MERLIN

Water Supply & Sanitation Sector Strategy:

Mainstreaming Nature-based Solutions for Resilience in the Water Sector

www.project-merlin.eu

MERLIN

Imprint

The MERLIN project (https://project-merlin.eu) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036337.

Authors: Marine Boulard (Aqua Publica Europea), Milo Fiasconaro (Aqua Publica Europea), Fanni Nyírő (WWF Hungary).

Due date of deliverable: 27 January 2025

Actual submission date: 03 March 2025

Acknowledgements: We would like to thank the Water Supply & Sanitation Sector Community of Practice for their tremendous support in drafting this Strategy. Special thanks are also extended to Bertrand Vallet, Policy Officer in the Circular Economy & Biobased Systems Unit at the European Commission's Directorate-General for Research and Innovation, for thoroughly reviewing the Strategy and providing highly insightful feedback.

To be cited as: Fiasconaro M., Boulard M. and Nyírő F. (2025). Water Supply & Sanitation Sector Strategy: Mainstreaming Nature-based Solutions for Resilience in the Water Sector.

Disclaimer: Throughout the participatory process and strategy revision, we received many valuable insights which were invaluable to foster discussion, though they sometimes revealed conflicting views which did not always lead to a consensus or a resolution. Therefore, the Strategy uses these insights but does not necessarily reflect the opinion of the full Community of Practice.

Key messages

1. Europe's water supply is under threat from climate change and pollution, requiring urgent and transformative action to secure a sustainable and resilient future.
2. Amidst these challenges, exploring the potential of Nature-based Solutions for the Water Supply and Sanitation Sector is essential. NbS have the potential to mitigate floods, alleviate the impact of droughts, and improve water quality by combating pollution.
3. Several barriers hinder the broader adoption of Nature-based Solutions in the Sector. Through the Sector's Community of Practice, three main obstacles have been identified: (1) the 'engineering culture' of water operators; (2) the lack of standardised metrics for evaluating the effectiveness of Nature-based Solutions compared to traditional 'grey' solutions; and (3) the complex governance of Nature-based Solutions.
4. This Strategy proposes three key actions to overcome these challenges:
   - → Boosting awareness and integration of Nature-based Solutions across the Sector.
   - → Streamlining methodologies supporting decision-making on Nature-based Solutions through Communities of Practice and better integration in project evaluation.
   - → Mainstreaming Nature-based Solutions into EU and national policies, as well as coordination frameworks.
5. For Nature-based Solutions to gain wider recognition in the Sector, the education and training systems must equip engineers and water operators with the knowledge and skills to design, implement, and maintain Nature-based Solutions.
6. For Nature-based Solutions to become more widely adopted in the Sector, clear metrics and compelling evidence are vital to demonstrating their effectiveness and cost-efficiency, thereby fostering confidence in their use.
7. For Nature-based Solutions to become indispensable in the Sector, policies and governance frameworks must prioritise them, remove barriers, and incentivise widespread use and adoption.
8. This Strategy is targeted at water operators, water experts, professional associations of water operators, educational and research institutions, public sector bodies, funding agencies, NGOs and environmental organisations, local authorities and municipalities, national governments, and European institutions.
9. Collaboration across sectors—including agriculture, urban planning, and energy—is critical to mainstreaming Nature-based Solutions and addressing interconnected water challenges. This holistic approach would ensure that solutions are both sustainable and scalable.
10. The aim is to fully implement this strategy by 2036, achieving a sector-wide transformation that secures Europe's water future through the adoption of innovative, resilient, and sustainable practices.

MERLIN Executive Summary

Europe's Water Supply and Sanitation Sector stands at a defining moment. Climate change, pollution, and resource overuse are pushing water systems to the brink, while rising costs, stricter regulations, and aging infrastructure add further pressure. To tackle these growing challenges, Nature-based Solutions – such as wetland restoration, floodplain reconnection, and riparian buffer restoration– offer a powerful alternative to traditional engineering solutions, providing flood protection, improving water quality, and ensuring long-term resilience. Yet, despite their benefits, NbS remain underutilised.

Three major barriers stand in the way. First, the **engineering culture** within the Sector prioritises traditional engineering solutions, leaving NbS outside the standard toolbox. Second, the **lack of standardised metrics** makes it difficult to measure their performance and cost-effectiveness against engineering solutions. Third, the **complex governance landscape** of NbS, requiring cross-sector collaboration, creates additional challenges for widespread implementation.

To break these barriers, this Strategy proposes three decisive actions. **Raising awareness and integration** will equip engineers and water operators with the expertise to design and implement NbS. **Developing standardised decision-making tools** will establish clear metrics to evaluate their impact and cost-efficiency. **Embedding NbS in EU and national policies** will create the necessary regulatory and financial incentives for widespread adoption.

By **2036,** this strategy envisions a Water Supply and Sanitation Sector where NbS are not just considered, but prioritised as the preferred solution. Fully integrated, backed by evidence, and supported by strong policies, NbS will enhance water resilience, restore ecosystems, boost biodiversity, and build climate-resilient communities.

Abbreviations and Acronyms

- APE – Aqua Publica Europea
- CoP – Community of Practice
- EEA – European Environment Agency
- EU – European Union
- GEMAPI – Gestion des Milieux Aquatiques et Prévention des Inondations
- IPCC – Intergovernmental Panel on Climate Change
- KPI – Key Performance Indicator
- MERLIN – Mainstreaming Ecological Restoration of freshwater-related ecosystems in a Landscape context: INnovation, upscaling and transformation
- NbS – Nature-based Solutions
- NGO – Non-governmental Organisation
- OECD – Organisation for Economic Co-operation and Development
- SDEA – Syndicat des Eaux et de l'Assainissement Alsace-Moselle
- UN – United Nations

Content

1 Introduction

The Horizon-funded project, *Mainstreaming Ecological Restoration of freshwater-related ecosystems in a Landscape context: INnovation, upscaling and transformation* (MERLIN), aims to showcase the benefits of and promote the adoption of Nature-based Solutions (NbS) for the restoration of freshwater ecosystems. To achieve this, MERLIN focuses on transformative changes across six economic Sectors: agriculture, hydropower, insurance, navigation, peat extraction, and Water Supply and Sanitation.

For the purpose of this strategy, we define **Nature-based Solutions** as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits" (UNEA, 2022). **Restoration** is defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Gann et al., 2019, p. 7). Its goal is to guide a degraded ecosystem toward recovery, enabling it to adapt to both local and global changes while ensuring the persistence and evolution of its species (ibid).

This strategy specifically addresses the Water Supply and Sanitation Sector, which encompasses both public and private entities responsible for providing drinking water to households and businesses, as well as treating wastewater before returning it to the environment. The Water Supply and Sanitation Sector plays a crucial role at the intersection of an essential public duty—ensuring the right to safe drinking water—and environmental responsibility, including the duty to treat polluted water prior to its return to the environment and to manage water resources sustainably.

To guide the development of this strategy, a Community of Practice (CoP) has been established, bringing together water sector experts, public and private operators, European policymakers, civil society, environmental NGOs, and academia.

1.1 Purpose of the Strategy

This strategy aims to define a pathway for accelerating and expanding the uptake of NbS within the Water Supply and Sanitation Sector, effectively incorporating them into the strategic planning, investments, and daily operations of water operators.

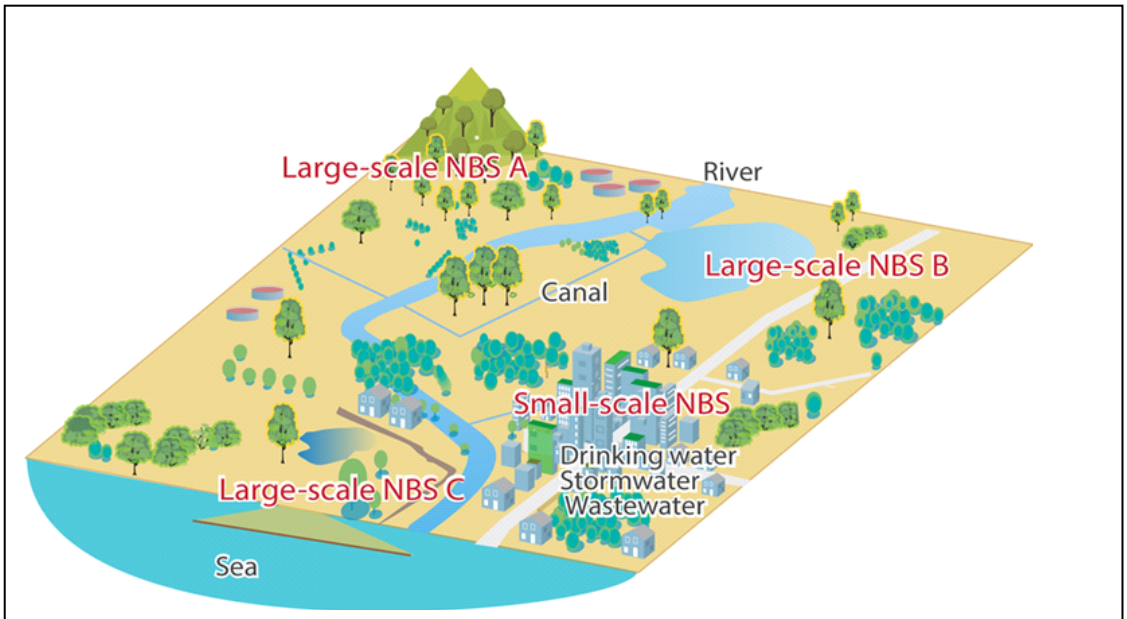
To achieve this, the strategy will first identify existing barriers and uncertainties that currently hinder water operators from implementing NbS to address water-related challenges. Based on these findings, the strategy will outline targeted actions. These actions will not only be directed at water operators but also at other stakeholders and relevant authorities upon whom operators depend to fulfil their mission. Ultimately, the goal is to overcome these barriers and facilitate the broader integration of NbS across the Sector.

