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Deliverable D5.3

Lessons learnt and recommendations to the main regional clusters (first version)

WP5 Demonstration and impact assessment

NENUPHAR

New governance models to enhance nutrient pollution handling and nutrients recycling

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Executive summary

This deliverable, D5.3 "Lessons Learnt and Recommendations to the Main Regional Clusters (First Version)," builds on the NENUPHAR project's previous work, mostly D2.4 "Best Practices for the Implementation of Governance Models" (Boy & Febrer, 2025), in developing sustainable solutions for nutrient management. Based on the practical experience of NENUPHAR partners gained during tasks 5.1 ("Roll-out of solutions in pilot sites") and 5.2 ("Monitoring and validation of solutions at field level"), this report analyses recommendations for optimizing nutrient management governance across three European river basins: Ebro, Lielupe, and Danube. Task 5.2 involves implementing and monitoring NENUPHAR solutions, gathering data using Key Performance Indicators (KPIs), and engaging with stakeholders. This practical experience directly informed the evaluation and analysis of recommendations from D2.4 Qualitative data from demonstration sites in Spain, Latvia, Lithuania, Slovakia, and Hungary was analysed using a methodology that included feasibility assessment elements to determine the priority and feasibility of each recommendation, identify potential obstacles and solutions, and propose prioritized implementation sequences.

The Ebro river basin analysis highlights the need for integrated governance, data platforms, and stakeholder engagement to address nitrate pollution. The Lielupe river basin analysis emphasizes the importance of transboundary cooperation, a basin-wide monitoring system, and stakeholder engagement. The Danube river basin analysis focuses on collaborative governance, policy coherence, and investments in research and innovation in both Slovakia and Hungary. Each regional analysis includes prioritized implementation sequences and policy recommendations.

While this first version of the report (July 2025) provides valuable insights for the ongoing implementation of NENUPHAR, it will be further refined at the conclusion of the project. The report is intended as a resource for policymakers, researchers, and stakeholders committed to effective nutrient pollution management strategies. Crucially, the insights and recommendations presented here can directly inform ongoing discussions and actions within the NENUPHAR regional Communities of Members (CoMs) in each region and country, thereby supporting their efforts to implement sustainable nutrient management strategies.

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List of abbreviations and acronyms

AKI – Institute of Agricultural Economics Nonprofit Kft.

BAT – Best Available Technologies

CAP – Common Agricultural Policy

CHE – Ebro Hydrographic Confederation

CIRCE – Centre of Research for Energy Resources and Consumption

CoM – Community of Members

D – Deliverable

e.g. – for example

EU – European Union

GDPR – The General Data Protection Regulation

HEU – Horizon Europe

IT – Information Technology

KPI – Key Performance Indicator

LBTU – Latvia University of Life Sciences and Technologies

LEGMC – state limited liability company “Latvian Environment, Geology and Meteorology Centre”

LRATC – Latvian Rural Advisory and Training Centre

LUKA – Latvian Water and Wastewater Works Association

MITA – Agency for Science, Innovation and Technology

MoUs – Memoranda of Understanding

NENUPHAR – New Governance Models to Enhance Nutrient Pollution Handling and Nutrient Recycling

NGO – Non-Governmental Organization

R – recommendation

RIS3 – Research and Innovation Strategy for Smart Specialisation

SAICA – Automated Water Quality Information System

SME – Small and Medium Enterprises

SUA – Slovak University of Agriculture in Nitra

SZE – Széchenyi István University

T – Task

UWWTD – Urban Wastewater Treatment Directive

VMU – Vytautas Magnus University

WP – Work Package

WWTP – Wastewater Treatment Plant

ZSA – Union “Farmers' Parliament”

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Introduction

In the face of escalating nutrient pollution and soaring fertilizer costs, the NENUPHAR project aims to transform waste into valuable resources. By focusing on the recovery of nitrogen and phosphorus from waste streams—specifically manure, sewage sludge, and dairy wastewater—this project seeks to provide sustainable solutions that not only supply new fertilizers at competitive prices but also contribute to cleaner soil, air, and water systems. However, the success of this initiative hinges on comprehensive political, regulatory, and governance efforts to unite key stakeholders across the board. The primary objective of the NENUPHAR project is to establish new circular value chains that demonstrate how nitrogen and phosphorus can be effectively recovered at the EU level. This involves developing holistic governance solutions that include collaboration schemes among stakeholders, enhanced processes for nutrient recovery, and revised regulatory and financial frameworks. The solutions are being demonstrated in three diverse geographical river basins across Europe, with plans for replication in island systems to ensure broad applicability and impact.

Within this context, the current deliverable 5.3 "Lessons learnt and recommendations to the main regional clusters (first version)" (hereinafter – Deliverable) focuses on exploring experience gained so far by implementing the NENUPHAR solutions and detailing the recommendations to optimize the performance of these governance solutions.

The development of Deliverable was carried out during Task T5.2 "Monitoring and validation of the solutions at field level". The aim of this task is to **supervise the proper operation of the technical solutions and governance models implemented** in Task 5.1 "Roll-out of the solutions in the pilot sites" and **to gather the data from the demo site activities** based on the monitoring framework and the Key Performance Indicators (KPIs). The task is divided in three **sub-tasks**, one for each demo site:

- Subtask 5.2.1 covers the activities carried out in the **Ebro river basin demo site (Spain)**, including the **valorisation of pig manure and liquid digestate** through an aerobic digestion process hybridized with an ammonia stripper

- Subtask 5.2.2 covers the activities of **sewage sludge composting and application** to agricultural fields in **Lielupe river basin** demonstration site in **Latvia and Lithuania**

- Subtask 5.2.3 covers the activities carried out in the **Danube river basin** demo site (detailed in including the **monitorization of the treated water from the membrane treatment** to implement the fine-tuning configurations considering the type of the raw material and its content and production peak (**Hungary**) as well as the **monitorization of the treated wastewater and the biomass**, to validate the N/P removal performance from this system and the soil and water characteristics before and after the application of the dried biomass for nutrient input (**Slovakia**).

The task objectives include testing and demonstrating the solutions in real-world environments, coordinating demonstration activities, monitoring and adjusting performance, and assessing environmental and socio-economic impacts compared to baseline conditions. **The ultimate aim of the Deliverable is to provide actionable recommendations for each demonstration environment**, paving the way for a more precise and sustainable implementation strategy.

Deliverable delves into these objectives, outlining the methodological framework employed and the analysis of the recommendations in each demo site and country. By exploring the recommendations thoroughly, it aims to prioritize them and identify a clear path forward, ensuring the NENUPHAR project's goals are met with maximum efficacy. Conclusions of the analysis, including the similarities, differences and main lessons learnt by carrying out the task so far, is provided at the end of the Deliverable.

This is the first version of the report on lessons learnt and recommendations to main regional clusters (M21) addressing specifically the Policy recommendations on the regional policies of nutrient management and the river basin management plans. This report will be revised at the end of the project (M42).[1]

This document can serve as a resource for further work within task T5.2 by informing the ongoing implementation and demonstration of the NENUPHAR solutions, as well as a resource for policymakers, researchers, and other stakeholders who are committed to implementing strategies for managing nutrient pollution. The insights and results gleaned from this report can also sustain the conversations initiated within the NENUPHAR regional CoMs. By establishing a foundation, this document ensures that the advancement attained so far in addressing nutrient pollution continues to build, facilitating long-term environmental and socio-economic benefits.

[1] *The Deliverable 5.5. "Lessons learnt and recommendations to the main regional clusters (final version)" will be an update of D5.3, addressing the final version of Policy recommendations on the regional policies of nutrient management and the river basin management plans, research, technical and financial needs for the processes upscaling and replication; effective connection among different stakeholders, considering aspects such as contractual relationships, communication channels and logistics.*

1.Methodological framework

This chapter provides an insight into the methodological framework of the Deliverable, describing the objectives and explaining the reasons for setting them, and describing the foundations - the previous work of the project - on which it is based.

1.1. Methodological foundation: previous NENUPHAR results

The NENUPHAR project develops and refines technologies and management models for nutrient recovery and management. The results are being demonstrated in three river basin regions – the Ebro, the Lielupe and the Danube – in Spain, Latvia and Lithuania, as well as in Slovakia and Hungary. Technology implementation and demonstration requires not only nutrient recovery technology research but also successful governance and the exploration and overcoming of bureaucratic, legal and social barriers. To do this, the project has already carried out extensive work. For example, within WP2 has already identified successful practices in nutrient pollution management, as well as key stakeholders in the NENUPHAR regional clusters, and established CoM – Community of Members – in each of them, which include key stakeholders and form the basis for multi-stakeholder involvement. Best practices in the implementation of governance models have also been identified, and key recommendations have been formed for each region and country.

In order to use the findings so far to demonstrate results in practice, Task 5.2 'Monitoring and validation of the solutions at field level' implements the solutions developed under the project. The Task started in January 2025 (earlier in some cases) and is being actively pursued during the development of this Task. As a result of this and other tasks, the partners involved in the project have gained experience – practical knowledge of both the technology demonstration and the governance situation in the regions.

This Deliverable seeks to explore various recommendations that have already been developed, drawing on the experience of the project partners, the professionals involved in the implementation of the Demonstration. The recommendations developed under D2.4 (Boy & Febrer, 2025) are analysed, also looking at the possibilities and options of implementing NENUPHAR technologies at national or regional level. NENUPHARs previous work on policy analysis has also been considered, for example, the baseline analysis of EU policies and regulations related to nutrient management, as presented in D4.1 (Boy & Febrer, 2024), as well as regulatory instruments analysed in D4.2 "Definition of current regulatory instruments and competencies of each demo case" (Laborda & Cebrián, 2024).

