ROUNDTABLE on Financing Water

Background note

Cost-effective Nature-based Solution integration in River Basin Management Planning in the Eastern Partner countries

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(for consultation)

This paper will inform discussions at the 11th Roundtable on Financing Water: regional meeting on the EU's Eastern Partnership (EaP) countries (Brussels, 30-31 May 2024), co-convened by the OECD and the European Commission.

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1 Introduction

The European Union (EU) and the EU Eastern Partnership (EaP) countries face increasing water demand, pollution, and climate change impacts (Trémolet et al., 2019). Amid these escalating challenges, the EaP countries are working to enhance their environmental resilience, water security, and a green transformation aligned with the European Green Deal and a post-COVID-19 recovery. Nature-based Solutions (NbS) are attracting interest in the region as a potentially cost-effective means to enhance water security and environmental resilience.

This background paper, developed with the support of the EU through the "EU4Environment – Water Resources and Environment Data" Programme, examines how cost-effective NbS could be financed and implemented in river basins in the EaP countries. It is a condensed version of a more detailed paper still under development that explores the spread and implementation of NbS in water management within the EU and EaP countries, with a focus on highlighting key cost-effective NbS solutions, assessing their relevance and effectiveness in water management, and identifying barriers and policy changes required for their broader adoption.

This study also explores the integration of NbS into the Alazani-Iori RBMP, assessing how these alternate solutions can be expanded and financed within the drafted RBMP. With the Alazani-Iori basin experiencing pressures from agricultural runoff, inadequate wastewater management, and extensive hydrological modifications, NbS can offer sustainable alternatives to traditional water management approaches. These solutions, such as constructed wetlands for wastewater treatment, riparian buffer zones to reduce sediment and nutrient loading, and green infrastructure to enhance water retention and flood mitigation, not only address the environmental challenges but also contribute to the economic and social fabric of the region (Souliotis & Voulvoulis, 2022; Oen & Hale, 2020).

2 Overview of NbS in EU water management

The current state and scale of Nature-based Solutions (NbS) projects in the EU present a complex and evolving scenario. A recent extensive review conducted by the European Investment Bank (Hudson et al., 2023) showed that public funding dominated NbS financing, where only 3% of projects reporting private sector financing covering over half of their total costs. Projects are also mostly small - 72% cover areas less than 1 square kilometre, and 81% have investment costs below €10 million, with 44% reporting costs under €1 million. Furthermore, the implementation rate of NbS is relatively slow, with the expected use over the next decade considerably lower than the potential based on ecosystem conditions. This slow pace suggests a significant untapped potential for NbS. The current state thus reflects a landscape where NbS are gaining traction but face challenges in scaling, funding, and realization of their full potential within the EU (Hudson et al., 2023). Figure 1 includes the results of the assessment based on the potential for upscaling of NbS by ecosystems.

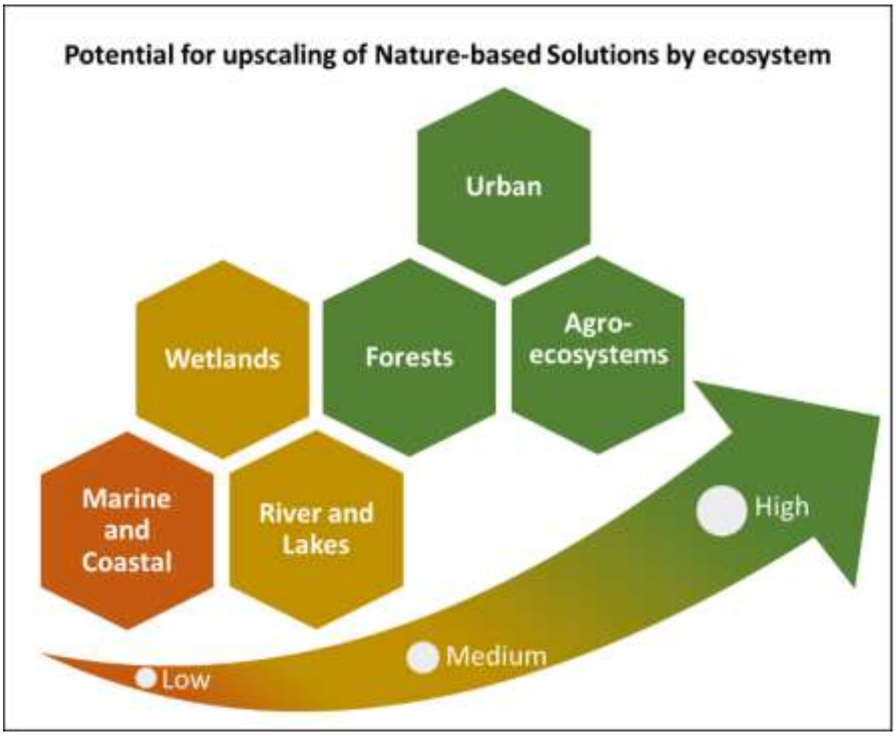

Figure 1: Potential for upscaling of Nature-based Solutions by ecosystem, adapted from Hudson et al., 2023.

The adoption of NbS into water management is gaining momentum, as countries recognize their potential to address various water-related challenges sustainably and cost-effectively (Taylor et al., 2018; UNESCO, 2018). The EU, in particular, has been proactive in this regard, with a focus on enhancing water quality, managing water risks, and ensuring water availability (European Commission, 2023; Wild, 2020). The Water Framework Directive (WFD) is a key driver of nature-based solutions at the EU level, obligating member states to develop River Basin Management Plans (RBMP) and implement measures to achieve good water quality status. This directive significantly influences NbS projects related to river and lake ecosystems. An example mentioned is the lower Danube green corridor (see case studies section), a significant floodplain restoration project for flood protection in Romania and Bulgaria, representing a major portion of the total area for NbS in river and lake ecosystems (Hudson et al., 2023). Additionally, some European cities have begun requiring new buildings and redevelopments to include green roofs as part of their commitment to NbS, with the UK, Germany, and France taking a leadership role in urban nature-based projects within the EU (Hudson et al., 2023).

Ecosystems with high potential for cost-effective NbS scale up

Urban

The urban environment covers an estimated area of approximately 222,000 km^2 in the European Union and the United Kingdom and continues to grow at a rate of approximately 3% per decade (Hudson et al., 2023; Maes et al., 2020).

Urban ecosystems present a significant opportunity for the upscaling of Nature-based Solutions (NbS). Investing in NbS in these urban spaces is crucial due to the higher efficiency and cost-effectiveness compared to grey infrastructure. According to (IISD, 2021), NbS provides 28% better value for money than traditional infrastructural approaches. Furthermore, a recent report by the United Nations Environmental Programme underscores the vast potential of NbS in influencing 79% of the targets across the Sustainable Development Goals (SDGs), particularly in water management (UNEP, 2023). Urban NbS are especially valuable as they often perform multiple functions simultaneously. This multifunctionality is particularly significant for urban climate change adaptation and mitigation. For example, in New York city, protected watersheds, which are largely forested, supply up to 90% of the city's water, reducing the need for built water treatment infrastructure (Browder et al., 2019; UNEP, 2023). Table 1 provides a summary of the key cost-effective NbS recommended for scale up in urban ecosystems across the EaP countries.