It is important to note that a variety of NbS are available for addressing water challenges. Traditionally, NbS can be distinguished between those implemented at the urban scale and those applied at a wider territorial scale. Given the MERLIN project's specific focus on large-scale freshwater restoration, this strategy will focus solely on large-scale NbS, excluding urban ones.

How does this look in practice? NbS for the restoration of large-scale freshwater ecosystems can take various forms, including but not limited to:

- **Constructed wetlands:** designing and building artificial wetlands to treat agricultural runoff or wastewater before it enters natural waterways, thereby improving water quality.
- **Floodplain reconnection:** restoring the natural connectivity between rivers and their floodplains to allow for seasonal flooding, which can help recharge groundwater.
- **Reforestation and afforestation:** planting trees in deforested areas or creating new forests to enhance water retention, reduce erosion, and improve overall water quality. This also benefits the local water cycle, as atmosphere-ground exchanges are facilitated through plants (green water). However, care must be taken with the species planted, as monocultures can make ecosystems more vulnerable to diseases.
- **Riparian buffer restoration:** re-establishing vegetation along riverbanks and streams to reduce erosion, filter runoff, and provide critical habitat for wildlife, which can improve the overall health of water bodies.

Stream and river restoration: restoring natural streams and riverbanks to enhance habitat quality and water flow, improve the ecological state of freshwater systems, increase water quality, and reduce flood risk by slowing water flow.
Wetland restoration: restoring natural wetlands or creating new ones to improve water quality and enhance water retention.



Large-scale NBS A illustrates NbS in mountainous regions (e.g. afforestation, slope stabilisation, etc.), large-scale NBS B illustrates NbS along river corridors (e.g. river re-meandering, riparian buffer restoration, etc.), large-scale NBS C illustrates NbS in coastal regions (e.g. sand dunes, protection dikes and walls, etc.), and small-scale NBS illustrates NbS in the city (e.g. green roofs, rain gardens, permeable pavements, etc.).

Figure 1 - Illustration of large-scale and small-scale NbS, retrieved from Nature-based solutions for hydro meteorological risk reduction: a state-of-the-art review of the research area (Ruangpan et al., 2020)

1.2 Water Supply and Sanitation Sectoral Community of Practice

The Water Supply and Sanitation Sector encompasses both public and private entities responsible for delivering drinking water and sanitation services. Its mission involves abstracting water from the environment (freshwater and/or groundwater), treating it to meet quality and safety standards for consumption, managing the transportation of water through a network of pipes and infrastructure to households and businesses, collecting and treating the wastewater generated by users, and finally returning the treated water back into natural ecosystems. Water services are also responsible for managing the waste generated (e.g. sludge), where NbS offer added value by reducing waste or offering treatment options.

The Sector fulfils a public service mission that is strictly regulated – both in its qualitative and socio-economic aspects – under national law and, to a significant extent, by EU legislation. At the EU level, this regulation is primarily enacted through the Drinking Water Directive (European Commission, 2020), the Urban Wastewater Treatment Directive (European Commission, 2024), the Bathing Water Directive (European Commission, 2006), and the Water Framework Directive (European Commission, 2000), particularly concerning cost-recovery aspects.

Despite this common legal framework, Water Supply and Sanitation services are provided by entities with a wide range of legal and industrial configurations. In essence, four primary types of arrangements for the provision of these services can be identified (based on EurEau, 2018):

Direct public management: under this system, the responsible public authority (under national or EU law) is directly in charge of services provision and management.
Delegated public management: under this system, a management entity is appointed by the responsible public authority or a consortium of public authorities to provide and manage water services. Management entities are fully owned by the responsible authorities, although the entity can be operated under private law.
Delegated private management: under this system, the responsible public authority or a consortium of public authorities appoints a private company to manage tasks based on a time-bound lease or concession contract. In some cases, the private company may be partially owned by the public authorities that grant the contract. In countries where this type of management is common, municipalities subcontract their duties to private companies. Ownership of the infrastructure remains in the hands of public authorities.
Direct private management: under this system, all management tasks, responsibilities, and ownership of water utilities are placed in the hands of private operators, while public entities limit their activities to control and regulation. This system is in place in very few European countries (England, Wales, and the Czech Republic).

In practice, various combinations of these four types can be observed, influenced by national legislation. The geographical scope of operators also varies; some serve exclusively urban areas, while others operate regionally or nationally. Furthermore, the range of services provided by water operators differs significantly. In some cases, distinct companies manage Water Supply and Sanitation services within the same area, sometimes through a mix of public and private management. In other instances, a single company handles both services.

Operators may also be responsible for stormwater management, although this is less common. Additionally, in some cases, operators can also provide water along with other services, typically energy production or waste management (as seen with several *Sadtwerke* in Germany or companies in Italy, both private – A2A – and public – Piave Servizi). In certain contexts, operators may also hold broader environmental responsibilities, such as flood protection and restoration (e.g. SDEA in France).

The Water Supply and Sanitation Sector is therefore characterised by a high degree of variability and contextualisation across regions and countries. This variability stems from broader differences in legal and governance systems, as well as the inherent connection between water resource management and local geographical realities.

Furthermore, as water operators carry out a public service mission, they are dependent on and accountable to a wide range of public authorities, operating within a complex network of dependence and accountability. These public authorities can include municipalities or other entities legally responsible for drinking water and sanitation services in accordance with EU legislation, public health authorities, environmental authorities, economic water regulators for tariff-setting (where they exist), river basin authorities, and the court of auditors, among others. The specific dynamics between Water Supply and Sanitation operators and these entities can vary significantly based on national and local governance structures.

In summary, while obligations related to Water Supply and Sanitation are largely defined at the EU level, the implementation of these services manifests in diverse forms on the ground. This strategy will, therefore, primarily target water and sanitation operators, regardless of their legal and ownership structures. However, it acknowledges that these dimensions can influence the barriers or incentives faced by water operators in adopting NbS.

Simultaneously, the strategy will consider the intricate web of relationships with other public authorities and stakeholders upon which water operators depend and interact. Some barriers or incentives for NbS adoption may stem from this network, extending beyond the strategic decision-making of water utilities.

Finally, the development of knowledge and practices related to NbS occurs to a significant extent outside the Water Supply and Sanitation Sector itself. This development involves research centres, consultants, and international institutions that play a fundamental role in mainstreaming NbS. Therefore, the strategy will also explore how experts and scholars in NbS can be associated within a CoP alongside water operators.

2 Methodology

The development of this strategy builds on the long-standing work conducted through the MERLIN project on the Water Supply and Sanitation Sector since 2021, alongside the knowledge of Aqua Publica Europea (APE) and its members, as well as the expertise and insights from the CoP. In particular, the methodology relies on the following sources:

Sectoral Roundtables: three roundtables have been organised since the beginning of the project, forming part of the knowledge-sharing and gathering process that results in the creation of this sectoral strategy and contributes to the establishment of the CoP. Stakeholders were invited to participate, including water sector experts, public and private operators, European policymakers, civil society representatives, environmental NGOs, and academics.

In the first roundtable, held in March 2022, the discussion focused on the risks posed by the climate and biodiversity crises for water and the sector, as well as the role of restoration and NbS, including the opportunities and challenges associated with implementing an NbS approach. This roundtable saw participation from representatives of the private water sector, public water sector, and water sector experts.

The second roundtable took place in June 2023 to discuss the challenges, benefits, and needs of applying NbS within the sector. The discussion centred around three main topics: (1) What are the primary barriers and constraints to working upstream? (2) How can partnerships be established upstream—who should be involved and who should coordinate? (3) What are some good examples to share regarding upstream restoration? This roundtable included participation from the public water sector, water experts, representatives from the European Commission, and civil society representatives.

The third and final roundtable was held in April 2024, bringing together water operators, representatives from the European Commission, environmental NGOs, and civil society representatives to analyse the challenges that hinder greater uptake of NbS in the sector. Three specific challenges were identified and agreed upon by the CoP as the most relevant facing the water sector: (1) The 'engineering culture' of water operators, (2) The lack of consolidated metrics for evaluating the effectiveness of NbS compared to traditional 'grey' solutions, and (3) The complex governance of NbS. These challenges are discussed later in this strategy and form the basis for a reflection on potential solutions for mainstreaming NbS. The draft report from the roundtable was shared with APE Members, the CoP, and the European Commission for feedback, and their contributions have been incorporated into this strategy.