In aforementioned D2.4, the concept governance is defined based on definition given by United Nations, as a concept that describes how various stakeholders, such as governments, private companies, and civil society, work together to address shared challenges and achieve collective goals. Unlike traditional government systems that often depend on centralized authority, governance emphasizes decentralization and participatory decision-making. It aims to create an environment conducive to collective action, rather

than merely exerting control. Within NENUPHAR project, it is kept in mind that the concept of governance is diverse, integrating economic, political, and administrative elements that interact to address social needs and protect the environment. These elements guide how resources are allocated, and policies are formulated and implemented, ensuring that inclusivity and accountability are maintained. Governance can become complex when stakeholders have conflicting interests or when there is resistance to decentralization. However, these challenges can also lead to innovative approaches and solutions.

This Deliverable derives from previous work done within the project by adhering to this definition of governance by exploring the feasibility of implementing the recommendations from different perspectives, taking into account the multidimensional implications of their implementation.

To do that successfully, a methodology was developed, based on various data collection and analysing methods described in the next subchapters.

1.2. Feasibility assessment

To assess the feasibility of the recommendations set for each regional cluster during the project recently, elements of a Feasibility Assessment method were used. Feasibility assessment is a systematic method used to evaluate the potential success of a proposed plan or project. It involves analysing various factors to determine whether the plan, in this case – recommended action – is viable and worth pursuing (Mukherjee & Roy, 2017; Ssegawa & Muzinda, 2021; Yoon, 2021; Grunov, 2025).

A feasibility assessment typically encompasses several key areas to ensure a comprehensive evaluation of a project's potential success. **Technical feasibility** investigates whether the necessary technology and resources are available, evaluating technical capabilities, existing infrastructure, and any potential technical challenges. **Economic feasibility** focuses on the financial aspects, including a cost-benefit analysis to determine economic viability, assessing initial investment, operational costs, and potential financial returns or savings. **Legal feasibility** considers the legal implications and regulatory requirements that must be met, ensuring compliance with existing laws and identifying any legal obstacles. Operational feasibility examines the practicality of the project in terms of operational requirements, understanding how the project will function daily and identifying any operational challenges. **Schedule feasibility** evaluates whether the project can be completed within a reasonable timeframe, involving the setting of timelines and milestones to ensure smooth progress. Lastly, **social feasibility** assesses the social impacts and acceptability of the project among stakeholders, considering community support, stakeholder engagement, and potential social benefits or concerns. However, the assessed areas can be set depending on a context and needs. Conducting a feasibility assessment helps making informed decisions about whether to proceed with a project or plan. This process helps identify potential risks and challenges, allowing for better planning and resource allocation (Mukherjee & Roy, 2017; Ssegawa & Muzinda, 2021). It also helps delving into these various areas to understand what potential risks could be when implementing a plan and therefore pre-emptively prepare and plan eliminating the risks. Feasibility

Assessment methods are widely used in public sector to adjust priorities among policy projects in a reasonable manner, in the prebudget phase especially when initiatives require significant investments. It allows assessing the adequacy of a plan and on its implementation possibilities to ensure sustainability. This process involves establishing fairness and social credibility through expert reviews, information disclosure, and alternative options (Yoon, 2021).

To ensure that the recommendations set for demo-sites can be detailed, this study derives elements from feasibility assessment methods, by assessing potential political, legal, social, economic and other obstacles that could hinder the implementation of each recommendation.

1.3. Prioritization matrix

A prioritization matrix is a decision-making tool that helps organizations evaluate and rank various options or tasks based on specific criteria. This method is particularly useful when resources are limited, and it is crucial to focus on the most impactful actions. By using a prioritization matrix, teams can systematically decide which tasks should take precedence, ensuring efficient resource allocation and effective strategic planning. The matrix works by listing tasks or options on one axis and criteria on the other. Each task is then scored against each criterion, allowing for a structured comparison. Common criteria might include impact, cost, urgency, feasibility, or alignment with strategic goals. Once scored, tasks are ranked based on their total scores, highlighting which options should be prioritized (Renzi & Agner, 2023).

In the context of policy implementation, such as nutrient management, a prioritization matrix (Figure 1) can help regions determine which policy recommendations should be acted upon first. For example, if a region is looking to implement several nutrient management strategies, they might evaluate each based on criteria like potential environmental impact, cost-effectiveness, ease of implementation, and stakeholder support. This analysis helps identify the strategies that offer the most significant benefits relative to the resources required. Utilizing a prioritization matrix ensures a transparent and objective decision-making process. It encourages stakeholder involvement and consensus, as the criteria and scoring can be discussed and agreed upon collaboratively. This approach not only streamlines decision-making but also enhances buy-in and commitment from all involved parties.

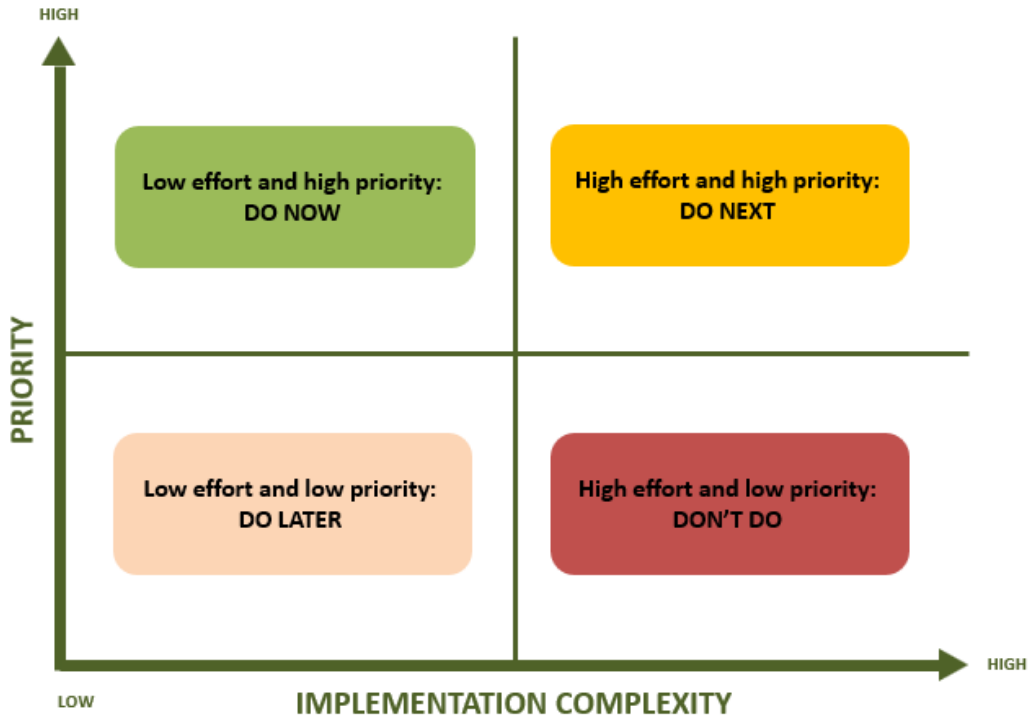

Figure 1 Prioritization matrix

Within preparing this Deliverable, the recommendations were evaluated by assessing their priority and implementation possibility. Then, the recommendations were placed in a matrix, depending on results.

1.4. Data collection and analysis

Considering the methodological framework and the context of the project, as well as the need to evaluate, prioritise and refine the recommendations, the questions for the group interviews for the evaluation of each recommendation have been developed in the framework of this assignment. The questions are structured in logical blocks to facilitate the flow of ideas (Figure 2). Full list of semi-structured group interview questions can be found in Annex 1.

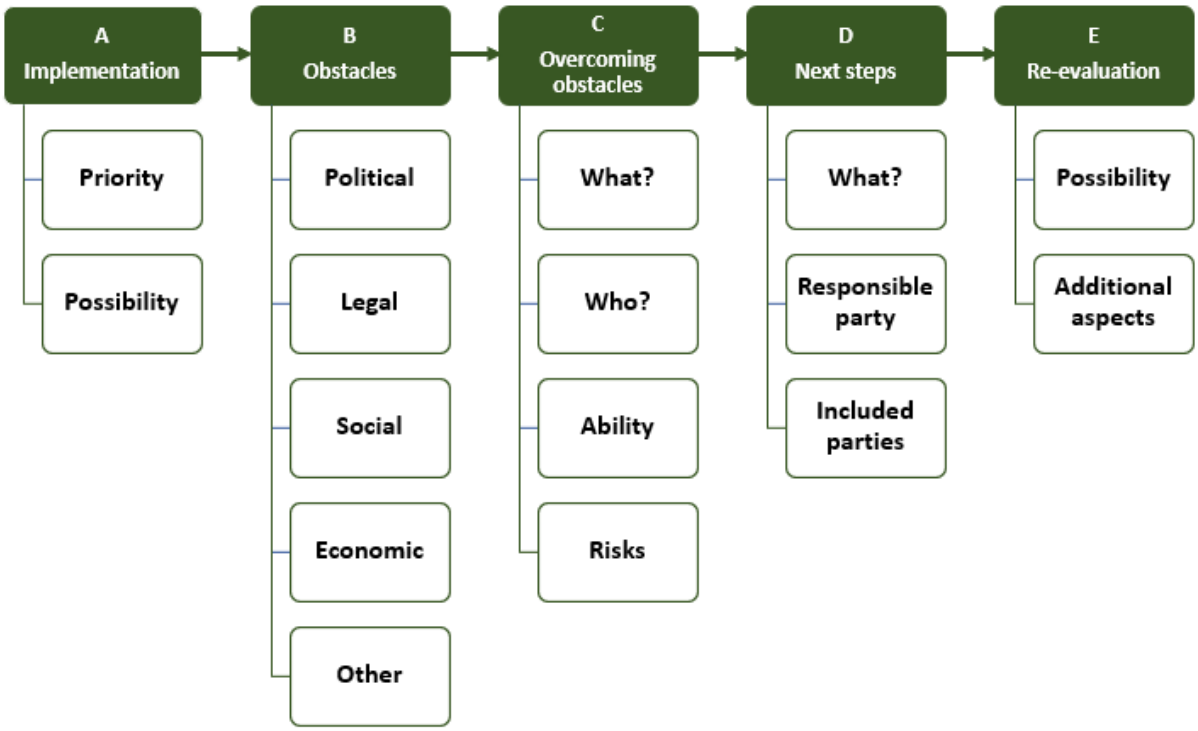

Figure 2 Question blocks for semi-structured group interviews

The Questions were divided in five blocks to build a logical trail of thought. The approach allowed to:

- Assess implementation priority quantitatively and qualitatively
- Assess potential political, legal, social, economic and other obstacles that could hinder the implementation of each recommendation
- Qualitatively assess ways to overcome potential obstacles
- Identify possible next steps for implementation (where possible)
- Re-evaluate implementation possibilities after analysis to ensure that all analysed factors and conclusions are taken into account

Semi structured group interviews for qualitative data collection were chosen because they are a valuable method for assessing recommendations as they offer a balance between structure and flexibility, allowing

for in-depth exploration of participants' insights while maintaining a focus on specific topics. Here are a few reasons why this approach is particularly effective:

- Semi-structured interviews use a set of predefined questions or topics, which ensures the discussion remains relevant to the research objectives. This guidance helps in systematically assessing specific recommendations, ensuring that all key areas are covered.
- Unlike fully structured interviews, this approach allows participants to express their thoughts more freely. This flexibility can lead to the uncovering of new insights and perspectives that might not have been anticipated, enriching the overall assessment.
- Conducting these interviews in a group setting leverages the dynamics of group interaction. Participants can build on each other's responses, challenge ideas, and collectively brainstorm solutions, leading to a more comprehensive understanding of the recommendations.
- Group interviews bring together individuals from different backgrounds or with varying expertise. This diversity can provide a holistic view of the recommendations, as participants offer insights based on their unique experiences and knowledge.
- By engaging multiple participants at once, semi-structured group interviews can be more time-efficient than conducting a series of one-on-one interviews, while still gathering rich qualitative data.
- This method allows for the exploration of context-specific factors that might influence the implementation of recommendations, making it easier to tailor strategies to specific settings or regions.

Given that the recommendations set in D2.4 were divided by country (or country and region, in case of Latvia and Lithuania), group interviews were conducted with partners from each demo-site country: Spain, Slovakia, Hungary, Lithuania and Latvia. Interviews were held in June 2025 online. In most cases, participants expressed wish to set an additional internal team meetings and provide answers orally or in written form afterwards. This ensured additional insight into the evaluation. Therefore, results were collected in both – video recording and written form. After collecting the results, they were analysed by using descriptive analysis.

Since each country has been given a very different number of recommendations, the feasibility of implementation in detailed was examined for the different numbers of recommendations to ensure that each partner team has a similar amount of work to do.

For example, ten recommendations were previously put forward for the Ebro river basin (Spain), six of which were studied in detail, while all ten were studied in terms of priority implementation. In turn, four recommendations were previously put forward for the Latvian part of the Lielupe river basin, four for the Lithuanian part, and four for the entire Lielupe basin region. Thus, the Latvian partners analysed four recommendations in full, the Lithuanian partners analysed four recommendations in full, and the teams

from both countries analysed four more recommendations together, agreeing on a common position. Meanwhile, for the countries in the Danube river basin—Slovakia and Hungary—the recommendations were set separately beforehand: six for Slovakia and eleven for Hungary. Therefore, in the case of Slovakia, all six recommendations were analysed, combining two of them in terms of content, while in the case of Hungary, the five most important recommendations were selected for detailed implementation analysis. Priority of the implementation was analysed for all recommendations.

2. Lessons learnt and path forward: Ebro river basin

The Ebro river basin in Northeastern Spain, encompassing the regions of Aragon and Catalonia, presents a unique set of environmental challenges and opportunities, particularly concerning nitrate pollution. This chapter aims to delve into the recommendations established in D2.4 (Boy & Febrer, 2025), focusing on their implementation in the region. This analysis will explore the proposed recommendations, considering the regional context and the pressing need for coordinated efforts to mitigate nitrate pollution. The priority of these recommendations is assessed, identifying potential barriers to their implementation, and highlighting opportunities for enhancing their impact through regional collaboration.

2.1. Context

As concluded in D2.4, in the Aragon and Catalonia region, nutrient management faces several challenges and opportunities. A significant challenge is regulatory fragmentation, where different administrative structures lead to inconsistencies in policy implementation, hampering effective cross-regional coordination. Additionally, diffuse pollution from livestock farms and intensive horticulture contributes to agricultural runoff, threatening water quality and necessitating targeted mitigation strategies. Stakeholder conflicts also arise, as varying priorities among farmers, environmental agencies, and industrial actors can delay the adoption of effective measures. Monitoring compliance with EU regulations like the Nitrate Directive requires robust enforcement mechanisms, which can be resource intensive. Climate variability, with changes in rainfall patterns and extreme weather events, further complicates nutrient transport, making pollution levels harder to predict and control.

Despite these challenges, there are opportunities to enhance nutrient management. Integrated policy approaches, such as joint policies and data-sharing between Aragon and Catalonia, could lead to more efficient strategies. Technological innovations, including precision agriculture and real-time soil nutrient monitoring, offer promising solutions to minimize nutrient loss. Promoting a circular economy in agriculture, through manure valorisation and composting, can turn waste into valuable resources, reducing environmental impact. Strengthening collaboration among farmers, policymakers, and research institutions can foster balanced and sustainable policy solutions. Additionally, EU funding and support for research, innovation, and infrastructure improvements can accelerate the adoption of sustainable practices across the region.

To tackle the challenges and to capitalize on opportunities, the following recommendations were set for a new governance model implementation in the region:

- Establish a joint governance body that can effectively coordinate nutrient management in Aragon and Catalonia (R1)

- Implement a common data platform for monitoring nutrient levels and pollution sources (R2)
- Create multi-stakeholder advisory groups for policy development (R3)
- Organise regular workshops and training sessions for stakeholders to promote best practices in nutrient use and pollution prevention (R4)
- Introduce financial incentives for farmers to adopt responsible nutrient management techniques (R5)
- Strengthen enforcement mechanisms through regular inspections and penalties for non-compliance (R6)
- Increase support for farmers, including access to finance and technical assistance (R7)
- Develop a digital reporting system to streamline compliance tracking and regulatory oversight (R8)
- Adopt circular economy principles – promote manure valorisation and composting, provide incentives for farms to implement closed-loop nutrient recycling systems etc. (R9)
- Secure long-term financial and institutional support for nutrient management initiatives (actively seek EU funding opportunities for research, innovation and infrastructure improvements, align nutrient management strategies with the objectives of the EU Green Deal, establish partnerships with EU research programmes) (R10)

Six recommendations for the Ebro river basin region were initially selected for detailed analysis based on their perceived high priority status: R1, R2, R3, R4, R7 and R9. The results of the analysis are reflected in the sub-chapter 2.2. To get a comprehensive view of the priorities, all 10 recommendations were analysed in sub-chapter 2.3.

As can be seen in the priority matrix (sub-chapter 2.3., Figure 3), through the detailed evaluation process, which included project partner input, one recommendation (R2) was subsequently re-evaluated as having a comparatively lower implementation priority. This finding demonstrates the value of the in-depth analysis process in refining our understanding of implementation priorities and practicalities.

2.2. Evaluation of recommendations for Ebro river basin

2.2.1. Establish a joint governance body that can effectively coordinate nutrient management in Aragon and Catalonia (R1)

The establishment of a joint governance body to coordinate nutrient management in Aragon and Catalonia is of very high importance. Currently, nutrient governance in the Ebro basin is fragmented across multiple administrative entities, including the regional governments of Aragon and Catalonia, and the

Ebro Hydrographic Confederation (CHE). This fragmentation poses a significant structural barrier, as the lack of coordinated decision-making leads to overlapping efforts and inefficiencies. A joint governance body could address these issues by promoting coherent regulations and enhancing the efficiency of nutrient management strategies. The establishment of CoM withing the NENUPHAR tasks and hosting an initial CoM meeting has already laid a foundation for soft governance, fostering dialogue, addressing shared concerns, and building trust between stakeholders. Institutionalizing this dialogue into a formal joint body represents the logical progression.

The complexity of implementing such a governance body is considered medium – not too complex and not too easy. The CoM has demonstrated that cross-regional collaboration is achievable on an informal level, indicating a favourable attitude and willingness to facilitate dialogue among regional administrations and the CHE. This groundwork makes formalization more feasible than starting from scratch. However, challenges persist, including the political autonomy of regions, the absence of a formal mandate for cross-regional action, and a limited tradition of interregional joint governance. Political factors, such as competing agendas and reluctance to delegate authority, alongside legal, social, and economic obstacles, could hinder implementation.

Overcoming these challenges involves utilizing the CoM as a pre-institutional governance arena to prototype collaboration, gradually upgrading it into a permanent advisory council with rotating leadership, and leveraging its neutrality and stakeholder legitimacy to facilitate dialogue. Key stakeholders in this endeavour include the private sector, public sector entities such as the governments of Aragon and Catalonia, the CHE, civil society groups, and academic institutions.

Resistance to implementing this recommendation and assigning responsibilities is anticipated, but if approached incrementally, it is manageable. The Ebro CoM already includes actors who support coordination. Initial actions should focus on organizing bilateral meetings, with academia, particularly UVIC-UCC, taking the lead. Regional authorities and the CHE should participate. Importantly, the facilitation should be informal to build trust and define common objectives.