Table 1: summary of the key cost-effective NbS recommended for scale up in urban ecosystems

Societal challenges	Key NbS	Water management benefits and co-benefits
• *Poor air quality* • *Localised flooding exacerbated by impervious surfaces* • *Urban heat islands (heat stress)* • *Pollution to waterways from stormwater and wastewater* • *Biodiversity loss*	• Urban landscape restoration (reclaiming brownfield sites) • Water retention infrastructure (Retention Ponds, Bioswales, urban wetlands) • Green roofs, parks, and gardens • Water flow alterations	• Water reuse and water supply regulation • Water purification and nutrient replenishment • Flood mitigation • Human health and well-being improvement • Educational and livelihood opportunities • Climate change mitigation • Urban agriculture and improved habitats • Cooling effects

Forests

Forests are the largest terrestrial ecosystem type in the European Union and in 2018 covered 1,770,997 km^2 or 39% of the European Union's land area (EEA, 2021; Hudson et al., 2023)

Forests play a crucial role in water management and ecosystem preservation (Hudson et al., 2023). The European Union recognizes the potential of afforestation and reforestation in addressing water quality challenges, particularly in the context of diffuse pollution, by reducing nutrient leaching and pollutant run-off (Altamirano et al., 2021; Trémolet et al., 2019). Critically, afforestation also supports hydrological functioning and natural water retention by converting impermeable land cover to tree-covered permeable areas, aiding in groundwater recharge, reducing surface runoff, and flooding risks. The market for NbS in forests is primarily composed of private and public forest owners and managers. Investments in NbS can lead to a reduction in timber production but offer various public and private benefits, including biodiversity outcomes, ecosystem services, and potential revenue streams from carbon credits and ecotourism. Despite current implementation challenges and data gaps, there is a significant potential for expansion in NbS to improve forest health and contribute to broader environmental goals (Hudson et al., 2023; Taylor et al., 2018; Trémolet et al., 2019). Table 2 provides a summary of the key cost-effective NbS recommended for scale up in forest ecosystems across the EaP countries.

Table 2: summary of the key cost-effective NbS recommended for scale up in forest ecosystems

Societal challenges	Key NbS	Water management benefits and co-benefits
• *Poor conservation status* • *Surface water contamination (microplastics and endocrine disruptors)* • *Groundwater quality degradation (diffuse pollution)* • *Biodiversity loss* • *Flooding and erosion risks*	• Reforestation and afforestation • Restoration activities (species introduction or control measures, tackling invasive alien species, grazing management) • Reconnecting forest and wetland water regimes • Irrigation to control forest fires	• Water supply regulation • Riverine flood mitigation • Water purification services • Erosion reduction • Local climate regulation • Enhanced biodiversity • Carbon sequestration • Livelihood opportunities (recreation and tourism)

Agro-ecosystems

Agricultural practices in the EU and Eastern Partnership countries are diverse, with 29% of EU agricultural land covered by permanent grassland, aiding in soil preservation (Krzyżanowski, 2018)*.*

Agricultural practices in the EU and Eastern Partnership countries are diverse, with 29% of EU agricultural land covered by permanent grassland, aiding in soil preservation (Krzyżanowski, 2018). However, issues like soil degradation, water scarcity, and loss of biodiversity are persistent challenges due to intensive agricultural practices in certain regions. In the Eastern Partnership countries, land reform and farm restructuring have led to a predominance of collective ownership and large cooperatives, and significant environmental challenges remain (Apostoaie, 2016). With agriculture consuming about 70% of global water withdrawals, the potential benefits of improved water management in agriculture are substantial (Taylor et al., 2018). NbS can address the intertwined challenges of water scarcity, soil degradation, and biodiversity loss, making them essential for sustainable agro-ecosystems. The Common Agricultural Policy (CAP) in the EU plays a pivotal role in influencing the adoption of NbS. Subsidies can encourage environmentally friendly practices, that benefit water management and biodiversity (Kaufmann et al., 2009). However, current subsidy structures, can inadvertently discourage NbS by making marginal agricultural lands more profitable for conventional farming. The implementation of NbS in agricultural areas within the EU and Eastern Partnership countries is crucial for sustainable water management and ecological resilience. Table 3 provides a summary of the key cost-effective NbS recommended for scale up in forest ecosystems across the EaP countries.

Table 3: summary of the key cost-effective NbS recommended for scale up in agro-ecosystems

Societal challenges	Key NbS	Water management benefits and co-benefits
• *Soil degradation* • *Water scarcity* • *Biodiversity loss*	• Low or zero-till systems • Mulching • Crop rotation • Conservation agriculture	• Enhance soil structure • Improve water retention and drainage • Reduce erosion and lessen pollution of surface waters • Boosting agricultural productivity • Resilience to drought and flooding

Ecosystems with medium potential for cost-effective NbS scale up

Rivers and lakes

Across the European Union and the United Kingdom, rivers and lakes cover an estimated 407,000 km^2 (Maes et al., 2020).

Freshwater ecosystems, including their catchments, riparian zones, floodplains, and lakeshores, are integral to environmental health and biodiversity. NbS applied in river and lake ecosystems primarily focuses on restoration efforts like river remeandering, floodplain restoration, reconnecting rivers and lakes, and removing barriers like dams (Hudson et al., 2023). Nature-based solutions (NbS) play a pivotal role in water management, particularly under the EU's Water Framework Directive (WFD). WFD mandates member states to develop River Basin Management Plans (RBMPs), integrating measures for maintaining good water quality. These solutions not only address water quality but also contribute to biodiversity, carbon sequestration, and recreational opportunities. RBMPs, as guided by the WFD, provide a framework for managing river basins in a holistic manner. Incorporating NbS into these plans can enhance their effectiveness, particularly in addressing challenges like pollution, sedimentation, and biodiversity loss. For instance, riparian buffer strips and wetlands can significantly reduce sedimentation in river channels, improving water quality and habitat for aquatic life (Hudson et al., 2023). Table 4 provides a summary of the key cost-effective NbS recommended for scale up across the EaP countries.

Table 4: summary of the key cost-effective NbS recommended for scale up in river and lake ecosystems

Societal challenges	Key NbS	Water management benefits and co-benefits
• *Water quality* • *Flood mitigation* • *Erosion and sedimentation* • *Biodiversity conservation*	• River re-meandering • Floodplain restoration • Riparian buffer strips • Wetland creation and restoration	• Improved water quality • Reduced flood risks • Enhanced biodiversity • Recreational and aesthetic benefits

Wetlands

Inland *wetlands cover an estimated area of 133,640 km^2 in the EU and face challenges due to management practices and the impact of industries like forestry and agriculture* (Hudson et al., 2023).