Policy Analysis: the MERLIN project and APE conducted a thorough analysis of European legislation to identify potential catalysts for mainstreaming NbS, as well as the main points that could hinder their greater uptake. Several pieces of legislation were analysed, including:

Common Agricultural Policy
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change (COM/2021/82)
Drinking Water Directive (Directive (EU) 2020/2184)
European Climate Law (Regulation (EU) 2021/1119)
Nature Restoration Law (Regulation (EU) 2024/1991)
Urban Wastewater Treatment Directive (Directive (EU) 2024/3019)
Water Framework Directive (Directive 2000/60/EC)

Knowledge from APE and its Members: public water operators have increasingly recognised the value of NbS over the past few years, given the specific benefits they offer to the Sector. Many members have actively begun implementing NbS or participating in projects and consortiums dedicated to their deployment. This engagement has fostered a growing pool of expertise and knowledge within the membership, which APE is diligently exploring and compiling.

Notably, APE is developing a publication focused on NbS that will feature a collection of case studies from various operators. Furthermore, NbS have also been addressed in a recent publication that investigates public water operators' strategies for managing water scarcity and drought (APE, 2023).

Members of APE have played an active role in the development of this strategy. They contributed by providing feedback on draft reports from previous roundtables, actively participating in the roundtable discussions, and offering direct comments on this strategy.

MERLIN Case Studies: this strategy includes an analysis of two case studies from the MERLIN project that directly impact water quality and/or quantity. These case studies have been selected to illustrate effective applications of NbS and their potential to enhance water management practices within the Sector. The first case study focuses on the restoration of a Danube side-branch at Liberty Island, Hungary (Case Study 7b[1]), while the second examines peatland rewetting in the Forth Catchment, Scotland (Case Study 17[2]).

1 https://project-merlin.eu/cs-portal/case-study-07b.html
2 https://project-merlin.eu/cs-portal/case-study-17.html

3 Why is change needed?

Europe is grappling with a water crisis that is being further intensified by climate change. This crisis manifests as both quality and quantity challenges. On the quality front, pollution continues to degrade our water resources, posing significant risks to human health and ecosystems. Simultaneously, we face the dual threats of excessive flooding and severe water scarcity, resulting in a precarious balance of either too much or too little water.

In this context, water operators and the wider Water Supply and Sanitation Sector are on the front lines of combating this crisis. They are actively seeking new solutions and approaches that not only enable them to fulfil their critical mission but also ensure the sustainable management and protection of water resources essential for their operations.

This urgency has led the water Sector to increasingly turn towards NbS, as they may offer substantial advantages for operators. NbS are often more sustainable and environmentally friendly than traditional engineering methods. Moreover, they may be more cost-effective and viable over the longer term, enhancing the resilience of water systems against the impacts of climate change. NbS also provide multiple co-benefits such as biodiversity support, landscape restoration, and many more.

3.1 What are the current problems?

The Water Supply and Sanitation Sector faces urgent environmental and socio-economic challenges, exacerbated by climate change and water scarcity. NbS can offer sustainable alternatives to traditional engineering methods; however, their integration is slowed by the engineering-focused culture within many utilities, uncertainties surrounding the effectiveness and costs of certain NbS, and the complex governance arrangements that often underpin these approaches. Consequently, a dedicated strategy is necessary to address these challenges comprehensively.

3.1.1 Environmental and socio-economic challenges

The Water Supply and Sanitation Sector is encountering significant socio-economic challenges, many of which are expected to intensify in the coming years. Key issues include the rising costs and complexities of complying with increasingly stringent water and wastewater quality standards and the urgent need to modernise aging infrastructure, such as water pipes. According to the OECD, ensuring compliance with these standards while maintaining service levels is one of the most pressing challenges for water operators today. A European Commission-OECD study (2020) estimated that almost €300 billion of additional investments are needed to ensure compliance with existing legislation; since then, key legislation has been revised with the introduction of stricter quality requirements and new objectives.

Additionally, the European Environment Agency (EEA), in its new State of the Water report, highlights the continuous struggles to meet water quality targets across European river basins, with recent data revealing concerning trends in the health of aquatic ecosystems and freshwater resources. Despite ongoing efforts, only about 37% of European surface water bodies currently meet good ecological and chemical status, with no improvement since the first River Basin Management Plans (RBMPs) were introduced (EEA, 2024).

Climate change further exacerbates these challenges, compounding issues like water scarcity and pollution. Rising temperatures, increased evaporation rates, and shifting precipitation patterns will increasingly disrupt the freshwater cycle (European Commission, 2010; Eurostat, 2024). The Sector also faces escalating threats from extreme weather events tied to global warming (IPCC, 2023), adding new complexities to resource management.

Meanwhile, water scarcity conditions persisted across 29% of the EU territory in 2019, despite a 15% decline in water abstraction between 2000 and 2019 (EEA, 2022). Overall, half of the EU population lives in water-stressed countries (European Commission, 2010). Southern Europe is particularly vulnerable, while in most countries, water scarcity conditions are the most intense between July and September. This is due to dry weather, reduced water flows, and higher abstraction for agricultural irrigation, tourism, and other recreational activities (EEA, 2023a, b).

Water scarcity is not confined to the summer months; rising industrial demands now exert year-round pressure on water resources. Urbanisation, hydropower, pollution, and agriculture are key factors that intensify the strain on freshwater sources (European Commission, 2010). Consequently, water operators face growing challenges, primarily from climate change but also from rising pollution levels and resource overuse. As the quality of freshwater declines, treatment costs increase, placing additional financial burdens on operators to ensure water quality for public supply.

The combined impact of ever stricter regulations, declining water quality, and the need to build resilience against climate change places significant financial strain on water operators. Depending on how these financial needs are recovered, this strain may ultimately impact accessibility and affordability for vulnerable households. Against this backdrop, operators are seeking the most cost-effective and sustainable solutions. NbS may represent a viable option, as they can address some of these challenges, offer long-term sustainability, and are potentially more cost-effective. However, there are also issues and uncertainties associated with NbS, which will be discussed in the following section.

3.1.2 Challenges of implementing NbS

NbS are increasingly recognised as a viable alternative to traditional engineering approaches for addressing challenges that water operators face in fulfilling their public service mission (Blackburn et al., 2021). NbS have shown effectiveness in tackling water pollution, managing drought, and controlling flood risks—critical challenges for water operators striving to ensure continuous service and meet EU water quality standards. Although traditional engineering solutions for these issues exist, NbS can offer greater cost-effectiveness, long-term sustainability, and resilience to evolving climate conditions (OECD, 2020). Additionally, NbS tend to generate lower CO_2 emissions due to their reduced reliance on concrete and other carbon-intensive materials (Pan et al., 2023).

However, despite a growing body of research and empirical evidence highlighting the benefits of NbS, the Water Supply and Sanitation Sector has yet to fully harness their potential. Insights from the third roundtable of the Water Supply and Sanitation Sector have pinpointed three main factors contributing to this sluggish adoption:

The ‘engineering culture’ of water operators

NbS are not typically ingrained in the modus operandi of water operators. Much of their work involves planning, building, and managing networks to control flows, relying heavily on traditional civil engineering skills and knowledge. However, developing NbS requires different expertise. Although progress is gradually being made, especially with the recruitment of younger professionals who bring fresh perspectives to water management, a significant knowledge gap regarding the potential of NbS likely persists within many utilities. In other words, NbS are not yet fully integrated into the ‘toolbox’ of water utilities.

Traditionally, engineers in the water Sector used to be trained in programmes that often did not include NbS, resulting in a workforce that is not fully aware of these approaches. The shift from a purely engineering culture to one that incorporates environmental engineering approaches and methodologies is key for embracing NbS.

Design and performance criteria for NbS must also become integral to engineering curricula, equipping future professionals with the skills to effectively plan, implement, and maintain NbS. Training should focus on answering practical questions: How do we design NbS? How do we build and maintain them to ensure long-term success? Addressing this shortfall is essential for embedding NbS into the Sector's toolbox.

Effective NbS implementation also requires collaboration across diverse disciplines. Engineers, ecologists, urban planners, and community stakeholders must work together, necessitating a new level of communication and cooperation across professions that have historically operated in silos.

In summary, a better integration of NbS into water operators depends also on an evolution of traditional management practices. This includes expanding education and training to encompass NbS approaches, promoting interdisciplinary collaboration, and securing political support to foster an inclusive water management paradigm that aligns with environmental goals.

The lack of consolidated metrics for evaluating the effectiveness of NbS in comparison to traditional 'grey' solutions

Water Supply and Sanitation services function both as natural monopolies (one cannot choose between different sources of drinking water) and a heavily regulated Sector. Whether managed privately under strict contractual obligations or publicly owned and subject to political oversight, water service providers face significant challenges due to the long lifespan of their assets—typically 20 years for water plants and 50 years or more for networks—which result in substantial sunk costs for investments. Consequently, water managers must exercise caution when making investment decisions to ensure solutions meet strict quality and performance standards. Unlike market-driven Sectors, water operators, especially those publicly owned, have limited flexibility for experimentation due to regulatory constraints.

A key challenge to NbS adoption is insurance on their effectiveness (in particularly to meet quality standard) and costs (in particular maintenance costs). A better understanding of NbS cost-effectiveness for the water Sector would thus require long-term monitoring, which is often underdeveloped in NbS projects. Without extensive, consistent monitoring, it is difficult to evaluate the long-term effectiveness, maintenance needs, and cost-benefit profile of NbS.