Upon re-evaluation, the implementation of this recommendation appears more feasible than initially thought. The CoM fosters trust, ownership, and shared problem framing, although there is a risk of losing momentum if not linked to formal mandates. Nonetheless, the CoM offers an opportunity to serve as a governance prototype, guiding formal coordination efforts.

2.2.2. Implement a common data platform for monitoring nutrient levels and pollution sources (R2)

Implementing a common data platform for monitoring nutrient levels and pollution sources in the Ebro basin is of utmost priority. Data integration has been identified as a critical challenge, with significant inconsistencies and the absence of a unified monitoring system highlighted by the CoM. Stakeholders agree that reliable data is essential for improving nutrient governance. CHE offers a successful model with

its SAICA-Ebro real-time water quality network, demonstrating how a centralized system can ensure data consistency and effective management.

The complexity of implementing such a platform is deemed medium. CoM members have shown a willingness to contribute data, provided that trust, usability, and feedback loops are established. There is also an openness to adopting digital tools collaboratively. However, challenges exist in creating a common platform without a leading institution or dedicated budget. The CHE's management of SAICA-Ebro exemplifies effective implementation by an established authority, ensuring consistent data collection and oversight. The CoM's structure could be scaled into formal advisory groups with minimal resistance, as members have expressed readiness to engage in data sharing under the right conditions.

Obstacles to implementation include the lack of harmonized indicators, data ownership concerns, and limited technical and financial capacity for platform design. Political factors such as asymmetric data governance practices, legal issues around data sharing protocols, social challenges like limited digital skills among smaller farmers, and economic considerations, including investment needs for sensors and maintenance, all pose significant hurdles.

To overcome these challenges, the CoM should collaborate with stakeholders to co-design platform goals and indicators, develop a phased and modular platform linked to user benefits, and promote open standards compatible with Common Agricultural Policy (CAP) digital tools. The private sector, public sector entities like the governments of Aragon and Catalonia and the CHE, civil society, and academic institutions all have roles to play in this initiative.

Resistance to implementing the platform is not expected to be substantial, as the CoM provides an ideal setting for aligning stakeholders, who have already reached a consensus on the need for a shared platform. Initial steps should involve organizing a CoM working session on data needs, with UVIC/UCC as the responsible party and participation from public administrations, farmers, and academia to build consensus on indicators.

Upon re-evaluation, the implementation appears more challenging than initially anticipated. It is crucial to ensure that the platform addresses 'what data matters' from a field perspective and guarantees data security and mutual benefits to gain traction. This initiative can serve as a model for other basins under the EU's Farm to Fork digitalization strategy, offering a pathway to enhanced nutrient management.

2.2.3. Create multi-stakeholder advisory groups for policy development in Ebro river basin (R3)

Creating multi-stakeholder advisory groups for policy development in the Ebro river basin is identified as a very high priority. The diversity of stakeholders in the Ebro basin, including farmers, cooperatives, water authorities, and civil society, highlights the need for an inclusive mechanism to integrate diverse perspectives into policy development. Currently, the lack of such a mechanism limits the effectiveness and legitimacy of policy initiatives. The CoM can serve a pivotal role here, functioning as a de facto

advisory group. Formalizing this role would significantly enhance the legitimacy and impact of policy decisions.

The complexity of implementing this recommendation is considered quite manageable. The existing structure and composition of the CoM can be scaled or adapted into formal advisory groups with minimal resistance. This adaptability makes the implementation process smoother and more straightforward.

However, potential obstacles could arise. Politically, the challenge lies in aligning diverse stakeholder interests and ensuring equitable representation. Legally, there may be uncertainties around the formalization of these groups and their decision-making authority. Economically, securing funding for the operational costs of these groups might be necessary. Socially, there is the risk of stakeholder fatigue or apathy if engagement processes are not well-managed.

To overcome these challenges, a phased approach can be adopted, initially focusing on building trust and demonstrating the benefits of stakeholder collaboration. Ensuring transparent processes and equitable representation is crucial. The CoM can act as a neutral facilitator to broker relationships and mediate conflicts. Key actors involved would include the private sector, regional governments and water authorities as well as civil society organizations, and academia, all playing roles in establishing and sustaining these advisory groups.

While the implementation appears straightforward, success will depend on effectively managing stakeholder relationships and ensuring that the advisory groups are perceived as legitimate and valuable. It is crucial to maintain a focus on inclusivity and transparency to foster trust and engagement.

2.2.4. Organise regular workshops and training sessions for stakeholders to promote best practices in nutrient use and pollution prevention (R4)

Organizing regular workshops and training sessions for stakeholders to promote best practices in nutrient use and pollution prevention is deemed a very high priority. There is a substantial interest in continuous learning and capacity-building among stakeholders, particularly concerning manure management, regulatory compliance, and nutrient recycling. These workshops can play a critical role in enhancing stakeholder knowledge and skills, thereby contributing to more effective nutrient management practices.

The implementation complexity of this initiative is considered very easy. Workshops are low-cost and enjoy high acceptance among stakeholders. The CoM already functions as a platform for such activities, making it highly feasible to scale these efforts. It is straightforward to incorporate training sessions into existing CoM meetings, ensuring that each gathering includes dedicated time for education and skill development.

Potential obstacles could include ensuring consistent participation from all stakeholders, aligning workshop content with diverse stakeholder needs, and maintaining engagement over time. Politically, there might be challenges in prioritizing which topics to cover and how to address different regulatory

environments. Economically, while the cost is low, securing ongoing funding for materials and expert facilitators could be necessary. Socially, varying levels of stakeholder knowledge and experience might require tailored training approaches.

To overcome these challenges, it is essential to engage stakeholders in the planning process, ensuring that the workshops meet their needs and interests. Utilizing feedback loops to refine content and delivery will help maintain relevance and engagement. Leveraging partnerships with local educational institutions and industry experts can also enrich workshop content and provide diverse perspectives.

Key actors would include farmers, cooperatives, environmental organizations, regional governments, and academia, all of whom can contribute to planning and executing these training sessions.

2.2.5. Increase support for farmers, including access to finance and technical assistance (R7)

Increasing support for farmers, particularly in terms of access to finance and technical assistance, holds a very high priority. This need has been consistently highlighted by stakeholders, especially for small and medium-sized farms that often lack the internal resources to implement sustainable practices. While this necessity is widely recognized, it hasn't been the top concern voiced by CoM members, where stakeholders showed a preference for supportive and collaborative approaches over punitive measures.

The complexity of implementing this recommendation is relatively easy. Support can be delivered through advisory services, regional extension programs, and schemes supported by the CAP. The CoM can serve as an effective channel for providing guidance and targeted support to farmers, ensuring that the assistance is both relevant and accessible.

However, several obstacles could potentially hinder implementation. Politically, there may be challenges in aligning support measures with regional and national policies. Legally, issues could arise around the allocation of funds and ensuring compliance with EU regulations. Economically, securing adequate funding and resources to sustain these support measures is crucial. Socially, there might be resistance from farmers accustomed to traditional practices, necessitating efforts to build trust and demonstrate the benefits of sustainable approaches.

To overcome these challenges, it is important to engage in continuous dialogue with farmers to understand their needs and customize support accordingly. Building partnerships with financial institutions and leveraging CAP funding can help secure necessary resources. Providing clear examples of successful sustainable practices can also help in overcoming resistance and encouraging adoption.

The key actors involved would include regional governments, agricultural cooperatives, financial institutions, and academic bodies, all of which can contribute to the design and delivery of support programs.

This initiative is relatively straightforward to implement due to the existing frameworks and the high level of stakeholder support. However, it is essential to maintain flexibility and responsiveness to the diverse needs of farmers to ensure the effectiveness of the support provided.

2.2.6. Adopt circular economy principles – promote manure valorisation and composting, provide incentives for farms to implement closed-loop nutrient recycling systems etc. (R9)

Adopting circular economy principles, such as promoting manure valorisation and composting, and providing incentives for farms to implement closed-loop nutrient recycling systems, is considered a very high priority. This initiative emerged as a central theme during the stakeholder discussions and demonstrations, reflecting strong stakeholder support for practices like manure composting and biogas production. These approaches not only align with previous recommendations but also represent significant steps toward sustainable nutrient management and environmental protection.

The implementation complexity of this initiative is deemed relatively easy, owing to the availability of both knowledge and technology. The CoM has already made strides by engaging with stakeholders in pilot practices, demonstrating the feasibility of these approaches. However, the challenge lies in scaling up these efforts, which will necessitate strategic incentives and effective coordination. These elements have been focal points of CoM discussions, emphasizing the need for cohesive efforts to advance these initiatives.

Nevertheless, several obstacles could impede progress. Politically, achieving alignment with regional policies and securing unanimous stakeholder support may present challenges. Legally, the establishment of regulations for nutrient recycling systems and ensuring compliance could pose difficulties. Economically, the upfront investment costs for farms might be prohibitive, highlighting the need for financial support mechanisms. Socially, there may be resistance to transitioning away from traditional farming practices, necessitating efforts to showcase the long-term benefits and sustainability of circular economy principles.

To overcome these challenges, it is essential to develop clear incentives and robust support structures that encourage widespread adoption. Engaging stakeholders through ongoing dialogue, education, and demonstration projects can help build understanding and acceptance. Collaboration with technology providers and financial institutions to offer cost-effective solutions will also be critical.

Key actors in this endeavour would include regional governments, agricultural cooperatives, environmental organizations, and academic institutions, each playing a vital role in promoting and facilitating the implementation of circular economy practices.