Inland wetlands, including vegetated water bodies, swamps, marshes, and periodically dry areas, are pivotal in both the European Union's and the Eastern Partnership countries' ecological and agricultural landscapes. However, these ecosystems face challenges due to their management and the impact of extractive industries like forestry and agriculture. Notably, drained peatland habitats, which constitute about 2.5% of the EU's agricultural area, are responsible for approximately a quarter of the total greenhouse gas emissions from this sector. A significant portion of these wetlands has been drained for agricultural (20%) and forestry purposes (28%). The implementation of NbS in inland wetlands, primarily through ecosystem restoration projects, has been substantial. Key actions include rewetting, irrigation management, and water retention measures. These projects, often driven by the EU Water Framework Directive, demonstrate the interconnectedness of inland wetlands with the broader freshwater ecosystem and agricultural sector. Financially, inland wetlands saw an investment of approximately €2.03 billion between 2000 and 2022, with a notable part funded through EU grants and loans. Financial incentives and policy frameworks need refinement to support these solutions better. Table 5 provides a summary of the key cost-effective NbS recommended for scale up in river and lake ecosystems across the EaP countries.

Table 5: summary of the key cost-effective NbS recommended for scale up in wetland ecosystems

Societal challenges	**Key NbS**	**Water management benefits and co-benefits**
• *Water supply regulation* • *Increased flood damage potential* • *Increased pollutant levels* • *Rising water temperatures* • *Extreme climate events*	• Rewetting Drained Peatlands • Irrigation Management • Constructed Wetlands for Wastewater Treatment • Water Retention Measures	• Enhanced water quality and availability • Reduced flood risks • Balance for agriculture and forestry • Enhanced Biodiversity • Recreational and aesthetic benefits

In conclusion, the five ecosystems with high to medium potential for the upscale of cost-effective NbS - including inland wetlands - are not functioning in isolation. Their interconnectivity mirrors the interconnected challenges they address. Through overlapping with other ecosystems like forests, rivers, lakes, and agro-ecosystems, they collectively form a dynamic and integrated network. This synergy is vital for realizing the full potential of NbS, ensuring that these ecosystems work in tandem to provide comprehensive, sustainable solutions for the complex environmental, social, and economic challenges faced by the EU and EaP countries.

Common barriers around NbS adoption

In the pursuit of sustainable water management and ecosystem conservation, the European Union (EU) and Eastern Partnership (EaP) regions face a complex array of challenges in adopting Nature-based Solutions (NbS). These barriers, span various dimensions including financial, technical, governance, and societal aspects. Overcoming these obstacles is crucial for the successful implementation and scaling up of NbS, which are increasingly recognized as vital components in enhancing water resources management (Altamirano et al., 2021; Hudson et al., 2023; Trémolet et al., 2019). A summary of key barriers to Nature-based Solutions (NbS) adoption in the European Union can be summarized per the following:

1. **Land Availability and Use:** Challenges include securing large, continuous sites for NbS projects, hindered by agricultural or forestry regimes, local opposition, high acquisition costs, and land fragmentation.
2. **Financial Constraints:** Despite the availability of public funding, financial resources for NbS are often insufficient, fragmented, and not consistently outcome-based, which complicates the mobilization of large-scale investments.

3. **Governance and Policy Inconsistencies:** There is variability in the transposition of EU directives into national laws across Member States, leading to diverse policy frameworks. Additionally, the water sector is characterized by fragmented governance, with numerous small entities and limited capabilities, further complicating NbS implementation and scaling.
4. **Technical and Scientific Barriers:** This includes the absence of robust quantitative studies on the benefits of NbS and physical limitations like insufficient land for green infrastructure, which restrict their integration into water management strategies.
5. **Market Dynamics and Investment Attractiveness:** Traditional investment models are often misaligned with the nature of NbS projects, resulting in a lack of private investment and difficulty in attracting conventional investors.
6. **Capacity Building for Innovative Business Models:** There is a need for early-stage support for viable business models and partnerships, as well as capacity building for financial institutions and end borrowers.
7. **Policy and Regulatory Support:** A requirement for enhanced regulatory support and tailored public policies to stimulate NbS investment, including the need to reform subsidies and develop new revenue models based on ecosystem services.
8. **Acquired Behaviors:** Resistance to change, particularly in the water sector, is a significant barrier. This resistance often stems from a reliance on traditional practices, complex governance arrangements, and concerns about the financial impacts of adopting new practices.

By addressing these barriers comprehensively, the EU and EaP countries can effectively enhance the adoption and scaling up of NbS, leading to more sustainable and effective water resource management and ecosystem conservation.

3 Policy insights and recommendations

For NbS to to be more regularly deployed, a coherent regulatory agenda and an improved understanding of benefits are essential. This approach should be accompanied by tailored financial measures, considering the entire range of project maturities, stages, sizes, and risks. An integrated approach to investment grants, subsidies, and repayable finance is needed to encourage deal flow, boost innovative examples, and overcome revenue gaps. This approach should be aligned with other fields such as greenfield infrastructure and venture capital finance, which have established funding and financing strategies for their different development stages (Altamirano et al., 2021; Hudson et al., 2023; Iwaszuk et al., 2019; Trémolet et al., 2019). In summary, the adoption and scaling up of NbS in the EU require a comprehensive approach that addresses the financial, regulatory, and operational challenges. By understanding these challenges and implementing tailored solutions, the EaP countries can effectively integrate NbS into their water management strategies benefiting, both the environment and society.

Policy Changes and Incentives:

1. ***Innovative Financing Models:*** Develop innovative financial instruments, such as land swaps, bridge capital for land restoration, and results-based financing, to address the challenges of land acquisition and project development.
2. ***Public-Private Partnerships:*** Strengthen public-private partnerships, utilizing combined ecological and financial models to make NbS projects more attractive to private investors.
3. ***Regulatory Standardization and Incentives:*** Standardize regulations and offer incentives to encourage NbS adoption, such as ecosystem payment schemes and user fees (e.g., moving away from the flat-rate payment system of CAP).
4. ***Tailored Financial Structures:*** Create diversified financial structures, combining grants, loans, equity investments, and green bonds, customized for NbS projects.
5. ***Mainstreaming NbS in Utility and Infrastructure Planning:*** Integrate NbS into the strategic planning of utilities, particularly water utilities, to exploit their potential in ecosystem services.

4 Case study: Cost-effective NbS in the Alazani-Iori RBMP

The Alazani-Iori River Basin, located in the Kakheti region of Georgia, represents a critical area both ecologically and economically. It is one of the most environmentally vulnerable territories in Georgia, facing frequent mudflows, which pose a significant risk to the local population, infrastructure, and agricultural lands. Agriculture dominates the region's economy, contributing 31.5% to the gross domestic product of Kakheti. The basin is also a hub for hydroelectric power, with nine operational small and medium-sized hydroelectric power plants (HPPs) and plans for 20 more by 2050, highlighting the basin's strategic importance in energy production (Zinke et al., 2020). The Alazani-Iori basin encounters several water management challenges (see Figure 2):

1. **Water quality and pollution**: the basin suffers from significant water quality deterioration due to inadequate sewer systems, with 90% of the population lacking access to sewers, leading to high volumes of untreated sewage discharges directly into the river (i.e., point source pollution). Additionally, diffuse source pollution from agriculture, animal livestock, and illegal landfills exacerbates the pollution levels. Agricultural activities contribute to high concentrations of ammonia nitrogen, iron, copper, and manganese, often exceeding permissible levels.