In addition to increasing resilience against droughts and floods, NbS inherently offer multiple co-benefits that extend beyond water quality and quantity, such as enhanced biodiversity, improved ecosystem services, and societal well-being. Quantifying these co-benefits poses additional challenges, making both governance and financing complex (see next section) and complicating comparisons with traditional engineering solutions. Conventional cost-benefit analyses, which typically underpin infrastructure investment decisions, struggle to account for these broader benefits, which are not easily monetised. Furthermore, the nature of NbS is highly context-dependent, often precluding the use of standardised construction methods that are common in conventional engineering solutions.

In summary, while traditional engineering solutions benefit from established performance data and predictable costs, NbS present unresolved uncertainties. These uncertainties include questions around pollutant reduction effectiveness, long-term maintenance costs, and the comprehensive assessment of their multi-faceted benefits—all of which complicate their inclusion in standard decision-making frameworks for water infrastructure investments.

The complex governance of NbS

Water operators typically have the autonomy to implement engineering solutions with minimal external coordination. For example, constructing or replacing pipes often only requires public authority permits for road excavation, after which the work proceeds independently. Similarly, building water retention tanks for stormwater management involves straightforward permissions and predictable execution. In contrast, implementing NbS on an urban scale—and even more so at larger scales, such as river morphology alterations or buffer zones—often involves decisions that affect land use and require cooperation with private landowners or other stakeholders. This means NbS decisions cannot rest solely with water operators; they require coordinated action with public administration departments and various stakeholders. This process of coordination is complex and time-consuming and is further hampered by the fact that water operators generally lack a clear mandate for intervening on land or river management. Establishing NbS often calls for coalition-building among stakeholders, and operators may need a formal mandate from a government authority to take on these initiatives.

Governance complexity is compounded when NbS projects extend beyond the geographic jurisdiction of a given operator. For instance, a river morphology restoration upstream could provide significant downstream benefits for water management and flood resilience. However, the downstream operator may not have the legal authority to implement or even influence NbS in upstream areas managed by different entities or operators. This misalignment of governance can also complicate the financing of NbS, as it is unclear which budget should cover NbS projects that offer multiple, cross-sectoral benefits. Where water tariffs are set by independent regulators, it is essential that investments in NbS, especially those implemented upstream, are recognised as part of the operator's mission. This recognition would ensure that costs for NbS, where appropriate, can be legally recovered through tariffs.

In summary, implementing NbS poses governance challenges for water operators, as these solutions often require coordination across various public and private stakeholders and can extend beyond the operator's

geographic or legal jurisdiction. Unlike traditional engineering solutions, NbS frequently necessitate cross-sectoral partnerships and mandates from different public authorities, complicating both decision-making and financing. As a result, a structured strategy is essential to address these governance complexities, enabling more effective integration of NbS in the water Sector.

3.2 What is the relationship between the Sector and MERLIN?

As mentioned above, the Water Supply and Sanitation Sector has traditionally relied on grey infrastructure, but there is growing interest among water operators in integrating NbS into their toolkit. Within the MERLIN project, two case studies particularly relevant to water supply illustrate how restoration efforts might improve water quality, helping operators mitigate the impacts of the water crisis.

3.2.1 MERLIN Case Studies

Case Study 7b – Restoration of a Danube Side-Branch at Liberty Island, Hungary

This project involves the restoration of a side-branch of the Danube, achieved by removing a rockfill dam with the active participation of the local drinking water supply company. Partnering with the water management body and the protected area manager, the drinking water supply pipeline was redesigned and relocated to accommodate the restoration. Although the direct impact on the water quality of nearby wells is still under study, anticipated outcomes suggest long-term positive effects on water quality.

Case Study 17 – Peatland Rewetting in the Forth Catchment, Scotland

This study focuses on peatland rewetting and its benefits for water supply. Research has shown that peatland degradation can negatively affect water quality (Williamson et al., 2023), while peatland restoration improves nearby land's buffering and filtration capabilities. Although the scale of existing studies on peatland restoration often falls short of directly correlating with drinking water supply points, this case study seeks to strengthen the evidence linking peatland restoration with improved water quality and quantity at points of abstraction. Additionally, the reconnection of floodplains in this project offers significant advantages for flood mitigation, further showcasing the multifaceted benefits of peatland restoration.

In summary, both case studies suggest that NbS can enhance water quality, though further research is needed to establish a robust evidence base for these benefits. Through these projects, MERLIN highlights the potential for NbS to contribute meaningfully to the resilience of water supply systems, though more empirical data is required to confirm these improvements.

Beyond MERLIN, additional examples connected through APE reinforce these findings, highlighting further NbS initiatives that bring substantial benefits to water management and environmental resilience (APE, 2023).

3.2.2 APE Case Studies

Forest Infiltration Areas for the Brenta River, Italy

Working with the local river basin authority, water operators ETRA (Energia Territorio Risorse Ambimientali) and Viacqua implemented Forest Infiltration Areas along the Brenta River (a Natura 2000 site in north-eastern Italy) as part of a broader nature protection project. These infiltration zones help recharge groundwater aquifers with surface waters during off-irrigation periods, simultaneously enhancing biodiversity and creating recreational value. Notably, these areas can foster wetland ecosystems that support natural purification of wastewater, improving both water quality and availability (IDEASS; Parco Fiume Brenta). Initiated through a feasibility study under the Life Programme, the project's funding via water tariffs was approved by the Italian water regulator, exemplifying effective public investment in NbS.

Restoration of the Stadenrhein River, Alsace, France

In Alsace, the Stadenrhein River restoration project tackled pollution and ecosystem degradation exacerbated by historical dredging and storm overflow discharges from combined sewer systems. To address these challenges, SDEA collaborated with other stakeholders to restore the river's minor bed and banks and install four Vegetated Discharge Areas (VDAs) to filter water discharged from sewer overflows. This dual approach improves water quality for varied uses by reducing pollution and supporting aquatic ecosystems that aid in

natural water purification. As a result, the project has enhanced the watercourse's resilience, mitigating the need for additional treatments and promoting healthier ecosystem functions.

These examples underscore the potential of NbS for achieving improved water quality, enhancing biodiversity, and strengthening water resilience. They further highlight the need for robust collaboration and regulatory support to realise the full benefits of NbS in water management.

3.3 What is the focus of the Strategy?

The strategy will centre on addressing the three main challenges identified as the most significant barriers to the adoption of NbS in the water Sector:

The 'engineering culture' within water operators.
The lack of consolidated metrics to assess the effectiveness of NbS compared to traditional 'grey' infrastructure solutions.
The complex governance requirements for implementing NbS.

In the next sections, we will present the vision and objectives of this strategy, followed by specific strategic actions designed to address these challenges, create an enabling environment for NbS, and facilitate their broader adoption within the water Sector.

4 What is the vision/goal of the strategy?

The overarching goal is to fully unlock the potential of NbS in addressing water-related challenges. This transformation will be driven by three key shifts:

Widespread understanding and integration of NbS in the water Sector: The full potential and benefits of NbS will be widely recognised across the water Sector. Water operators will proactively integrate NbS into their strategies to address the diverse and complex challenges of water management, ensuring that these solutions are routinely considered and applied wherever appropriate. Knowledge and expertise on NbS will be widespread, making them the first-choice option rather than an alternative. Design of NbS will be robust and integrated into professional trainings.

Clear and accessible evidence on the value of NbS: The long-term cost-effectiveness of various NbS will be well understood, with data that is easily and freely accessible. This will include robust, transparent information on their effectiveness in addressing water-related challenges, how they compare to engineering solutions, and their long-term maintenance costs. The water Sector will have a solid foundation of –and easy access to– tools, methodologies, and case studies to guide investment and operational decisions, enabling water operators to confidently adopt and incorporate NbS into their strategies. Co-benefits will be mainstreamed to facilitate decision-makers' choices.

Mainstreaming NbS in policy and practice: NbS will be deeply embedded in policy, legislation, and governance at all levels. This includes ensuring their effective implementation when provided for by legislation, addressing governance-related obstacles that hinder their proper application, and mainstreaming NbS into relevant water Sector policies. Future water-related policies will prioritise NbS as a core strategy for achieving sustainable, resilient, and adaptive water management whenever possible.

We aim to realise this vision by 2036, transforming the water Sector with NbS at its core. To achieve this ambitious goal, we have outlined a set of three strategic actions, each designed to drive meaningful progress towards the realisation of this vision. These actions, which will be detailed in the next chapter, include: 1) Boosting Awareness and Integration of NbS in the Water Supply and Sanitation Sector — a comprehensive effort to raise knowledge, understanding, and adoption of NbS across the Sector; 2) Streamlining Methodologies to Support Decision-making on NbS through Communities of Practice and Better Integration in Project Evaluation — creating and strengthening networks of experts to share best practices, tools, and methodologies that facilitate the integration of NbS into water management decisions; and 3) Mainstreaming NbS in EU and National Policies and Coordination Frameworks — advocating for the integration of NbS into both EU and national policies, ensuring that governance frameworks are aligned to prioritise and support NbS as a key solution for water management challenges.

5 Strategic actions

Strategic actions to tackle the three key challenges have been developed in collaboration with the CoP, focusing on targeted interventions that address each challenge at its root. The aim is to enable more effective, widespread adoption of NbS in the water Sector by creating a clear roadmap for change. These actions have been designed to provide practical support, foster cross-disciplinary collaboration, and drive institutional and regulatory shifts necessary for integrating NbS into water management. By implementing these strategic actions, the Sector can move towards more resilient, sustainable, and environmentally integrated approaches to Water Supply and Sanitation.