While the concept is straightforward to implement, the success of this initiative will heavily depend on maintaining stakeholder engagement and ensuring the availability of attractive incentives. To ensure the initiative can be implemented successfully, it is crucial to provide clear, attractive incentives and maintain strong stakeholder engagement through continuous dialogue and education. Also, clear and strategic

communication to reach the target groups is important. Collaborating with technology providers and financial institutions to ensure cost-effective solutions will also enhance the initiative's success.

2.3. Priorities in Ebro river basin

In analysing all of the recommendations set for Ebro river basin through the lens of priority and implementation complexity, each has been strategically positioned within the prioritization matrix (Figure 3). This analysis has revealed a clear sequence for implementation, beginning with the most impactful and manageable actions.

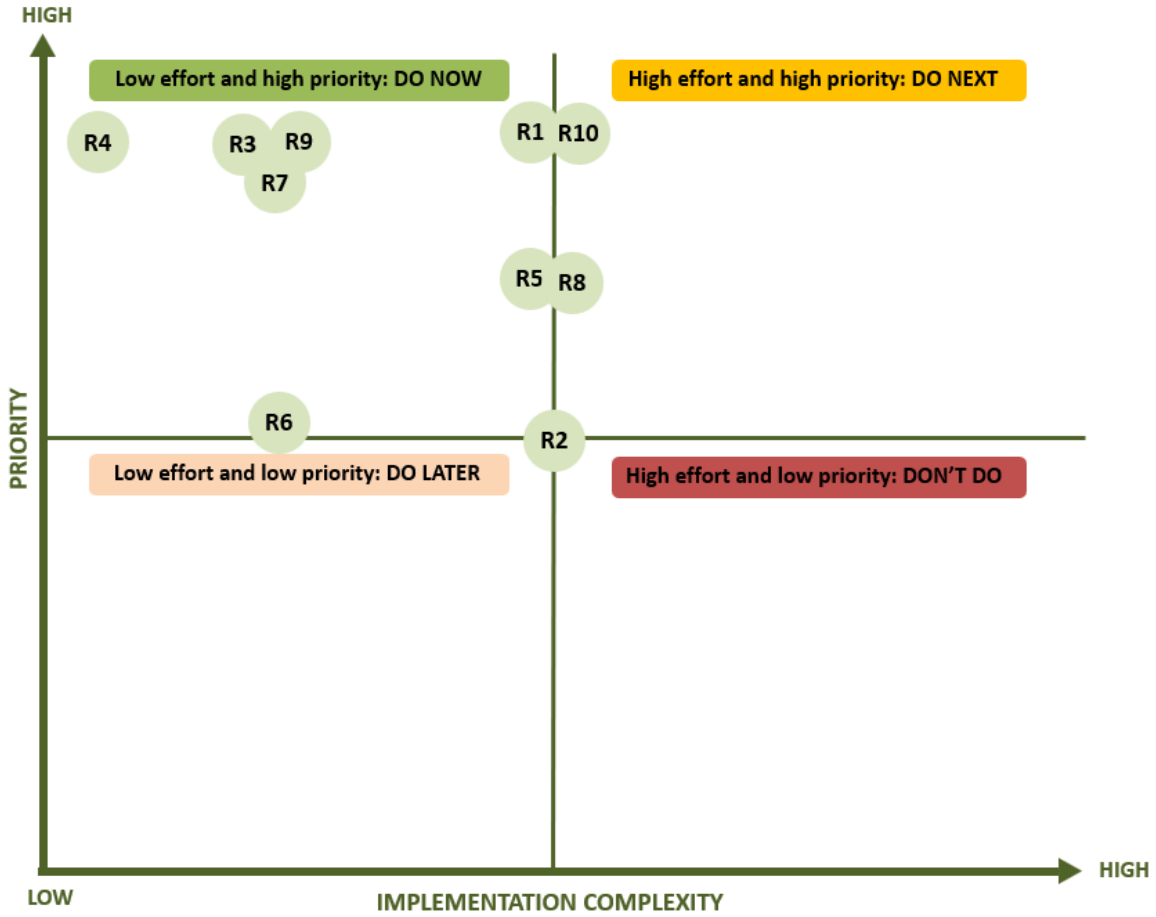

Figure 3 Priority Matrix: Recommendation Implementation in Ebro river basin

The first step involves R4, which emphasizes organizing regular workshops and training sessions for stakeholders. This is crucial for promoting best practices in nutrient use and pollution prevention, setting

a solid foundation for subsequent actions, ensuring that all parties are well-informed and engaged from the outset.

Following closely are R3 which focus on creating multi-stakeholder advisory groups to guide policy development, R7 which aims to increase support for farmers by enhancing access to finance and technical assistance, and R9, which advocates for the adoption of circular economy principles, encouraging manure valorisation and composting while incentivizing farms to implement closed-loop nutrient recycling systems. By forming advisory groups, enhancing farmer support, and promoting circular economy principles, these recommendations lay the groundwork for integrated and holistic nutrient management strategies. This phase ensures that policy and practice are aligned, fostering a collaborative environment that encourages stakeholder participation and innovation.

Next, but still of high priority, are R1 that proposes the establishment of a joint governance body to coordinate nutrient management efforts across Aragon and Catalonia effectively and R10 which underscores the importance of securing long-term financial and institutional support for these initiatives, ensuring their sustainability and success.

Following these R5 suggests introducing financial incentives for farmers to adopt responsible nutrient management techniques, while R8 recommends developing a digital reporting system to streamline compliance tracking and regulatory oversight.

Finally, it is recommended to strengthen enforcement mechanisms through regular inspections and penalties for non-compliance, ensuring adherence to established standards (R6) and to emphasize implementing a common data platform for monitoring nutrient levels and pollution sources, providing a comprehensive understanding of the environmental landscape (R2). Strengthening enforcement mechanisms ensures adherence to standards, while a common data platform facilitates informed decision-making and a deeper understanding of nutrient dynamics across the region.

While the recommendations have been prioritized in a specific sequence, it's important to note that nearly all of them are located in or near the "do now" section of the matrix. This indicates that each recommendation is considered both significant and feasible for immediate implementation.

3. Lessons learnt and path forward: Lielupe river basin

The Lielupe river basin, a vital ecological and economic region shared by Latvia and Lithuania, faces unique challenges in nutrient management. This chapter explores strategic recommendations aimed at enhancing nutrient governance and sustainability within the basin. Given its transboundary nature, the Lielupe river basin is characterized by diverse agricultural practices, industrial activities, and varying regulatory frameworks, all contributing to nutrient loading in the river system. As such, effective management requires a coordinated approach that aligns cross-border efforts and integrates stakeholder perspectives.

3.1. Context

To recap analysis of Lithuanian governance model for nutrient management developed within D2.4, in Lithuania, the primary challenge lies in balancing agricultural productivity with environmental sustainability. Intensive fertilizer use and manure management threaten water quality, requiring strict regulation enforcement. Small and medium-sized farms face particular hurdles due to limited resources, complicating the adoption of best practices. Fragmented governmental coordination further hinders effective policy implementation. However, opportunities exist to improve governance. Digital technologies in monitoring and precision agriculture can boost efficiency and reduce environmental impacts. Collaborations between research institutions and farms could lead to innovative nutrient recycling solutions. Increasing financial support and enhancing extension services are vital for promoting sustainable farming. Engaging stakeholders and sharing knowledge can create a more inclusive governance model, ensuring long-term protection of water resources. Additionally, recycling wastewater sludge through composting could significantly benefit both the environment and agriculture.

Latvia's efforts to implement effective nutrient management policies face challenges stemming from regulatory complexity, requiring continuous alignment with EU directives. Significant financial investment is needed to upgrade and maintain wastewater treatment infrastructure. Small farms, a substantial portion of the agricultural sector, struggle to comply due to limited resources. However, opportunities for improvement exist. Knowledge transfer programs, led by organizations such as the Latvian Rural Advisory and Training Centre, can promote sustainable agriculture. Biogas production, supported by the Latvian Biogas Association, offers a circular economy approach, utilizing agricultural and wastewater by-products for energy. Furthermore, EU funding provides financial support for sustainable agriculture and wastewater management. Fostering cooperation between government, private stakeholders, and research institutions is key to leveraging these opportunities.

To address the identified challenges and leverage existing opportunities, the recommendations have been developed to guide the implementation of new governance models in Latvia and Lithuania. These are complimented by some recommendations for region in general. They include:

- Simplification of regulatory compliance in Latvia (R1)
- Upgrading of wastewater treatment infrastructure in Latvia (R2)
- Expansion of the role of institutions in Latvia, such as the Latvian Rural Advisory and Training Centre (R3)
- Promotion of circular economy initiatives in Latvia, including sewage sludge composting and sustainable manure management (R4)
- Establishment of a more cohesive coordination framework among national ministries, municipal governments, and private sector stakeholders in Lithuania (R5)
- Integration of digital monitoring tools, such as precision agriculture and remote sensing technologies, in Lithuania (R6)
- Provision of enhanced financial and technical support for small and medium-sized farms in Lithuania (R7)
- Closer collaboration between research institutions in Lithuania (R8)
- Establishment of a transboundary coordination platform in Lielupe river basin (Latvia and Lithuania) (R9)
- Introduce a basin-wide monitoring system, supported by a shared data platform in Lielupe river basin (Latvia and Lithuania) (R10)
- Initiation of collaborative research endeavours between academic institutions in Latvia and Lithuania (R11)
- Strengthening of stakeholder engagement in Latvia and Lithuania through the incorporation of local communities, farmers, and environmental organisations in decision-making processes (R12)

The set of recommendations aims to create a more effective and sustainable system for nutrient management in the region. The recommendation evaluation is described in the next sub-sections (3.2.–3.7.), separately analysing the recommendations for Latvia (R1, R2, R3 and R4), Lithuania (R5, R6, R7 and R8) and the whole Lielupe river basin – Latvia and Lithuania (R9, R10, R11 and R12).