2. **Hydrological and geomorphological issues**: the basin's hydrology is heavily impacted by extensive water abstraction, primarily for irrigation and hydropower, which constitutes 92% of total water abstraction. The poor condition of irrigation systems and inefficient water use technologies lead to substantial water losses. Moreover, geomorphological modifications due to sand and gravel mining disrupt river ecosystems across various municipalities.

3. **Climate change impacts and increased risk of disasters:** predicted increases in precipitation and the frequency of extreme weather events are likely to enhance the risks of mudflows, flooding, and landslides, significantly affecting agricultural land and local communities.

4. **Governance and monitoring deficiencies**: the region struggles with implementing the Water Framework Directive (WFD) due to the absence of river basin councils and a comprehensive monitoring network. This issue is compounded by insufficient data on water use, pesticide application, and the overall impacts of diffuse pollution, which hinder effective management and policy enforcement.

Programme of Measures (PoMs) for the Alazani-Iori RBMP

In response to the extensive water management challenges in the Alazani-Iori basin, the developed RBMP has a comprehensive Programme of Measures (PoMs). These measures, developed through stakeholder engagement, baseline assessments, and questionnaires, are aimed at mitigating the identified issuesFigure 2. The Alazani-Iori basin RBMP, finalized in November 2020, categorizes the measures into basic and supplementary types, reflecting a holistic approach to addressing the diverse pressures within the basin (Figure 3). These measures target various challenges, from pollution to hydrological alterations, and are designed to be implemented despite constraints in funding and regulatory approvals (Zinke et al., 2020).

Basic Measures

- **Sewerage and wastewater management**: construction and renovation of sewer systems and wastewater treatment plants (WWTPs), particularly in urban areas experiencing significant point source pollution.
- **Agricultural practices**: renovation of agricultural drainage systems, creation of buffer strips and hedges, and promotion of vermicomposting to mitigate diffuse pollution from crop production and livestock.
- **Water abstraction**: rehabilitation of major irrigation systems including Zemo Alazani, Kvemo Alazani, and several others, to address the excessive water abstraction predominantly for irrigation purposes.

Supplementary Measures

- **Education and public awareness**: implementation of educational campaigns, training, and publicity initiatives to enhance community awareness and engagement in pollution control and water management.
- **Monitoring and enforcement**: investigative monitoring of sand-gravel enterprises and illegal landfills, coupled with the imposition of sanctions and enhancements in waste management practices.

- **Climate change adaptation**: research to assess the current and potential impacts of climate change on water bodies, aiming to incorporate findings into future water management strategies.

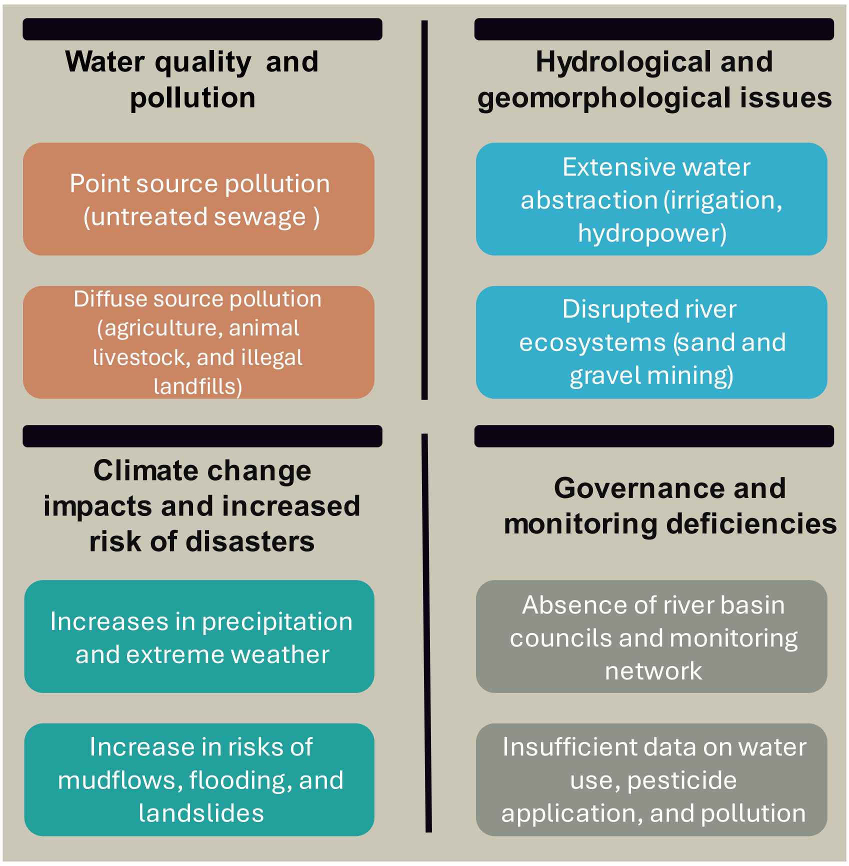

Figure 2: Summary of the main pressures (water management challenges) in the Alazani-Iori River basin adapted from (Zinke et al., 2020)

The RBMP emphasizes the full deployment of these measures through coordinated efforts by national authorities. Where current measures prove insufficient to meet the objectives of the Water Framework Directive (WFD), targeted supportive measures will be introduced. Despite the pressing need for sustainable water management strategies, NbS have not been fully integrated into the current PoMs of the Alazani-Iori RBMP. There is a significant opportunity to incorporate solutions such as riparian buffers, constructed wetlands, and sustainable agricultural practices that not only address the environmental challenges but also enhance the economic and social well-being of the region. The subsequent section will provide an overview and a summary table outlining where and how NbS can be relevant and effectively applied within the basin's context.