Action A: Boosting Awareness and Integration of NbS in the Water Supply and Sanitation Sector

Description of the action

This action aims to address the first challenge in mainstreaming NbS within the Water Supply and Sanitation Sector: the traditional 'engineering culture' within water operators. Integrating NbS into the standard toolbox of water utilities is essential for evolving traditional management practices and advancing sustainable solutions. Achieving this shift is a necessary precondition for fully mainstreaming NbS in the Sector.

To effectively tackle this challenge, we need to boost awareness and integrate NbS across the Sector. This requires a multifaceted approach, including targeted actions to raise awareness among water operators, primarily through professional associations that are well-positioned to promote NbS and shift the Sector's mindset. Additionally, educational institutions must update curricula to equip future engineers, technicians, and managers with the skills to adopt NbS, while public institutions must acknowledge NbS as valuable approaches to water management. Gaining support and endorsement from public institutions, including financial backing, is also critical.

Specific actions include:

Leverage professional associations of water operators to promote the benefits of NbS

- **Dissemination activities:** co-host events and publish articles, publications, and position papers in collaboration with professional associations of water operators to highlight the advantages of NbS over conventional approaches.
- **Community of Practice (CoP):** establish an NbS-focused CoP with associations of water operators, land managers, farmers, to encourage peer learning and exchange best practices related to NbS projects and implementation.
- **Pilot projects for demonstration:** showcase successful NbS implementations in the water Sector through case studies or site visits to build confidence and demonstrate the viability and effectiveness of NbS solutions.

Strengthen workforce capacity for NbS implementation

- **Recruitment initiatives:** develop recruitment programmes aimed at attracting young professionals with skills relevant to NbS (e.g. ecology, environmental engineering, social sciences).
- **Re-training programmes:** implement training modules for existing staff to bridge the knowledge gap in NbS concepts, integrating ecosystem-based approaches and design aspects of NbS into traditional water management practices.
- **Partnerships with educational institutions:** collaborate with universities and technical institutions to incorporate NbS-focused courses in water management programmes, ensuring a steady pipeline of skilled professionals ready to support NbS integration.

Engage public institutions to support NbS awareness-raising efforts

- **Dissemination strategy development:** collaborate with public institutions to design and fund an NbS dissemination strategy aimed at both public and private water operators, promoting widespread adoption.
- **Secure EU-level funding support:** prepare proposals that outline the costs and benefits of awareness campaigns, advocating for EU funding to support training and outreach activities on NbS.

Who can help deliver this action?

Water operators: central to the implementation of NbS, they can lead pilot projects and demonstrate the practical benefits of NbS.
Professional associations of water operators: essential for disseminating knowledge and creating supportive communities for sharing best practices.
Educational institutions: play a crucial role by updating curricula to include NbS and preparing a skilled workforce capable of integrating these solutions effectively.
Public institutions: key for endorsing NbS as a priority and securing necessary funding.
Funding bodies and the European Union: provide financial support necessary to scale NbS efforts and foster collaboration, making NbS a more recognised and viable approach in the Sector. Coordination between educational, practitioners, and industrial interfaces involves transaction costs, which might not be covered autonomously by the actors, particularly if NbS do not become a legal requirement. These coordination costs may then need to be covered through public funding.

Timeline

To achieve the vision of mainstreaming NbS in the Water Supply and Sanitation Sector by 2036, the timeline for this action would need to be structured in phases, with short, medium, and long-term goals. The initial phase (2026-2028) should focus on raising awareness and building momentum. This would involve developing partnerships with key stakeholders to lay the groundwork for the adoption of NbS. By 2028-2031, the focus should shift towards scaling up these efforts. This would involve expanding the number of NbS projects and training programmes, incorporating NbS into the curricula of universities and schools, and securing financial support from public institutions and international funding bodies. From 2032 to 2036, the focus should be on consolidating the adoption of NbS across the Sector, ensuring that it becomes an established practice within water utilities. By this time, NbS should be fully integrated into the operations of water operators, with the necessary governance frameworks and policies in place to ensure long-term continuity.

Action B: Streamlining Methodologies Supporting Decision-making on NbS through Communities of Practice and Better Integration in Project Evaluation

Description of the action

This action addresses the second challenge in mainstreaming NbS in the Water Supply and Sanitation Sector: the lack of standardized metrics to evaluate the effectiveness of NbS compared to traditional engineering solutions. Bridging this gap is essential for demonstrating the cost-effectiveness and added value of NbS relative to conventional approaches.

To meet this goal, this action seeks to streamline decision-making by developing Communities of Practice and standardized assessment frameworks. These frameworks will facilitate direct comparison between NbS and traditional engineering solutions, giving water managers clear methodologies to assess efficacy, operational and capital costs, and compliance with relevant policies, such as CO2 emissions reduction targets and green finance standards.

A key aspect of this action is addressing the uncertainties surrounding the long-term maintenance costs and design criteria of NbS. By understanding the full life-cycle costs, water operators will be better equipped to plan financially and make informed investments in NbS. Additionally, establishing common metrics for evaluating the impacts of NbS on biodiversity, climate mitigation, and other relevant factors is crucial. These evaluations should consider co-benefits, water management challenges, and climate change scenarios to assess the resilience of NbS under future conditions.

Developing methods to economically assess these benefits will help build the business case for investing in NbS. Lastly, successful NbS implementation requires long-term maintenance and monitoring, which often go beyond typical project timelines and budgets. Once NbS are streamlined, securing funding for continuous monitoring, enabling meaningful data collection, and establishing feedback mechanisms will come naturally. Identifying parties responsible for funding and oversight will be key to sustaining NbS projects in the long run.

Specific actions include:

Develop a data collection framework for NbS performance and cost-effectiveness

Define Key Performance Indicators (KPIs): identify KPIs that are specifically relevant for the water Sector, such as water quality improvement, cost reduction, ecosystem restoration, and climate resilience metrics.

Monitoring systems: establish systems to collect ongoing data NbS project sites, incorporating baseline and long-term performance metrics.

Conduct long-term cost-benefit analyses for NbS projects

Life-cycle cost assessments: compare initial and long-term costs of NbS with conventional engineered solutions, factoring in maintenance, resilience, and ecosystem benefits.

Develop financial models for NbS ROI: create financial models to assess the return on investment (ROI) and cost-effectiveness of NbS to support the business case for their adoption.

Develop specific metrics based on the monitoring of NbS

Experience-based design criteria: define and validate design criteria derived from monitoring data that can be standardized, reproduced, and adapted to other sites.

Facilitate engineering transition and training: use these criteria to drive the integration of NbS into engineering practices and develop targeted training programmes for water Sector professionals.

Build partnerships with research institutions for NbS data collection and analysis

Joint research initiatives: engage universities and environmental research centres to conduct studies on NbS, assessing both environmental and economic impacts.

Data sharing partnerships: establish partnerships for data sharing across regions to enable broader analysis within the Sector.

Develop an integrated NbS information repository for the water Sector

Map existing resources: conduct a comprehensive mapping of existing repositories, tools, and databases on NbS developed by various organisations.

Promote an integrated "one-stop shop": establish an integrated, user-friendly platform tailored specifically for the water Sector, consolidating relevant NbS information and resources. This platform will provide water managers with accessible, actionable information to support investment decisions in NbS.

Who can help deliver this action?

Water operators: central to collecting operational data and testing standardized assessment frameworks.

Research and educational institutions: provide scientific expertise for robust data collection and conduct long-term cost-benefit analyses, establish design criteria.

Professional associations of water operators: connect water operators across regions, support data-sharing, and foster a CoP help to establish design criteria.

Public institutions and funding bodies: essential for financing data collection, monitoring, and reporting efforts, as well as for offering policy guidance to ensure sustainable funding.

Environmental organisations and NGOs: assess ecological and social benefits, such as biodiversity and community engagement, and advocate for NbS adoption through public and stakeholder education. An essential component is adding requirements for long-term monitoring on publicly funded projects.

Timeline

To realise this action by 2036, the timeline will unfold in four phases. The first phase (2026-2028) will focus on establishing partnerships, developing KPIs, and testing assessment frameworks through pilot projects. The second phase (2028-2031) will expand data collection and refine the cost-benefit analyses of NbS, while publishing the first impact reports. In the third phase (2032-2034), the action will scale up, integrating NbS assessment frameworks across the Sector and securing broader support. The final phase (2035-2036) will consolidate NbS as a mainstream solution, ensuring long-term monitoring, funding, and the institutionalisation of NbS evaluation methods. This phased approach will ensure NbS are fully integrated into water management practices by 2036.

Action C: Mainstreaming NbS in EU and National Policies and Coordination Frameworks

Description of the action

This action addresses the third challenge in mainstreaming NbS in the Water Supply and Sanitation Sector: the complex governance requirements for their implementation. The aim is to simplify the governance landscape by fostering alignment and collaboration across various policy dimensions and stakeholder groups.