3.2. Evaluation of recommendations for Latvia

3.2.1. Simplification of regulatory compliance in Latvia (R1)

Simplifying regulatory compliance for nutrient management in Latvia is a very high priority. Cabinet Regulation No. 362, governing sewage sludge composting and use, presents challenges for farmers due to overly burdensome requirements for soil analysis before using composted sewage sludge as fertilizer. Proposed legislative changes aim to address this, along with clarifying confusing terminology related to chemical compounds. These changes are currently under review.

While initially assessed as having very easy implementation, the reality is proving more complex. While the proposed changes are well-received, the alignment with the outdated Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture presents a substantial hurdle. Until the directive is updated, the feasibility of simplifying soil sampling remains uncertain.

Potential obstacles extend beyond the EU directive. Stakeholders might oppose the proposed changes during the legislative update process. There may also be a lack of clarity on how to translate the changes into concrete action, given the outdated nature of the EU directive. A lack of sufficient funding for public awareness campaigns could also hamper implementation.

To overcome these obstacles, proactive engagement with all stakeholders is necessary. This includes actively participating in public consultations, anticipating and addressing potential counterarguments, and securing broad-based support for the proposed changes. A clear communication strategy explaining the rationale and benefits of simplification will be essential. Collaborating with the Ministry of Agriculture and relevant farmer NGOs is crucial to ensure the farmers' interests are fully represented.

The key stakeholders—farmer NGOs and the Ministry of Agriculture—must actively lobby for these changes, monitoring the public consultation process and advocating for the farmers' interests. Despite the initial optimism, the re-evaluation suggests that implementation is significantly more difficult than initially anticipated due to the limitations imposed by the Directive.

While the need for simplification is clear and the proposed changes are well-received, the outdated directive introduces substantial uncertainty and complexity. Success will depend on navigating both national and EU-level legislative processes.

3.2.2. Upgrading of wastewater treatment infrastructure in Latvia (R2)

Upgrading wastewater treatment infrastructure in Latvia is a high priority, as it will provide possibilities to prepare high-quality fertilizer for farmers on a national scale. The plan is to centralize composting, but this requires municipalities to agree to collaborate and apply for funding, creating a medium

implementation complexity. While funding mechanisms exist (two EU programs for dewatering sludge and creating composting centres), agreements between municipalities are needed before WWTPs can apply for funding. This is outlined in the Sewage Sludge Management Plan (2024-2027). While composting centres have been identified, securing funding for process improvements and securing agreements between municipalities remain key challenges.

Potential obstacles include the need for inter-municipal agreements to access funding, short implementation deadlines imposed by EU funding periods, and uncertainty of WWTPs regarding farmer demand for composted sludge. The Ministry of Climate and Energy, responsible for the centralization plan, is a key stakeholder. Other potential challenges include shifting national priorities that might overshadow this initiative, and unforeseen external political circumstances. Further, securing farmer commitment is crucial; without a clear demonstration of demand, WWTPs may be hesitant to invest in upgrading their facilities.

To overcome these obstacles, several steps are crucial: First, facilitating agreements between municipalities is paramount. This requires proactive communication and negotiation, potentially leveraging the resources and cooperation framework established by CoM. Second, advocating for extensions to EU funding deadlines will be necessary, as the current timelines may prove too restrictive. Third, a concerted effort to demonstrate strong farmer interest in utilizing the composted sludge is essential. This could involve surveys, market analyses, and targeted communication campaigns. Farmer NGOs should play a leading role in these efforts.

Key stakeholders include the Ministry of Climate and Energy, municipalities, WWTPs, and farmer NGOs. The Ministry of Climate and Energy, having already developed the centralization plan, is well-positioned to facilitate inter-municipal agreements. Farmer NGOs are crucial for demonstrating farmer demand.

While the vision for centralized composting is established, the practical implementation faces significant hurdles. The success hinges on securing inter-municipal cooperation, managing tight deadlines, and demonstrating clear farmer demand.

3.2.3. Expansion of the role of institutions in Latvia, such as the Latvian Rural Advisory and Training Centre (R3)

The expansion of the role of institutions such as the Latvian Rural Advisory and Training Centre (LRATC) would serve to strengthen knowledge transfer and provide farmers with better access to sustainable practices. LRATC provides organization of consultancy services related to rural development in Latvia This recommendation could be implemented, by adding a topic of using composted sewage sludge as a fertilizer as a priority in LRATC consultancy services.

The expansion of the role of institutions such as the Latvian Rural Advisory and Training Centre (LRATC) is considered a very high priority, particularly in strengthening knowledge transfer and providing farmers with better access to sustainable practices. LRATC's existing role in providing consultancy services related

to rural development positions it well to incorporate topics such as the use of composted sewage sludge as fertilizer into its priority services.

The implementation complexity is rated as relatively easy due to LRATC's established infrastructure, existing relationships with farmers, and proven track record in knowledge dissemination. However, several obstacles need to be addressed for successful implementation.

One of the significant obstacles for implementation could be a potential lack of LRATC capacity. All new services require additional time and effort from staff, specialized training for staff, and resources for developing new educational materials and programs. The existing workforce may already be operating at full capacity with current responsibilities, making it challenging to incorporate new priorities without either reducing attention to other important areas or hiring additional personnel. This capacity constraint could be particularly challenging during peak agricultural seasons when advisory services are in highest demand. Furthermore, developing expertise in sewage sludge composting and its agricultural applications requires substantial investment in staff training, potentially creating temporary gaps in service delivery while advisors acquire new knowledge and skills. The organization would need to carefully balance resource allocation, potentially requiring a phased approach to implementation to maintain service quality across all areas of responsibility.

Political circumstances could potentially present challenges including potentially changing policy priorities, insufficient political support the changes as a large part of the centre's services are subsidised by the state budget and competing priorities in agricultural advisory services. Legal aspects that could potentially hinder implementation involve the need to align new advisory services with potentially changing regulations on sewage sludge use and potential requirements for additional certifications or approvals for advisors.

Social obstacles include potentially low interest among farmers in new advisory priorities or training programmes, which could lead to poor participation rates and ineffective knowledge transfer. There might also be scepticism about sewage sludge use in agriculture, requiring targeted awareness campaigns. Economic aspects primarily concern the possible lack of funding for expanding LRATC's list of priorities, including costs for training advisors, developing materials, and conducting outreach activities.

To overcome these obstacles, several strategies are proposed. To address capacity constraints, LRATC can leverage the extensive knowledge and resources developed within the NENUPHAR project, utilizing them to create standardized training materials and digital resources that would reduce the need for frequent in-person consultations. With NENUPHAR partners in Latvia ready to provide support through meetings and guidance, LRATC can establish clear timelines for incorporating new services while building on existing research about farmer needs and technical requirements. This collaboration can be strengthened by securing dedicated funding through EU opportunities and exploring new partnerships (e.g. with research institutions and waste treatment facilities), potentially allowing for additional staff positions. The combination of NENUPHAR's established framework and external support mechanisms would significantly reduce the initial burden on LRATC's resources while ensuring high-quality service delivery.

Also, using the said resources, comprehensive training programs could be developed for LRATC advisors. To overcome potential lack of interest in the services, awareness campaigns highlighting the benefits of sewage sludge compost should be created and carried out.

The key stakeholders, including LRATC, Farmers, Farmer NGOs (e.g. ZSA), wastewater treatment NGOs (e.g. Latvian Water and Wastewater Works Association (LUKA)), research institutions (like Latvia University of Life Sciences and Technologies (LBTU)) generally possess both the capacity and potential willingness to implement these changes, particularly LRATC and ZSA, given their established role in agricultural advisory services. However, success will depend on securing adequate resources and maintaining strong farmer engagement.

Next steps include:

1. Involving LRATC in stakeholder meetings within CoM/NENUPHAR (ZSA should make sure LRATC is included and motivate them to participate)
2. Developing detailed training programs and materials (NENUPHAR partners should provide NENUPHAR results to LRATC to proceed with the step)
3. Establishing partnerships with waste treatment facilities (LUKA should provide LRATC with support within CoM)
4. Creating monitoring and evaluation frameworks (LRATC should develop systematic approach to track the progress and effectiveness of its expanded services, including setting measurable indicators (e.g. number of farmers reached through advisory services, farmer satisfaction with advisory services, adoption rates of recommended practices, quantity of sewage sludge compost utilized; these could be counted and tracked by using client surveys).

Additional challenges include maintaining consistent quality of advisory services across regions, ensuring long-term sustainability of the expanded services, and measuring the impact of knowledge transfer on actual farming practices.

Overall, the expansion of LRATC's role presents a significant opportunity to bridge the gap between sewage sludge compost producers and potential users. While implementation appears relatively straightforward due to LRATC's established reputation and existing infrastructure, success will largely depend on addressing capacity constraints and securing sustainable funding. The availability of NENUPHAR project resources and partner support offers a strong foundation, but careful attention must be paid to balancing new priorities with existing services. A phased approach, leveraging digital resources and standardized materials, could help manage the transition while maintaining service quality. Most importantly, maintaining clear communication with farmers and demonstrating tangible benefits will be crucial for building trust and ensuring long-term adoption of sustainable practices.

3.2.4. Promotion of circular economy initiatives, including sewage sludge composting in Latvia (R4)

The promotion of circular economy initiatives, particularly sewage sludge composting in Latvia, is rated as a very high priority. This urgency stems from two key factors: farmers' increasing need for high-quality organic fertilizers to maintain soil health and productivity, and the current challenges in sewage sludge utilization, where a significant portion is managed through unaccounted or poorly documented methods. Additionally, proper composting could transform a waste management challenge into a valuable agricultural resource.