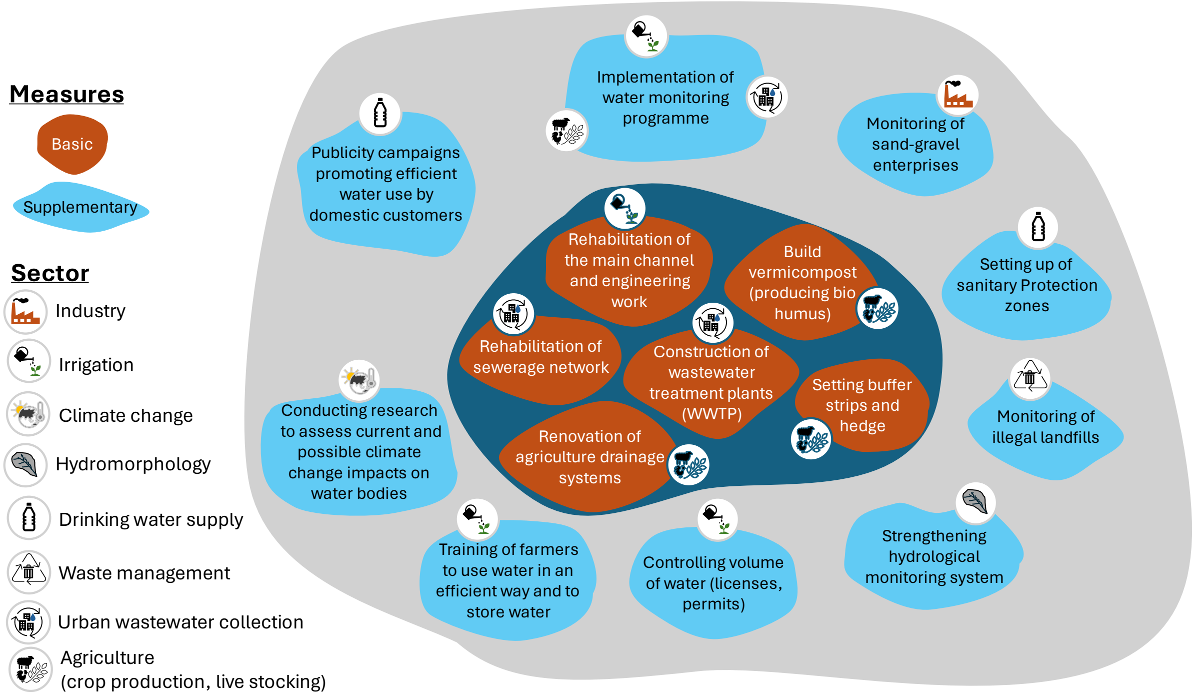

Figure 3: The measures selected during the 1st implementation cycle for the Alazani-Iori River basin, adapted from (Zinke et al., 2020)

Opportunities for the application of cost-effective NbS in Alazani-Iori RBMP

Cost-Effective Nature-based Solutions (NbS)

NbS for water management involve the "planned and deliberate use of ecosystem services to improve water quantity and quality and to increase resilience to climate change, often adopted alongside conventional water infrastructure for more sustainable outcomes" (Taylor et al., 2018). Cost-effectiveness in this context refers to solutions that consider whole life costs, including long-term maintenance, ecosystem services, and potential co-benefits like biodiversity enhancement and carbon sequestration. The previous assessment of NbS within the EU and EaP countries (refer to Task 1 for more details) reveals that certain ecosystems exhibit higher potential for the implementation and scale up of NbS due to their inherent characteristics and the multifunctionality they offer (Hudson et al., 2023). Based on the review of existing literature, five ecosystems were identified with varying potential for NbS scale up:

Table 6: Summary of ecosystems with high and medium potential for NbS scale up (Task 1 outcomes) based on Hudson et al., 2023.

Potential	Ecosystem	Key challenges	Potential NbS	Benefits and co-benefits
High	Urban	Poor air quality, localised flooding exacerbated by impervious surfaces, urban heat islands (heat stress),	Urban landscape restoration (reclaiming brownfield sites), water retention infrastructure	Water reuse and water supply regulation, water purification and nutrient replenishment, flood mitigation, human health and well-being

		pollution to waterways from stormwater and wastewater, biodiversity loss	(retention ponds, bioswales, urban wetlands), green roofs, parks, and gardens, water flow alterations)	improvement, educational and livelihood opportunities, climate change mitigation, urban agriculture and improved habitats, cooling effects
	Forest	Poor conservation status, surface water contamination (microplastics and endocrine disruptors), groundwater quality degradation (diffuse pollution), biodiversity loss, flooding, and erosion risks	Reforestation and afforestation, restoration activities (species introduction or control measures, tackling invasive alien species, grazing management), reconnecting forest and wetland water regimes, irrigation to control forest fires	Water supply regulation, riverine flood mitigation, water purification services, erosion reduction, local climate regulation, enhanced biodiversity, carbon sequestration, livelihood opportunities (recreation and tourism)
	Agro-ecosystems	Soil degradation, water scarcity, biodiversity loss	Low or zero-till systems, mulching, crop rotation, conservation agriculture	Enhance soil structure, improve water retention and drainage, reduce erosion, and lessen pollution of surface waters, boosting agricultural productivity, resilience to drought and flooding
Medium	River and lakes	Water quality, flood mitigation, erosion and sedimentation, biodiversity conservation	River remeandering, floodplain restoration, riparian buffer strips, wetland creation and restoration	Improved water quality, reduced flood risks, enhanced biodiversity, recreational and aesthetic benefits
	Wetlands	Water supply regulation, increased flood damage potential, increased pollutant levels, rising water temperatures, extreme climate events	Rewetting drained peatlands, irrigation management, constructed wetlands for wastewater treatment, water retention measures	Enhanced water quality and availability, reduced flood risks, balance for agriculture and forestry, enhanced biodiversity, recreational and aesthetic benefits

NbS within the RBMP

The presence of ecosystems with high and medium potential for NbS scale-up within the Alazani-Iori River Basin provides a strategic opportunity to enhance the current River Basin Management Plan (RBMP). The ecosystems identified—urban, forest, and agro-ecosystems with high potential, and wetlands, rivers, and lakes with medium potential—cover significant portions of the basin (Zinke et al., 2020). The inclusion and scale up of NbS within these ecosystems in the RBMP can substantially advance the environmental objectives and priorities of the Alazani-Iori River basin, mainly; achieving good ecological and good chemical status for all surface water bodies and good quantitative and chemical status for all groundwater bodies; and preventing deterioration of water status and ensuring sustainable water management across the basin (Zinke et al., 2020).

Strategic Inclusion of NbS:

- **Urban Ecosystems**: There are 9 urban settlements and 333 villages in Kakheti, with just over 20% of the population living in urban areas. These areas can benefit from NbS like green roofs and bioswales, which not only manage stormwater and reduce flooding but also contribute to cooling urban heat islands and enhancing urban air quality and management of wastewater effluents.
- **Forest Ecosystems**: 31% of Alazani-Iori River basin is covered with forest and are crucial for maintaining hydrological balance and filtering pollutants. Implementing NbS such as reforestation and sustainable management practices can enhance water quality and forest health, providing long-term sustainability benefits.
- **Agro-ecosystems**: given the basin's substantial agricultural activity (i.e., Kakheti has 70% of all Georgia's vineyards and the total size of agricultural lands used by farmers in Kakheti is 315,499 ha), introducing NbS such as conservation agriculture, crop rotation, and organic farming can significantly reduce soil erosion, enhance water efficiency, and improve crop yields, aligning with sustainable agricultural practices.
- **Rivers and Lakes**: enhancing them through measures like river remeandering and floodplain restoration can improve water quality, restore natural flow regimes, and increase biodiversity, contributing to the overall health of the aquatic systems.

Revised Programme of Measures (PoMs):

To effectively integrate these NbS into the RBMP, a revised Programme of Measures (PoMs) should explicitly include these solutions, mapped directly to the challenges they aim to mitigate. This approach ensures that the selected NbS not only address the specific challenges but also enhance the overall resilience and sustainability of water management practices implemented in the basin. It's important to note that the supplementary measures within the PoMs focus predominantly on monitoring and raising awareness; thus, the substantial integration of NbS has been directed towards the basic measures only (e.g., no NbS was attached to point source pollution from Industrial wastewater discharges (sand-gravel extraction) and diffuse source pollution from illegal landfills pressures because only secondary measures were proposed for both).This approach leverages NbS to directly address the primary environmental and water management challenges identified at the basin level. The application of these NbS is designed to be broad and encompassing, addressing common pressures that are persistent across the entire Alazani-Iori basin rather than being tailored to specific sub-basins. This basin-wide perspective ensures a cohesive and unified strategy in mitigating environmental pressures such as water quality degradation, habitat loss, and hydrological disruptions.