The fragmented nature of water management systems and the limited recognition of NbS' multi-benefit potential make effective governance critical. National and EU policies must prioritise NbS over traditional solutions, creating incentives for local authorities to design integrated governance frameworks. Existing legislation, such as the revised Drinking Water Directive and Urban Wastewater Treatment Directive, is beginning to incorporate NbS, but efforts must expand to other areas like the Programme of Measures under the Water Framework Directive, particularly for addressing water scarcity and drought.

While top-down measures are necessary, the engagement and commitment of local leaders are also vital. Building trust and a shared narrative about the role of NbS can drive local implementation, with political awareness helping foster collaboration among stakeholders and ensuring projects meet community needs. To support NbS, financing models must adapt to their long-term, multi-benefit nature. Innovative mechanisms like green bonds or payments for ecosystem services should be explored, and dedicated funds for monitoring and assessment post-implementation should be established.

Effective NbS implementation requires cross-sectoral coordination, especially between water management, urban planning, and agriculture. Developing a common language among stakeholders will enhance collaboration, and emphasising NbS' role in mitigating climate change impacts can garner broader support.

Specific actions include:

Support policy development for NbS in water management

- **Advocate for NbS-inclusive water standards:** work with policymakers to include NbS in water quality and resilience standards, incentivising their adoption.
- **EU-level guidance on NbS for policy alignment**: develop and disseminate guidance documents that illustrate how NbS are essential for meeting objectives set forth in various EU water-related legislation.

Create multi-stakeholder governance structures for NbS projects

- **NbS stakeholder committees:** form committees with representatives from water operators, public agencies, local communities, and environmental groups to guide the planning, implementation, and monitoring of NbS projects.
- **Inter-agency collaboration:** facilitate coordination among water, environment, and urban planning agencies to ensure NbS projects receive cross-sectoral support.
- **Citizen engagement Initiatives:** engage citizens in identifying water resilience challenges and co-building solutions by leveraging existing communication channels to raise awareness and encourage participation in NbS initiatives.

Who can help deliver this action?

- **National governments and the European Union**: key players with the authority to create and enforce policies that integrate NbS into water management frameworks.
- **Public sector institutions (including environmental and urban planning agencies)**: critical for fostering coordination across various government levels and ensuring NbS prioritisation in regulatory frameworks.
- **Local authorities and municipalities**: essential for on-the-ground implementation of NbS.
- **Professional associations of water operators and water operators**: help translate policies into practical solutions and collaborate on the development of governance structures.
- **Research institutions and NGOs**: provide technical expertise, evidence, and advocacy to support NbS adoption at both local and national levels.

Timeline

To successfully realise this action by 2036, a phased approach will be required. In the first phase (2026-2028), the focus should be on establishing a solid foundation for policy development by engaging key stakeholders, including national governments, EU institutions, and local authorities. This phase will involve mapping out

existing governance frameworks, identifying gaps, and initiating dialogues with public sector institutions. In the second phase (2028-2031), efforts should shift to formalising policies and creating guidelines for NbS implementation, ensuring that governance structures are in place at both national and local levels. This phase will also focus on piloting governance models through collaborative projects, involving local communities and stakeholders. The final phase (2032-2036) will emphasize the integration of NbS into mainstream water management practices, with established multi-stakeholder governance systems fully operational. By this time, the action should be fully embedded within water Sector policies and practices, supported by long-term funding mechanisms and a cohesive regulatory framework.

Table 1 - Overview of the strategic actions

	What it is about	Description of actions	Who is responsible	Timeline
Action A	Boosting Awareness and Integration of NbS in the Water Supply and Sanitation Sector	Leverage professional associations of water operators to promote the benefits of NbS Strengthen workforce capacity for NbS implementation Engage public institutions to support NbS awareness-raising efforts	→ Water operators and utilities → Professional associations of water operators → Educational institutions and schools → Public institutions → Funding bodies and international organisations (such as the EU)	Three phases: 2026-2028 2028-2031 2032-2036
Action B	Streamlining Methodologies Supporting Decision-making on NbS through Communities of Practice and Better Integration in Project Evaluation	Develop a data collection framework for NbS performance and cost-effectiveness Conduct long-term cost-benefit analyses for NbS projects Develop specific metrics based on the monitoring of NbS Build partnerships with research institutions for NbS data collection and analysis Develop an integrated NbS information repository for the water Sector	→ Water operators and utilities → Research institutions and universities → Professional associations of water operators → Public institutions and funding agencies → Environmental organisations and NGOs	Four phases: 2026-2028 2028-2031 2032-2034 2035-2036
Action C	Mainstreaming NbS in EU and National Policies and Coordination Frameworks	Support policy development for NbS in water management Create multi-stakeholder governance structures for NbS projects	→ National governments and the European Union → Public sector institutions (including environmental and urban planning agencies) → Local authorities and municipalities → Professional associations of water operators and water utilities → Research institutions and NGOs	Three phases: 2026-2028 2028-2031 2032-2036

6 Discussion

Having explored the main challenges to mainstreaming NbS in the Water Supply and Sanitation Sector, as well as the actions required to address these challenges, it is evident that successful integration requires a comprehensive and inclusive approach. This approach must actively engage a diverse range of stakeholders across multiple sectors. To effectively mainstream NbS, it is essential to account for differences between Member States and regions, and to recognise the importance of cross-sector collaboration.

6.1 Are there important differences between Member States or regions to consider?

NbS are inherently local, requiring adaptation to specific contexts that vary significantly across Europe. A key enabler for the systematic implementation of NbS is a governance framework that establishes clear rules outlining the necessity of these interventions, the conditions under which they are required, the responsible parties, and the sources of funding.

Without such a framework, the implementation of NbS on a structural basis becomes challenging. They risk remaining isolated, one-off projects with limited systematic impact. Currently, there is no clear framework at the EU level for streamlining NbS in the water Sector. However, recent developments such as the Nature Restoration Law and the revised Urban Wastewater Treatment Directive—which requires prioritising NbS to address stormwater pollution—along with better enforcement of existing legislation such as the Floods Directive and the Water Framework Directive, are expected to encourage greater adoption of NbS. Consequently, the variation in the use of NbS across Europe is also influenced by the presence of specific policies at national or sub-national levels that provide enabling frameworks, particularly for financing NbS. The French GEMAPI law, highlighted in Annex 1, serves as an example of a governance framework that supports the systematic implementation of NbS.

In the absence of specific laws, economic regulation can play a pivotal role. Water regulators, for example, can impose objectives on operators that explicitly prioritise NbS. This approach allows regulators to act as drivers for NbS adoption by setting specific goals that operators must achieve by using NbS, providing a strong incentive for their integration into water management strategies.

Furthermore, geographical, climatic, and socio-economic conditions vary widely between Member States, further influencing the feasibility and design of NbS. Political will, public awareness, and institutional capacity also differ across countries, impacting the level of priority given to NbS in water management strategies.

Collaboration with other Sectors—such as agriculture, urban planning, and energy—is another pivotal aspect. Integrated approaches are often necessary to maximise the benefits of NbS, such as improving water quality, enhancing biodiversity, and providing recreational spaces. These collaborations, however, demand careful coordination across diverse governance systems and policies, which may be more advanced in some Member States than in others.

6.2 Do actions require help from other sectors?

As previously mentioned, cross-sector coordination is essential for the successful implementation of NbS. This is because NbS inherently transcend traditional silos, requiring cooperation and alignment among multiple Sectors to address complex and interconnected challenges.

The Water Supply and Sanitation Sector operates under considerable pressure from various sources. For instance, demographic growth in some areas increases demand for water resources, while urbanisation exacerbates runoff due to soil-sealing, impacting aquifer recharge. Similarly, agriculture exerts a dual influence, being both a major water user and a source of nutrient and chemical pollution in water bodies. Industry and energy production add to these pressures, with activities such as manufacturing and electricity cooling relying heavily on water abstraction, often contributing to resource depletion.

According to the EEA (2024), “countries report that the main pressures on surface waters are linked to pollution from diffuse sources such as atmospheric deposition (52%), changes to the physical features and natural flow of rivers, lakes, transitional and coastal waters (51% of surface waters), agriculture (29%) and point sources such as from wastewater discharges (13%) and abstraction (8%).” For groundwater, the main pressures

“are reported to be diffuse pollution, especially from agriculture (32%), and abstraction (18%), most commonly from agriculture, public water supply and industry.”

Given these interdependencies, the implementation of NbS requires collaboration with sectors such as agriculture, energy, and urban planning. For example, green infrastructure in urban areas can mitigate the effects of urban runoff while enhancing biodiversity and cooling cityscapes. Similarly, integrating NbS into agricultural practices can improve water retention in soils, reduce nutrient runoff, and support sustainable water use. Only by fostering cross-sector partnerships can the full potential of NbS be realised in addressing water-related challenges.

Table 2 - Examples of positive cross-sectoral cooperation

Sector	Sectoral Partner	Example	Description
Water supply & sanitation	Agriculture	Eau de Paris, France	Eau de Paris has established a compensation scheme for farmers, encouraging the adoption of organic and less polluting agricultural practices. As a result, the water is of higher quality, reducing treatment costs and improving environmental outcomes.
Water supply & sanitation	Peat extraction	Case Study 17 – Peatland Rewetting in the Forth Catchment, Scotland	This study highlights the benefits of peatland rewetting in the Forth Catchment. Peatland degradation negatively impacts water quality, but restoration efforts enhance the land’s natural filtration and buffering capacity. Although broader studies are needed, this case study strengthens evidence linking peatland restoration with improved water quality and availability.