Implementation complexity is initially assessed as relatively easy in terms of information dissemination but challenging when it comes to influencing stakeholder behaviour and securing long-term engagement. While sharing knowledge about circular economy practices is straightforward, achieving actual adoption requires overcoming various obstacles.

Potential obstacles include resistance to change from traditional practices, lack of comprehensive understanding about composting benefits, and coordination challenges between waste producers and potential users. Political circumstances might include competing priorities in environmental and agricultural policies, and potential resistance from traditional fertilizer industry stakeholders. Legal aspects involve complex regulations around waste management and agricultural use of processed sewage sludge, as well as compliance with EU directives.

Social obstacles extend beyond economic concerns, including public perception issues around sewage sludge use, potential scepticism about new practices, and the need for cultural shifts toward circular economy thinking. Economic barriers are significant, including lack of sustainable financing mechanisms, the need for financial incentives to drive adoption, and the reliance on project-based funding rather than permanent support structures.

To overcome these obstacles, several strategies are proposed:

1. Developing clear demonstration projects showing economic and environmental benefits
2. Creating financial incentive programs for early adopters
3. Establishing knowledge-sharing networks between successful implementers and potential adopters
4. Building public awareness about the safety and benefits of properly processed sewage sludge
5. Securing long-term funding mechanisms beyond project-based support

The implementation plan should begin with:

1. Creating a comprehensive promotion strategy within NENUPHAR
2. Identifying and engaging key stakeholders in both waste management and agricultural sectors

3. Developing targeted communication materials for different audience segments
4. Establishing monitoring mechanisms to track adoption and impact
5. Creating platforms for knowledge sharing and best practice exchange

After re-evaluation, while initial steps are relatively straightforward, achieving lasting change requires sustained effort and resources. Success depends on building trust, demonstrating clear benefits, and ensuring long-term support mechanisms.

The implementation could be made sustainable by:

- Institutionalizing circular economy practices within existing agricultural support systems
- Developing self-sustaining business models for composting operations
- Creating permanent platforms for stakeholder engagement and knowledge sharing
- Establishing clear metrics for success and impact measurement

In conclusion, while promoting circular economy initiatives presents significant challenges, the pressing need for sustainable nutrient management solutions makes this a crucial priority. Success will require a balanced approach combining practical demonstrations, financial incentives, and sustained stakeholder engagement.

3.3. Priorities for Latvia

In analysing the recommendations set for Latvian part of Lielupe river basin through the lens of priority and implementation complexity, each has been strategically positioned within the prioritization matrix (Figure 4). This analysis has identified a strategic order for action, starting with those initiatives that are both highly impactful and relatively easy to implement.

Interestingly, all four recommendations for Latvia were evaluated by Latvian NENUPHAR team as being very high priority. The implementation complexity was evaluated differently and was the deciding factor that influenced the positioning within the priority matrix.

Firstly, as immediate actions – are placed two recommendations with the same ratings: R3 – Expansion of the role of institutions in Latvia, such as the Latvian Rural Advisory and Training Centre and R4 – Promotion of circular economy initiatives in Latvia, including sewage sludge composting. Both R3 and R4 are classified under "Do Now" due to their high priority and ease of execution.

A subsequent action is R2 – Upgrading of wastewater treatment infrastructure in Latvia. This is rated with medium implementation complexity, suggesting it should follow the immediate actions.

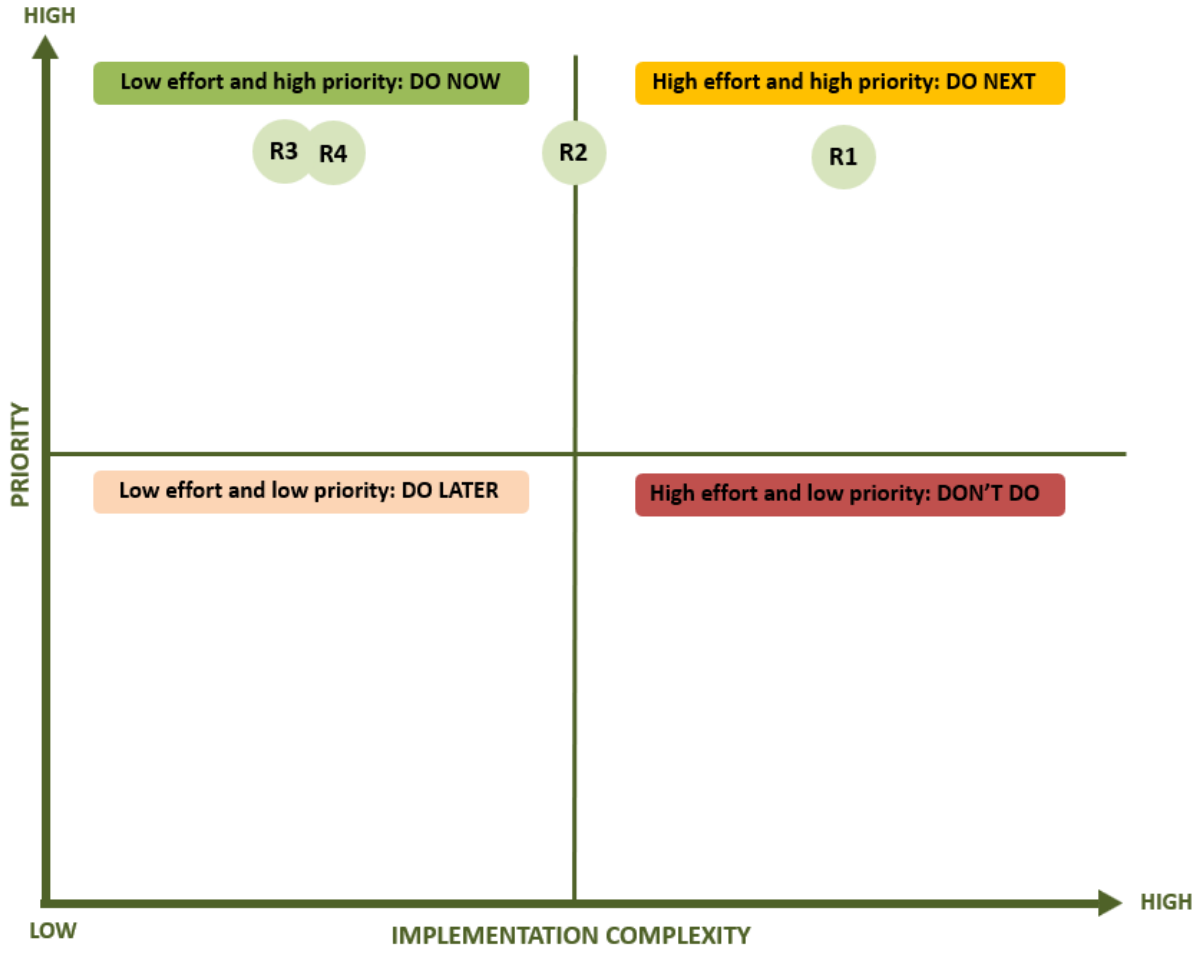

Figure 4 Priority Matrix: Recommendation Implementation in Latvia, Lielupe river basin

Finally, R1 - Simplification of regulatory compliance in Latvia is on the list as “to do next”, because it is rated as having higher implementation complexity. Initially considered relatively easy, further analysis revealed higher complexity due to aspects like potential changes in EU Directive. This places R1 in the "To Do Next" category.

The prioritization matrix serves as a vital tool in directing resources and efforts precisely where they are most needed. By efficiently implementing these recommendations in the right order, Lielupe river basin region in Latvia stands to significantly enhance both its environmental sustainability and the efficacy of its institutions related to nutrient management. To ensure continued relevance and effectiveness, it's essential to conduct regular evaluations, allowing for a reassessment of priorities as circumstances shift and evolve.

3.4. Evaluation of recommendations for Lithuania

3.4.1. Establishment of a more cohesive coordination framework among national ministries, municipal governments, and private sector stakeholders in Lithuania (R5)

The establishment of a more cohesive coordination framework among national ministries, municipal governments, and private sector stakeholders in Lithuania is rated as a high priority. However, implementation is initially considered challenging due to several complex factors affecting institutional cooperation and stakeholder engagement.

Key obstacles include overlapping responsibilities and unclear mandates between ministries and municipalities, potential resistance to change, lack of trust between public and private stakeholders, and the absence of formal platforms for engagement. Lithuania's relatively centralized administrative system can create tensions when shifting coordination responsibilities to local governments. Municipalities may resist increased oversight from national ministries, citing local governance rights, while EU requirements add another layer of complexity.

Legal challenges include the absence of formal provisions for structured coordination, inflexible procedures limiting innovation, and restrictions on data sharing, particularly with private sector actors. Social aspects present additional hurdles, such as weak citizen engagement mechanisms, capacity gaps in smaller municipalities, and inefficient communication between government levels. Economic obstacles encompass budget constraints, regional disparities, and heavy reliance on EU funding cycles.

To overcome these challenges, several strategies are proposed. Politically, fostering high-level commitment and establishing cross-party agreements can ensure policy continuity. Legal reforms should clarify roles and responsibilities while supporting data sharing. Social obstacles can be addressed through transparent decision-making and inclusive participation, while economic challenges require securing dedicated funding and demonstrating coordination benefits through pilot projects.

Key stakeholders include the Ministries of Agriculture and Environment, the Association of Local Authorities in Lithuania, municipal administrations, the Lithuanian Farmers Union, the Lithuanian Business Confederation, and academic institutions. While these organizations possess the necessary capacity, resource limitations and resistance to changing established routines may slow progress.