To ensure the effective integration of Nature-based Solutions (NbS) into the River Basin Management Plan (RBMP) for the Alazani-Iori basin, it may be helpful to align the selection and implementation of these solutions with IUCN global standards on NbS. The standard provides a structured approach to evaluate NbS across eight critical criteria, each supported by specific indicators. This alignment guarantees that the chosen NbS not only tackle the basin's unique challenges but also promote sustainability, resilience, and broad societal benefits. The forthcoming Catalogue of NbS, produced as part of the EU4Environment Water & Data Programme, is also a valuable reference.

IUCN Global Standards for NbS: Application in the Alazani-Iori RBMP

The inclusion of NbS in the RBMP will be assessed against the following IUCN criteria Figure 4, ensuring each solution is robust, scalable, and beneficial:

1. **NbS effectively address societal challenges**: NbS must prioritize and effectively mitigate the most pressing societal challenges within the basin, such as water scarcity, pollution, and biodiversity loss.

2. **Design of NbS is informed by scale:** the design of each NbS should account for the ecological, economic, and social interactions at multiple scales and integrate risk management strategies.
3. **NbS result in a net gain to biodiversity and ecosystem integrity:** actions should enhance biodiversity and ecosystem health, with measurable conservation outcomes and periodic assessments to monitor unintended impacts.
4. **NbS are economically viable:** each NbS should demonstrate cost-effectiveness compared to traditional approaches, with a clear analysis of benefits, costs, and potential funding mechanisms.
5. **NbS are based on inclusive, transparent, and empowering governance processes:** governance processes must be transparent, inclusive, and empowering, involving all stakeholders in decision-making and ensuring equitable benefit distribution.
6. **NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits:** NbS should equitably manage trade-offs between primary goals and other ecosystem services, with safeguards in place to address potential conflicts.
7. **NbS are managed adaptively, based on evidence:** implementation should be adaptable, with a strong foundation in regular monitoring, evaluation, and iterative learning to respond to new challenges and information.
8. **NbS are sustainable and mainstreamed within an appropriate jurisdictional context:** NbS should be designed to be sustainable and integrated within local to national policy frameworks, contributing to broader environmental and social targets.

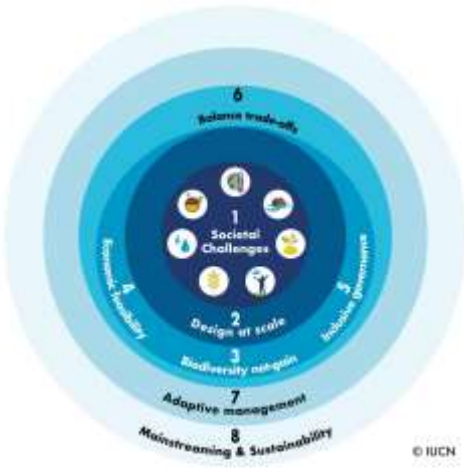

Figure 4: The eight Criteria that make up the IUCN Global Standard for NbS are all interconnected.

Final Strength Measure Assessment Using the Traffic Light System

After evaluating each NbS against the 8 criteria of the IUCN's global standard for NbS and their 28 indicators, a final strength measure is assigned based on the level of adherence. This measure is visually represented using a traffic light colour coding system, facilitating an intuitive understanding of each NbS's compliance:

- **Green (strong adherence)**: indicates that the NbS fully meets the IUCN standards, addressing all relevant criteria and indicators effectively. This level signifies that the intervention is likely to achieve its intended outcomes while delivering maximum ecological, economic, and social benefits.

- **Light Green (adequate adherence)**: suggests that the NbS meets most of the IUCN standards but may have minor areas that require improvement. These interventions are generally effective but might benefit from minor adjustments to fully realize their potential.
- **Orange (partial adherence)**: reflects that the NbS meets some of the IUCN standards, but significant gaps exist which may affect the intervention's overall success. These areas need substantial modifications or enhancements to meet the desired objectives.
- **Red (insufficient adherence)**: indicates that the NbS does not meet the IUCN standards sufficiently, with many criteria not addressed or poorly implemented. Interventions in this category are unlikely to succeed without major revisions and reconsideration.

Incorporating this color-coded system into the RBMP documentation and reporting provides a clear and easily interpretable assessment of each NbS Figure 5. This method aids stakeholders in quickly understanding the level of compliance and areas needing attention and supports decision-making processes for future NbS planning and implementation. While this traffic light system provides a preliminary assessment based on current literature and standards, it is imperative to engage with all basin stakeholders to refine these evaluations. Such a participatory approach will ensure that each NbS is not only scientifically and technically sound but also socially and culturally appropriate. This iterative process is crucial for the adaptation and sustainability of the interventions within the Alazani-Iori basin context. The traffic light evaluation system now has an online version that can be accessed through the IUCN Global Standard for Nature-based Solutions self-assessment tool, hosted at https://nbs-sat.iucn.org/.

	Key (%)		Output
	≥75	Strong	Intervention adheres to the IUCN Global Standard for NbS.
	≥50 & <75	Adequate	
	≥25 & <50	Partial	
	<25	Insufficient	Intervention does not adhere to the IUCN Global Standard for NbS.

Figure 5: Example of how the traffic light system looks in the online self-assessment tool.

The following Table 7 suggests complementary and cost-effective NbS for each combination of pressure and measure. Each entry also includes a source that illustrates the application and effectiveness of the suggested NbS, thereby demonstrating their practical relevance. While the table specifically matches NbS to existing pressures and Programmes of Measures (PoMs) within the RBMP, it also serves as an excellent starting point for engaging stakeholders.

Table 7: Suggested complimentary cost-effective NbS based on the proposed basic measures within the River Basin Management Plan (RBMP) for the Alazani-Iori basin.