7 Conclusions and next steps

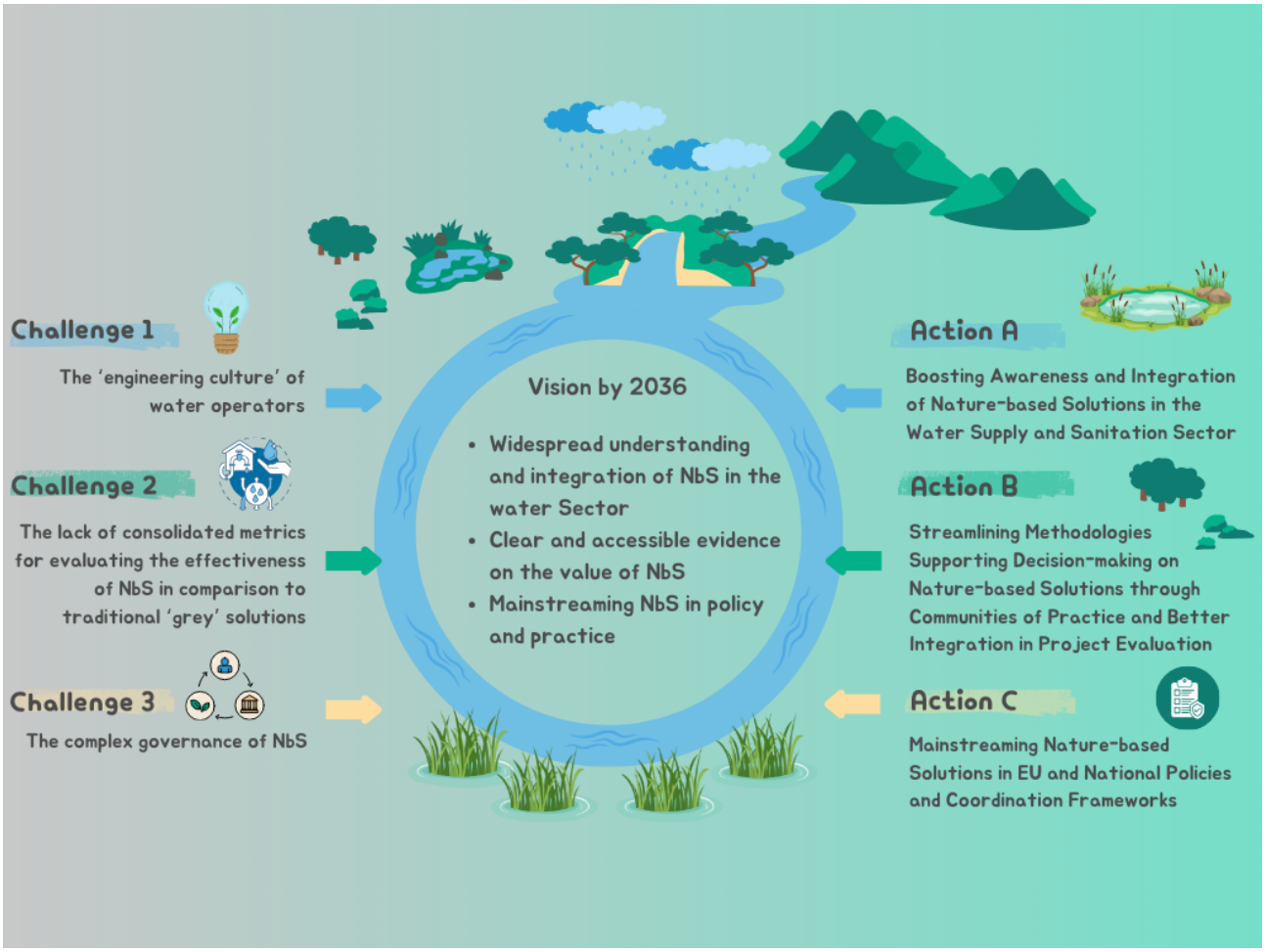
As the Water Supply and Sanitation Sector faces unprecedented challenges, from climate change to pollution, the need for innovative and sustainable solutions has never been more urgent. NbS offer a transformative approach, combining sustainability with economic efficiency to address the Sector's complex challenges.

This strategy outlines a clear vision for the Sector to embrace NbS as a cornerstone of water management by 2036. The outlined actions—raising awareness, standardizing methodologies, and streamlining governance—equip stakeholders with the tools to implement and mainstream NbS effectively. Through continued commitment and collective effort, the water sector can lead the transition toward sustainable practices that enhance environmental, economic, and societal well-being.

In taking these steps, we stand proud to not only safeguard water resources for future generations but also to unlock co-benefits such as biodiversity restoration, resilience of ecosystems, and community engagement.

In 2025, APE will release a publication on NbS, featuring best practices from member public water operators. This publication will highlight both past achievements and ongoing initiatives, aiming to inspire other operators to adopt similar measures. It will also explore strategies to ensure the widespread adoption and long-term success of NbS.

8 Visualisation of the strategy



References

Aqua Publica Europea (APE) (2023). Resilience in Action: Public Water Operators' Strategies to Tackle Water Scarcity and Drought. Aqua Publica Europea. Retrieved from https://www.aquapublica.eu/sites/default/files/document/file/APE%20publication%20-%20Resilence%20in%20action.pdf

Blackburn, E. A. J., Emelko, M. B., Dickson-Anderson, S., & Stone, M. (2021). Advancing on the promises of techno-ecological nature-based solutions: A framework for green technology in water supply and treatment. Blue-Green Systems, 3, 81–94. https://doi.org/10.2166/bgs.2021.008

EurEau. (2018). Report on the governance of water services in Europe. Retrieved from https://www.eureau.org/resources/publications/eureau-publications/150-report-on-the-governance-of-water-services-in-europe/file

European Environment Agency (2022). Water abstraction by source and economic sector in Europe. Retrieved from https://www.eea.europa.eu/en/analysis/indicators/water-abstraction-by-source-and

European Environment Agency (2023a). Water use and environmental pressures. Retrived from https://www.eea.europa.eu/themes/water/european-waters/water-use-and-environmental-pressures/water-use-and-environmental-pressures

European Environment Agency (2023b). Water scarcity conditions in Europe (Water exploitation index plus).Retrieved from https://www.eea.europa.eu/en/analysis/indicators/use-of-freshwater-resources-in-europe-1?activeAccordion=ecdb3bcf-bbe9-4978-b5cf-0b136399d9f8

European Environment Agency (2024). Europe's state of water 2024: the need for improved water resilience. Retrieved from https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024

European Commission. (2000). Water Framework Directive 2000/60/EC. Brussels: European Commission. Brussels, European Commission. https://eur-lex.europa.eu/eli/dir/2000/60/oj

European Commission (2006). Bathing Water Directive 2006/7/EC. Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32006L0007

European Commission (2010). Water is for life – How the Water Framework Directive helps safeguard Europe's resources. Directorate-General for Environment, Publications Office. Retrieved from https://data.europa.eu/doi/10.2779/83017

European Commission (2020). Drinking Water Directive 2020/2184 (recast). Brussels, European Commission. https://eur-lex.europa.eu/eli/dir/2020/2184/oj

European Commission (2024). Urban Wastewater Treatment Directive 2024/3019 (recast). Brussels, European Commission. https://eur-lex.europa.eu/eli/dir/2024/3019/oj

Eurostat. (2024). Water statistics: Water as a resource. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Water_statistics#Water_as_a_resource

Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., Hallett, J. G., Eisenberg, C., Guariguata, M. R., Liu, J., Hua, F., Echeverría, C., Gonzales, E., Shaw, N., Decleer, K., & Dixon, K. W. (2019). International principles and standards for the practice of ecological restoration (2nd ed.). Restoration Ecology. https://doi.org/10.1111/rec.13035

IPCC 2023: IPCC (2023). Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647

OECD (2020), Financing Water Supply, Sanitation and Flood Protection: Challenges in EU Member States and

Policy Options, OECD Studies on Water, OECD Publishing, Paris, https://doi.org/10.1787/6893cdac-en.

Pan, H., Page, J., Shi, R., Cong, C., Cai, Z., Barthel, S., Thollander, P., Colding, J., & Kalantari, Z. (2023). Contribution of prioritized urban nature-based solutions allocation to carbon neutrality. Nature Climate Change, 13, 862–870. https://doi.org/10.1038/s41558-023-01737-x

Ruangpan, L., Vojinovic, Z., Di Sabatino, S., Leo, L. S., Capobianco, V., Oen, A., McClain, M. E., & Lopez-Gunn, E. (2020). Nature-based solutions for hydro-meteorological risk reduction: A state-of-the-art review of the research area. Natural Hazards and Earth System Sciences, 20(1), 243–270. https://doi.org/10.5194/nhess-20-243-2020

UNEA. (2022). UN environment assembly concludes with 14 resolutions to curb pollution, protect and restore nature worldwide. UN Environment. http://www.unep.org/news-and-stories/press-release/un-environment- assembly-concludes-14-resolutions-curb-pollution

Williamson, J., Evans, C., Spears, B., Pickard, A., Chapman, P. J., Feuchtmayr, H., Leith, F., Waldron, S., & Monteith, D. (2023). Reviews and syntheses: Understanding the impacts of peatland catchment management on dissolved organic matter concentration and treatability. Biogeosciences, 20(18), 3751–3766. https://doi.org/10.5194/bg-20-3751-2023

Annex

Annex I. Snapshot on the French GEMAPI law

The French GEMAPI law, short for "Gestion des Milieux Aquatiques et Prévention des Inondations" (Management of Aquatic Environments and Flood Prevention), is a legislative framework designed to improve the management of water bodies and mitigate flood risks. It was introduced as part of a broader effort to decentralize water management and enhance local authorities' responsibility in environmental management and flood prevention. This initiative is grounded in the European Water Framework Directive and the Floods Directive, which aim to promote sustainable water management and protect populations from flood risks.

