/company; researchers/university
- *Sources of funding:* EU funds; public national budget; funds provided by NGO

Image: Ljubljana River, Ljubljana.

Credits: <https://www.mojaobcina.si/vrbnika/dogodki/ljubljana-reka-sedmerih-imen-reka-ki-povezuje.html>

Case: Greening the Historical Canal, Utrecht, Netherlands



- *Duration:* 2016-2019
- *City population:* 315851
- *Scale:* Micro-scale
- *NbS:* Grey infrastructure featuring greens; parks and urban forests
- *Management set-up:* Co-governance with government and non-government actors
- *Type of initiating organisation:* Local government/municipality; citizens or community group
- *Source of funding:* Public local authority budget

Image: Historical Canal, Utrecht.

Credits: https://arquitecturaviva.com/assets/uploads/obras/54769/av_234887.webp?h=3d027223

Case: Renaturalization of the Wupper Stream, Wuppertal, Germany

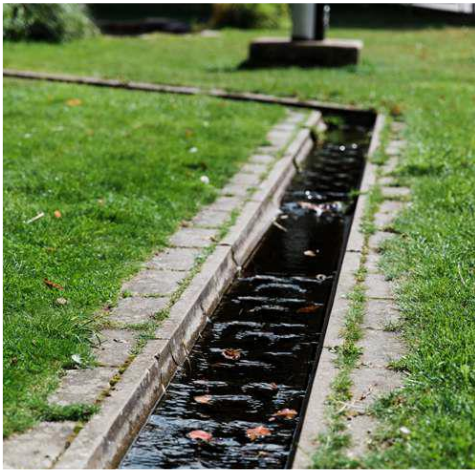


- *Duration:* 2006-2025
- *City population:* 340237
- *Scale:* Meso-scale
- *NbS:* Grey and blue infrastructure; parks
- *Management set-up:* Government-led
- *Type of initiating organisation:* Local government/municipality; public sector institution
- *Source(s) of funding:* Public regional budget; public local authority budget

Image: Urban stream Wupper, Germany.

Credits: <https://blog.sparkasse-wuppertal.de/renaturierung/>

Case: Eco City Augustenborg, Malmö, Sweden



- *Duration:* 1998-now
- *City population:* 306502
- *Scale:* Micro-scale
- *NbS:* Blue infrastructure; green areas for water management; nature on buildings; parks
- *Management set-up:* Co-governance with government and non-government actors
- *Type of initiating organisation:* Local government /municipality; private sector/corporate actor/company
- *Source(s) of funding:* Public national budget; public local authority budget; corporate investment; EU funds

Image: Stormwater system, Sweden.

Credits: Sanna Dolck

Appendix K – Ustyia River Projects

| Name of the event | Program | Authority/organisation responsible for implementation | Additional information, comments |
|---|---|---|--|
| Reconstruction of sewage treatment facilities and sewage networks in the village of Kvasyliv, Rivne TG, Rivne district, Rivne region | "Drinking water of Ukraine" program, regional, oblast programs, social and economic development programs of the city of Rivne; Development and support program of the Regional Regional Development Committee of the VKG "Rivneoblvodokanal" for 2019-2026 " | Rivne City Council | "As of March 2023, there is no PCD. The approximate cost is provided by the relevant programs and is indicated in the prices for 2019. Also, the cost of the event is calculated roughly considering the cost of BIO, 115 euros per person and TRO worth 138 euros per person." |
| Construction of sewage treatment facilities and reconstruction of the sewage network of the city of Rivne, Rivne TG, Rivne district, Rivne region | "Drinking water program of Ukraine", Regional and regional programs, Programs of socio-economic development of the city of Rivne; Program of development and support of the Regional Regional Development Committee of the VKG "Rivneoblvodokanal" for 2019-2026 " | Rivne City Council | "As of March 2023, there is no PCD. The approximate cost is provided by the relevant programs and is indicated in the prices for 2019. Also, the cost of the event is calculated roughly taking into account the cost of BIO, 115 euros per person and TRO worth 138 euros per person." |
| Reconstruction of the storm sewer network of KP "SHEU" of the city of Rivne, Rivne TG, Rivne district, Rivne region | "Program for clearing and streamlining small rivers and protecting groundwater from pollution for 2020-2025 (Given the current situation, measures will be forced to be postponed by the program for the period 2025-2030), "Drinking Water of Ukraine" program, regional and regional programs, social programs economic development." | Rivne City Council | "As of March 2023, there is no PCD. The estimated cost is provided by the relevant program and is indicated in the prices for 2020. Considering the current situation, the measures specified in 2020-2025 will be forced to be postponed by the program to the period 2025-2030. Project measures are expected to be implemented in different parts of the city, which make up the general storm sewer system. The cost is calculated taking into account the inflation index. In the future, the |

| | | | |
|--|--|--------------------|--|
| | | | KD network should be owned." |
| Restoration and maintenance of a favourable hydrological regime of the Basivkut reservoir from PC0+00 to PC35+56 in the city of Rivne, Rivne MTG, Rivne district, Rivne region | "Regional environmental protection program for the period 2022-2026; Program for cleaning and streamlining of small rivers and protection of groundwater from pollution for 2020-2025, approved by the decision of the Rivne City Council dated February 11, 2021, No. 47" | Rivne City Council | "The PCD was developed in 2020 and received a positive expert report dated 11/30/2020. Since the total estimated cost of construction is determined in current prices as of 11/30/2020, the estimated part of the PCD needs to be adjusted." |
| Reconstruction of the hydro-technical structure of the sluice-regulator of the Basivkut reservoir in the city of Rivne, Rivne MTG, Rivne district, Rivne region | "Regional environmental protection program for the period 2022-2026; Program for cleaning and streamlining small rivers and protecting groundwater from pollution for 2020-2025, approved by the decision of the Rivne City Council dated February 11, 2021 No. 47" | Rivne City Council | "As of June 2023, there is no approved PCD. PKD was developed in 2018-2020. Based on the results of processing the Report with the Department of Internal Affairs, the Department of Ecology and Natural Resources of the Rivne Regional State Administration issued a negative conclusion in 2020. The preliminary total estimated cost of the event is set in 2020 prices and provided for by the relevant Program." |

Source: Author's elaboration. Adopted from DARV (2023)