Pressures	Proposed Basic Measures	Complimentary cost-effective NbS	Source
Point source pollution from urban wastewater discharges	Construction of new wastewater treatment plant (WWTP) Construction of the sewerage system. Rehabilitation wastewater network, which includes replacement of the pipes and collectors Environmental inspection controls on wastewater discharges to the rivers	• **For Raw Domestic Wastewater:** surface aerated ponds, facultative ponds, anaerobic ponds, french vertical flow Treatment wetlands (TWs), and multi-stage Treatment wetlands (TWs).	Cross et al., 2021; Mara & Johnson, 2007; Al-Isawi, Ray, & Scholz, 2017; Foladori, Ruaben, & Ortigara, 2013; Sperling, 2015.
Diffuse source pollution from agriculture-crop production	Rehabilitation of drainage systems to reduce water induced erosion and agriculture run-off Setting buffer strips and hedges (establishment of 3m buffer strip) Codes of Good Agricultural Practices for Protection of Waters against Agricultural Nitrate Pollution (the reduction in the use of fertilizers in agriculture) Establishment of organic farms Actions plans for Nitrate Vulnerable Zones (this measure consists of the preparation of Actions plans for Nitrate Vulnerable Zones in the river basin and is in line with the EU-Nitrate Directive (91/676/EEC))	• **Free Water Surface Constructed Wetland (FWS CW) System** utilizes natural wetland processes to treat agricultural runoff. Enhancements include the incorporation of carbon-rich materials to boost denitrification and nutrient recovery capabilities. • **Vegetated Drainage Ditches (VDD):** these are agricultural drainage ditches designed to mimic the biological and physical processes of FWS wetlands. Improvements can be made by using phosphorus-sorbent materials for nutrient recovery and structural modifications like low-grade weirs or two-stage ditches to improve nutrient removal efficiency**.** • **Buffer Strips (BS-R for surface runoff and BS-G for groundwater):** strips of vegetation planted between agricultural fields and water bodies to intercept pollutants. Enhancements may involve reshaping the riparian zones to enhance root interception with groundwater or integrating permeable reactive barriers and edge-of-field wetlands for more effective pollutant filtration. • **Vegetated Channels:** implemented within agricultural lands to intercept and filter nutrients from runoff or tile drainage water, enhancing water quality before it reaches larger water bodies. • **Water Sediment Control Basins:** these basins are strategically placed near sloping agricultural lands to temporarily hold runoff water, allowing for sediment settlement and nutrient absorption	Rizzo et al., 2023; Mancuso et al., 2021; Kumwimba et al., 2018; Stutter et al., 2019; Vidon et al., 2019 ; Kröger et al., 2014; Baker et al., 2016; Davis et al., 2015; Hodaj et al., 2017.

		before the water is released either through a drainage channel or by infiltration into the soil.	
Diffuse source pollution from agriculture-animal live stocking	Setting up vermicompost (producing bio humus) Construction and use of biogas plants (biogas digesters) for households or for a whole municipality Avoidance of livestock grazing in water protection strips by providing alternative zones Codes of Good Practices for Livestock in the Alazani-Iori River basin	• **Aerated wetlands** have shown promisingly higher nutrient removal performance for manure treatment. Also, the use of **subsurface flow wetlands** or highly adsorbent filling media such as zeolites could enhance performance.	Rizzo et al., 2023 ; Kato et al., 2013 ; Zhang et al., 2017; Borin et al., 2013 ; Masi et al., 2017.
Excessive water abstraction (irrigation, public water supply, hydropower plant (HPP), fish farm, etc.)	Using modern and efficient irrigation technologies to economize the water uses Rehabilitation of the main canal, collectors, and engineering works of the irrigation systems in the Alazani-Iori River basin Regulations for abstractions and impoundments to prevent deterioration of water body status (the system of abstraction licensing control)	• **Agricultural Water Management:** conservation agriculture, natural water harvesting, effective soil water management through irrigation scheduling and increased soil water holding capacity through mulching and mowing are proven to have a high impact on irrigation water use. • **Hydropower and River Management:** floodplain restoration, river restoration, removal of barriers. • **Public Water Supply:** wetland restoration, semi-artificial wetlands, riparian zone restoration. • **River Connectivity and Fish Passage Improvements**: enhancing river connectivity through the removal or modification of barriers to restore natural flow regimes. This can improve ecosystem health and fish migration, which is particularly relevant for river management and biodiversity conservation. • **Forest Management for Water Regulation**: implementing sustainable forest management practices to enhance water regulation, reduce soil erosion, and improve water quality. This can be particularly effective in large river basins prone to sedimentation and pollution.	Pisinaras et al., 2024; Maes & Jacobs, 2017; Faivre et al., 2017; O'Hogain & McCarton, 2018.

		• **Managed Aquifer Recharge**: using natural or engineered systems to enhance the natural process of groundwater recharge. This can be particularly effective in areas facing groundwater depletion. • **Urban Green Infrastructure**: developing green roofs, parks, and urban forests to manage stormwater, reduce flooding, and improve air and water quality. This approach can be integrated into public water supply systems to enhance resilience against climate impacts. • **Bioengineering for Slope Stabilization**: employing vegetation and other natural materials to stabilize slopes and banks in hydropower reservoirs and irrigation canals. This can prevent landslides and erosion, reducing sediment load in water bodies. • **Wetland Restoration and Creation**: restoring and creating wetlands to enhance water purification, flood protection, and biodiversity habitats. This can be integrated into both agricultural and urban water management strategies.	
Hydromorphological alteration (Hydrological flow changes, Longitudinal River and habitat continuity interruption, Morphological alterations)	**Measures for the pressure category-water flow changes** - Creation of ecologically compatible hydraulic conditions through flow control (e.g. water level regulation) - Creation of water course pass ability for upstream and downstream migration of location specific species and for sediments transport; management of sediments **Measures for the pressure category-sediment dynamics** - Improvement of sediments transport continuity via dams' management - Material removal and sediments extraction regulation - Moderate watercourse maintenance **Measures for the pressure category-morphological changes** - Improvement and diversification of bank and bed structures, riparian and aquatic habitats (vegetalization)	• **Water Management and Hydrological Alterations:** re-naturalizing river segments, restoring natural flow regimes, and enhancing habitat diversity, include the **removal of barriers** like small dams or weirs, **replanting native vegetation** along the riverbanks, and reconfiguring the riverbed to allow more natural meandering patterns to restore river ecosystems and ensure continuity for species migration. • **Sediment Dynamics Management:** use of **ponds and other features** to capture and manage sediment such as establishing **riparian buffer strips** (i.e., vegetated areas along riverbanks designed to intercept surface runoff, trap sediment, and reduce erosion), i**n-stream structures** (i.e., use of natural materials such as wood or boulders to create in-stream structures that slow down water flow, encourage sediment deposition at specific sites, and enhance habitat complexity). • **Morphological Changes: restoring riverbanks and beds** to their natural state through the removal of artificial structures and the reintroduction of native plant species, **channel reconfiguration** by creating meanders, widening or narrowing the river, and installing structures that mimic natural geomorphological features, floodplain restoration, **installation of engineered log jams and boulder clusters** by using natural materials like logs and boulders to create	Turconi et al., 2020; Robotham et al., 2022; Pugliese et al., 2020 ; Chausson et al., 2020.