The GEMAPI law has two main objectives: the management of aquatic environments and the prevention of floods. It seeks to ensure the preservation, restoration, and management of aquatic ecosystems, including rivers, lakes, and wetlands, while also implementing measures to reduce flood risks, protect populations, and mitigate the impact of floods.

Since January 1, 2018, the responsibility for GEMAPI has been transferred to inter-municipal structures, specifically to institutional entities gathering several municipalities (EPCI - Établissements Publics de Coopération Intercommunale). These bodies now oversee the tasks previously managed by various local authorities.

The GEMAPI law has 4 missions:

- The development of a watershed or a portion of a watershed.
- The maintenance and development of a watercourse, canal, lake, or body of water, including access to these watercourses, canals, lakes, or bodies of water.
- Flood and coastal defence.
- The protection and restoration of sites, aquatic ecosystems, wetlands, and riparian forest formations.

The definition of the four GEMAPI missions comes from parliamentary debates that focused on the tasks assigned to the local government block through the lens of flood prevention. In this context, lawmakers considered that the maintenance and restoration of aquatic environments complement actions aimed at preventing and protecting against floods. Indeed, the maintenance of watercourses, which is necessary to achieve good water quality as required by the Water Framework Directive, specifically aims to maintain the watercourse in its balanced profile and to allow the natural flow of water. Similarly, the restoration and maintenance of wetlands connected to watercourses are essential for preserving floodplain areas[3].

To finance these activities, the GEMAPI law allows the EPCI to levy a specific tax, known as the GEMAPI tax. This tax is intended to provide the necessary resources to fulfil GEMAPI responsibilities. Additionally, the law emphasises the need for collaboration among various stakeholders, including municipalities, water agencies, environmental organizations, and the state, which is crucial for the effective implementation of flood prevention and water management strategies. The EPCI can also delegate operations to water utilities (among others) if they wish, similar to the delegation of water provision services.

Implementing GEMAPI has faced several challenges, including ensuring effective collaboration among numerous entities with varying interests and responsibilities, adequately funding the necessary projects and infrastructure improvements, and providing local authorities with the technical expertise and resources needed to manage complex water management and flood prevention tasks. Despite these challenges, the GEMAPI law represents a significant step towards integrated water management and flood risk prevention in France. By enhancing local responsibility, improving flood management, and promoting sustainable water management, the law aims to balance ecological preservation with the safety and well-being of the population.

[3] https://www.ecologie.gouv.fr/sites/default/files/documents/Document_maitre_FAQ_Gemapi_final_01_03_2024.pdf

Annex II. Relevance of European policies of the Water Supply & Sanitation Sector on Nature-based Solutions

Water Framework Directive (Directive 2000/60/EC)

Aims and objectives of the policy:

Aims to achieve good water status for all European waters by 2027.
Promotes the sustainable use of water resources and encourages member states to implement integrated river basin management strategies.
The directive recognises the value of ecosystem services, including those provided by NbS, in achieving water quality and quantity objectives.

Enabling aspects:

Establishes a framework for integrating NbS into water management practices at the river basin level.
Encourages member states to consider the ecological status of water bodies, promoting the restoration and preservation of aquatic ecosystems.
Provides a platform for stakeholder engagement and collaboration in the planning and implementation of water management strategies.

European Climate Law (Regulation (EU) 2021/1119)

Aims and objectives of the policy:

Establishes a framework for the irreversible and gradual reduction of anthropogenic greenhouse gas emissions by sources and enhancement of removals by sinks regulated in Union law.
Sets out a binding objective of climate neutrality in the Union by 2050.
Sets out a binding Union target of a net domestic reduction in greenhouse gas emissions for 2030.

Relevant mentions and articles:

Article 5 – Adaptation to climate change – 4. "Member States shall adopt and implement national adaptation strategies and plans, taking into consideration the Union strategy on adaptation to climate change referred to in paragraph 2 of this Article and based on robust climate change and vulnerability analyses, progress assessments and indicators, and guided by the best available and most recent scientific evidence. In their national adaptation strategies, Member States shall consider **the particular vulnerability of the relevant sectors**, inter alia, agriculture, **and of water and food systems**, as well as food security, and **promote nature-based solutions and ecosystem-based adaptation**. Member States shall regularly update the strategies and include the related updated information in the reports to be submitted under Article 19(1) of Regulation (EU) 2018/1999."

Nature Restoration Law (Regulation (EU) 2024/1991)

Aims and objectives of the policy:

Aims to restore ecosystems across the EU to enhance biodiversity, climate resilience, and water quality.
This legislation mandates that member states take action to restore natural habitats and ecosystems, prioritising NbS as a key approach.

Enabling aspects:

Establishes legal requirements for ecosystem restoration, emphasising the role of NbS in improving water quality and quantity.
Provides a framework for financing restoration projects, supporting long-term investment in sustainable water management practices.
Encourages cross-sectoral collaboration to ensure that restoration efforts align with broader environmental and climate goals.

Recast Urban Wastewater Treatment Directive (Directive (EU) 2024/3019)

Aims and objectives of the policy:

The directive regulates the treatment of urban wastewater and emphasises the need for efficient management of rainwater.
It includes provisions for promoting NbS at an urban scale, particularly for stormwater management.

Enabling aspects:

Encourages the implementation of NbS in urban areas to manage rainwater and improve wastewater treatment.

Supports innovative approaches to stormwater management, reducing reliance on conventional grey infrastructure.

Promotes collaboration among urban planners, water operators, and local communities to design integrated water management solutions

Drinking Water Directive (Directive (EU) 2020/2184)

Aims and objectives of the policy:

This directive establishes new standards for drinking water quality and emphasises the protection of water sources.

It encourages preventive approaches to safeguard catchment areas and improve overall water quality.

Enabling aspects:

The Directive's focus on preventive approaches aligns well with Nature-based Solutions, making it a supportive framework for such initiatives.

Encourages local authorities to implement preventive measures that enhance water quality and reduce pollution.

Supports stakeholder engagement and community involvement in water source protection efforts.

EU Biodiversity Strategy for 2030

Aims and objectives of the policy:

The Biodiversity Strategy outlines actions to protect and restore ecosystems across Europe, emphasising the importance of NbS in enhancing biodiversity and ecosystem services.

The strategy sets ambitious targets for the restoration of degraded ecosystems and the establishment of protected areas.

Enabling aspects:

Encourages the integration of NbS in water management to enhance biodiversity and improve water quality.

Supports funding and resources for projects aimed at restoring aquatic ecosystems and promoting sustainable practices.

Promotes collaboration among various sectors, including agriculture, urban planning, and water management, to achieve biodiversity goals.

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change (COM/2021/82)

In this communication, **section 2.2.4.** is dedicated to **promoting NbS for adaptation**. It mentions that implementing nature-based solutions on a larger scale would increase climate resilience and contribute to multiple Green Deal objectives, and that nature-based solutions are essential for sustaining healthy water, oceans, and soils.

The Commission will:

Propose Nature-based Solutions for carbon removals, including accounting and certification in upcoming carbon farming initiatives.

Develop the financial aspects of nature-based solutions and foster the development of financial approaches and products that also cover nature-based adaptation.

Continue to incentivise and assist Member States to rollout nature-based solutions through assessments, guidance, capacity building, and EU funding.

Annex III. List of participants from the 3 roundtables of the Water Supply and Sanitation Sector

AbC a.s. Napoli
Alliance for Water Stewardship
APE - Aqua Publica Europea
AQUAFED - International Federation of Private Water Operators
Aqualia
Barcelona Cicle de l'Aigua
The Consortium for the Management of Environmental Services of the Badajoz Provincial Council (Consorcio para la Gestión de los Servicios Medioambientales de la Diputación de Badajoz)
De WaterGroep
Ecologic Institute
EIB - European Investment Bank
EPSU - European Federation of Public Service Trade Unions
EurEau – European Federation of National Associations of Water Services
European Commission, Directorate General for Climate Action
European Commission, Directorate General for Environment
European Commission, Directorate General for Research and Innovation
EUWMA – European Union of Water Management Associations
EWA – European Water Association
EYDAP
Irrigants d'Europe
James Hutton Institute
MPWiK Warszawie S.A.
Office of the United Nations High Commissioner for Human Rights
OiEau - International Office for Water / Office International de l'Eau
SDEA – Syndicat des Eaux et de l'Assainissement Alsace-Moselle
UKCEH - UK Centre for Ecology & Hydrology (UKCEH)
Uisce Eireann
Veolia
WAREG - European Association of Water Regulators
WWF European Policy Office
WWF Hungary