	- Supporting hydraulic engineering measures for morphological restructuring of the water course	structures within the river that enhance habitat complexity, promote sediment deposition, and control flow dynamics**, vegetated geogrids** by incorporating vegetation into geosynthetic materials to stabilize and protect riverbanks and slopes from erosion. These biotechnical solutions combine engineering with ecological techniques to reinforce soil and manage water flows in a sustainable manner. • **Natural Water Harvesting and Rainwater Management Public Features: managed aquifer recharge** through percolation ponds and infiltration basins, **climate adaptation measures** through green roofs, urban wetlands, and tree planting and urban forestry.	
Climate change pressure	Restoration of floodplain forests Considering climate change aspects in the implementation of infrastructure or bank protection projects Considering climate change impact when calculating water demand/supply balances for water supply companies Monitoring of water abstraction considering decreased precipitation, ensuring sustainable use of water	Many of the Nature-based Solutions (NbS) previously suggested for addressing various pressures such as Hydromorphological changes and sediment dynamics inherently include strategies to adapt to and mitigate the impacts of climate change. When designing and implementing these solutions, it's crucial to incorporate climate change considerations to ensure they are resilient and effective under changing conditions. For instance, restoration of floodplain forests, bioengineering for bank stabilization, and water-sensitive urban design not only address specific environmental issues but also enhance the overall resilience of ecosystems and human communities to climate variability. Therefore, while specific NbS for climate change are integral, they should be viewed as part of a broader strategy where every NbS accounts for the anticipated impacts of climate change to ensure sustainable and adaptive management of natural resources.	**-**

Opportunities for financing cost effective NbS in Alazani-Iori RBMP

Implementing Nature-based Solutions (NbS) within the Alazani-Iori River Basin Management Plan (RBMP) requires a strategic approach to financing, leveraging diverse funding sources and partnerships to ensure both effectiveness and sustainability. Here are key strategies to facilitate financing for NbS in the Alazani-Iori RBMP:

1. **Identify Financial Pathways**:
    - Explore **Global Environmental Facility (GEF)** and **Green Climate Fund (GCF)** as primary funding sources, given their focus on climate adaptation and sustainable ecosystem management.
    - Consider involvement in the **International Climate Initiative (IKI)**, which supports climate and biodiversity projects in various countries, including Eastern Partnership countries. Data on specific funding by IKI in these regions can provide insight into available financial support.
    - **European Structural and Investment Funds (ESIF):** utilize ESIF, particularly the Cohesion Fund and the European Regional Development Fund, which support environmental sustainability and climate adaptation projects in eligible regions, including Eastern Europe.
    - **Water Funds:** establish or tap into existing water funds where public and private sector contributions are pooled to finance water conservation projects in a river basin. This model has been successful in various global contexts and can be tailored to the specific needs of the Alazani-Iori basin.
    - **Corporate Environmental Responsibility Initiatives:** engage corporations operating in or near the river basin to invest in NbS through their corporate social responsibility programs, focusing on environmental sustainability initiatives that benefit both the community and their operations.
    - **Crowdfunding and Community-based Initiatives:** develop community-driven funding models through crowdfunding platforms dedicated to environmental projects. This method can complement larger funding streams by mobilizing local and international community support.
2. **Engage with Local and International Partners**:
    - Foster partnerships with local government entities such as the **Municipal Development Fund of Georgia** and the **Ministry of Regional Development and Infrastructure of Georgia**.
    - Collaborate with private sector stakeholders like the **Ltd United Water Supply Company of Georgia** and **Ltd Georgian Amelioration** to integrate private investment in public projects.
    - Involve non-governmental organizations such as **ELKANA (Organic Farming & Rural Tourism Network in Georgia)**, which could support NbS through community-based projects and sustainable tourism.
3. **Incorporate NbS into Programmes of Measures (PoMs)**:

- Align NbS with the Water Framework Directive (WFD) requirements as part of PoMs, emphasizing holistic water management approaches that address both point and diffuse source pollution (starting from Table 7).
- Design interventions that restore natural ecosystems and manage environmental pressures effectively, as outlined in the WFD's 5th Implementation Report, which advocates for the broad use of NbS.

4. **Leverage Successful Case Studies**:

- Reference successful financial models like the **restoration of the Emscher Landscape Park in Germany,** which not only improved ecological outcomes but also improved local economies by creating jobs and enhancing recreational opportunities, **the Danube River Basin,** where the Integrated River Basin Management Plan under the EU's Water Framework Directive has successfully implemented NbS to manage water quality and flood risks, supported by a combination of EU funds, national budgets, and private partnerships, and **the Murray-Darling Basin in Australia**, a comprehensive plan focusing on water rights reallocation and infrastructure investment for water efficiency, funded through national government investment and contributions from state governments, this plan offers a robust model for managing water resources in a large and ecologically diverse river basin.
- Adapt these models to local contexts within the Alazani-Iori basin, ensuring that financial strategies are tailored to the specific environmental and socio-economic conditions of the region.

5. **Conduct Comprehensive Feasibility Studies**:

- Undertake feasibility studies to identify additional stakeholders, assess the economic benefits of NbS, and define specific project needs. This helps in making a compelling case for investment from varied sources, including international donors and local businesses.

6. **Develop a Monitoring and Evaluation Framework**:

- Implement a robust monitoring system to track the effectiveness of funded projects, ensuring accountability and facilitating ongoing support from financial partners. This data will be crucial for adapting strategies and securing sustained funding.

5 Conclusion and way forward

For NbS to become mainstream in EaP countries, a coherent regulatory agenda and an improved understanding of their benefits are essential. This approach should be accompanied by tailored financial measures, considering the entire range of project maturities, stages, sizes, and risks. An integrated approach to investment grants, subsidies, and repayable finance is needed to encourage deal flow, boost innovative examples, and overcome revenue gaps.

The Alazani-Iori River Basin Management Plan (RBMP) represents an essential effort in advancing sustainable water management practices within Georgia's vulnerable regions. As detailed in this study, the integration of Nature-based Solutions (NbS) in the Alazani-Iori River Basin RBMP's is not only a strategic response to immediate environmental challenges but also a proactive approach to fostering long-term resilience and sustainability in the face of climate change and increasing pressures. The success of the RBMP depends on enhanced collaboration among local and international stakeholders, including governmental bodies, private sectors, and NGOs. The involvement of these entities not only diversifies financial inputs but also enriches the planning and implementation processes with varied expertise and perspectives.

Strengthening policy frameworks to support NbS integration into national water management strategies is crucial. This involves aligning local policies with international standards, such as the IUCN Global Standards for NbS, to ensure that these practices are sustainable, equitable, and effective. Although most of the recommendations for including NbS in the RBMP focused on basic measures, supplementary measures can also be used to enhance community engagement and education about the benefits and practices of NbS will foster greater public support and participation. This approach not only enhances the social acceptability of these solutions but also empowers communities to actively participate in sustainable water management practices.

Policy Changes and Incentives:

- ***Innovative Financing Models:*** Develop innovative financial instruments, such as land swaps, bridge capital for land restoration, and results-based financing, to address the challenges of land acquisition and project development.
- ***Public-Private Partnerships:*** Strengthen public-private partnerships, utilizing combined ecological and financial models to make NbS projects more attractive to private investors.
- ***Regulatory Standardization and Incentives:*** Standardize regulations and offer incentives to encourage NbS adoption, such as ecosystem payment schemes and user fees (e.g., moving away from the flat-rate payment system of CAP).
- ***Tailored Financial Structures:*** Create diversified financial structures, combining grants, loans, equity investments, and green bonds, customized for NbS projects.
- ***Mainstreaming NbS in Utility and Infrastructure Planning:*** Integrate NbS into the strategic planning of utilities, particularly water utilities, to exploit their potential in ecosystem services.

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