Actions to start with are detailed in Table 1.

Table 1. Action plan for first recommendation in Lithuania (VMU)

Establishment of a more cohesive coordination framework			
Action	**Responsible stakeholder**	**Participating stakeholders**	**Notes**
Analyse current laws, mandates, and coordination practices to spot gaps or barriers.	Parliament, Government	Ministries/Private sector/ Farmers and Business unions	
Identify specific regions for trial coordination activities.	Local authorities	Academia, NGOs, farmers union	The initiative needs to come from public sector, sending an official invite to demonstrate the interest
Bring stakeholders together to share the vision, discuss challenges, and agree on next steps.	Ministries of Agriculture and the Environment, Farmers union, NGO's, Local authorities.	All relevant stakeholders	
Identify budget sources (national/EU) and allocate staff.	Government/Local authorities	Academia, NGOs, farmers union	

Implementation should follow a structured approach, beginning with stakeholder identification and analysis of existing laws and mandates. This should be followed by defining roles and responsibilities, securing funding, launching pilot initiatives, providing training, and developing progress indicators. Regular public communication is essential to maintain trust and engagement.

After analysis, the recommendation is re-evaluated as considerably easier to implement than initially thought, due to the clear path forward identified.

3.4.2. Integration of digital monitoring tools, such as precision agriculture and remote sensing technologies in Lithuania (R6)

The proposed integration of digital monitoring tools, such as precision agriculture and remote sensing technologies, into Lithuania's agricultural framework represents a promising venture with substantial potential to enhance productivity and environmental management. While this initiative holds a medium

priority, its benefits align well with national and EU agricultural policies, aiming to optimize resource use and increase yield predictability.

However, the medium complexity of implementation reflects several challenges. Economic barriers are significant, with possible high initial costs deterring adoption, particularly among smaller farms. These costs make the economic benefits appear uncertain in the short term, further complicating adoption prospects. Additionally, social challenges arise from the limited digital literacy among farmers, especially older generations who may be sceptical of new technologies, compounded by deeply rooted traditional farming practices.

From a legal perspective, data privacy concerns and ambiguous regulations regarding data ownership and usage pose potential obstacles. Politically, while Lithuania's agenda includes digital transformation, this priority must compete with other pressing national interests, highlighting the need for alignment between national agricultural policies and EU funding mechanisms. Coordination among national ministries and regional authorities is crucial for the successful delivery of programs (as discussed in analysis of the previous recommendation for Lielupe river basin in Lithuania in sub-chapter 3.4.1.). The technical landscape is also challenging, with inadequate digital infrastructure in rural areas and a lack of technical support services impeding widespread adoption.

To overcome these barriers, a comprehensive strategy is required. Financial incentives, such as subsidies, could significantly reduce the cost burden for farmers, making technology more accessible. Capacity-building programs aimed at enhancing digital literacy and confidence are essential for fostering adoption. Moreover, improving rural digital infrastructure and fostering public-private partnerships can facilitate the integration of these technologies. Engaging stakeholders through mapping and dialogue to align resources and interests is a critical initial step. The Lielupe river basin CoM, which has already laid a solid foundation for cooperation between different types of institutions in the region, can serve as a good basis to start implementing the Recommendation. Various pilot projects can serve as demonstration platforms to illustrate benefits and refine implementation strategies. Developing sustainable funding models that leverage EU agricultural and rural development funds is also vital.

Nevertheless, risks persist. Low adoption rates may limit the initiative's impact, and there is a danger of exacerbating the digital divide, with larger farms reaping more benefits than smaller ones, thereby increasing inequality. Also, possible dependence on a limited number of technology providers could lead to monopolistic practices and elevated costs. Interestingly, after re-evaluating the implementation complexity of this recommendation post-analysis, it is rated as slightly easier to implement than beforehand, placing it on the “easy” mark on the complexity scale.

In conclusion, the integration of digital monitoring tools in Lithuania's agricultural sector, while challenging, offers a transformative opportunity to enhance efficiency and sustainability. Addressing economic, social, and technical barriers through strategic planning, collaboration, and innovation is crucial for success. By fostering an environment conducive to technological adoption, Lithuania can significantly advance its agricultural productivity and sustainability.

3.4.3. Provision of enhanced financial and technical support for small- and medium-sized farms in Lithuania (R7)

Providing enhanced financial and technical support to small and medium-sized farms in Lithuania is rated as a high-priority initiative, aimed at bolstering the competitiveness and sustainability of these crucial agricultural sectors. This recommendation arises from the need to address disparities in resources and capabilities compared to larger farms, ensuring equitable growth within the agricultural landscape.

Initially rated with medium implementation complexity, this recommendation recognizes several inherent challenges. Chief among these are budgetary constraints, which limit the scope and scale of support available. The bureaucratic complexity involved in accessing funds further complicates the process, often deterring farmers who are unfamiliar with new support mechanisms. In remote areas, outreach is limited, and tailored technical assistance is often lacking, leaving many farmers without the necessary guidance to effectively utilize available resources.

Political circumstances play a significant role in this context. While there is government commitment to rural development and alignment with EU CAP funding, potential political changes could disrupt program continuity. Effective coordination between the Ministry of Agriculture, Ministry of Finance, and Regional Development Agencies is crucial to ensure seamless program execution.

Legally, the success of this initiative hinges on establishing clear eligibility criteria and transparent application procedures, aligning with EU funding and audit rules. From a social perspective, building trust among small farmers through community engagement is essential, as is addressing digital literacy to facilitate effective participation in support programs. Economically, ensuring that financial aid is both sufficient and timely is vital to addressing regional disparities in farm sizes and productivity.

To overcome these obstacles, several strategies are proposed. Simplifying application and reporting procedures can reduce bureaucratic barriers, while targeted communication campaigns can increase awareness and engagement. Investing in training for advisors and farmers will enhance the technical support available. Utilizing digital platforms can expand reach, although providing offline support remains necessary to accommodate all farmers.

Key organizations, including the Ministry of Agriculture, Ministry of Finance, local municipal governments, agricultural advisory services, and various financial institutions, are well-positioned to spearhead these efforts. While resistance is expected, particularly due to farmers' scepticism and digital literacy barriers, such resistance can be mitigated through transparent communication and inclusive consultations. Simplifying processes and providing hands-on support are crucial steps, as is ensuring fair and equitable access to resources.

The next steps involve engaging stakeholders for input and partnership building, designing enhanced financial and technical support packages, and securing funding from both EU and national budgets. Piloting these initiatives in selected regions or sectors will provide valuable insights, allowing for adjustments based on feedback.

Re-evaluation of the implementation complexity, after thorough analysis, suggests that with the right strategies in place, the initiative could be easier to implement than initially assessed. However, risks such as insufficient funding, low uptake by farmers, and poor coordination must be addressed. The potential benefits of increased farm productivity, sector modernization, and improved competitiveness make this endeavour crucial for the long-term sustainability of Lithuania's agricultural sector.

To ensure sustainability, a long-term funding commitment is necessary, alongside capacity building and knowledge transfer. Encouraging private sector participation can further enhance the program's impact, ensuring resilience to climate change and market fluctuations.

3.4.4. Closer collaboration between research institutions in Lithuania (R8)

Fostering closer collaboration between research institutions in Lithuania is identified as a high-priority initiative, critical for elevating the quality and impact of scientific research. This collaboration is essential for tackling complex national challenges, accessing broader EU and international funding, boosting innovation and competitiveness, and enhancing Lithuania's global scientific profile.

Despite being rated as relatively easy to implement, several obstacles could hinder progress. Institutional competition over funding and recognition is a significant barrier, as it discourages collaborative efforts. Furthermore, there is a lack of incentives for producing shared outputs, leading to uneven capacity and resources among institutions. Politically, effective government leadership is necessary to encourage collaboration, but intellectual property rights, data sharing complexities, and funding regulations can create friction. University autonomy can also pose challenges to coordination without sufficient external incentives.

Socially, a lack of trust between institutions and differing research cultures or communication styles may complicate collaboration efforts. Economically, the competition for limited national and EU funding, along with an unequal distribution of research infrastructure, presents substantial challenges.

To overcome these obstacles, creating effective incentives for collaboration is paramount. Harmonizing administrative procedures will streamline processes, while building shared research infrastructure and promoting researcher mobility and exchange are critical steps. The Ministry of Education, Science and Sport, Lithuanian Research Council, universities, research institutes, innovation agencies like MITA, and EU funding bodies such as Horizon Europe are key players in driving these efforts.

Resistance is expected from stakeholders, primarily due to institutional rivalry, concerns over unequal benefits, administrative burdens, and the absence of immediate payoffs. However, these challenges can be mitigated through several measures. Establishing incentives for joint projects, such as co-funding and performance bonuses, and organizing networking events and thematic workshops could be essential. Developing shared infrastructure, including labs and data platforms, is crucial, as is encouraging joint PhD programs and more intensive researcher exchanges. Setting up inter-institutional advisory or governance boards can also help, along with promoting success stories to build trust and momentum.

The potential benefits of closer collaboration are substantial. It promises higher quality and more impactful research, greater access to EU and international funding, shared resources that reduce costs, improved talent development, and boosted global visibility. Additionally, it facilitates the creation of policy-relevant knowledge essential for addressing national challenges.

In conclusion, promoting closer collaboration between research institutions in Lithuania is both feasible and necessary for building a resilient, coordinated research system. By addressing identified obstacles and leveraging existing opportunities, Lithuania can strengthen its scientific standing on the global stage and ensure its research system is robust and forward-looking.

3.5. Priorities for Lithuania

By evaluating the recommendations set for Lithuanian part of Lielupe river basin through the lens of priority and implementation complexity, each has been strategically positioned within the prioritization matrix (Figure 5).

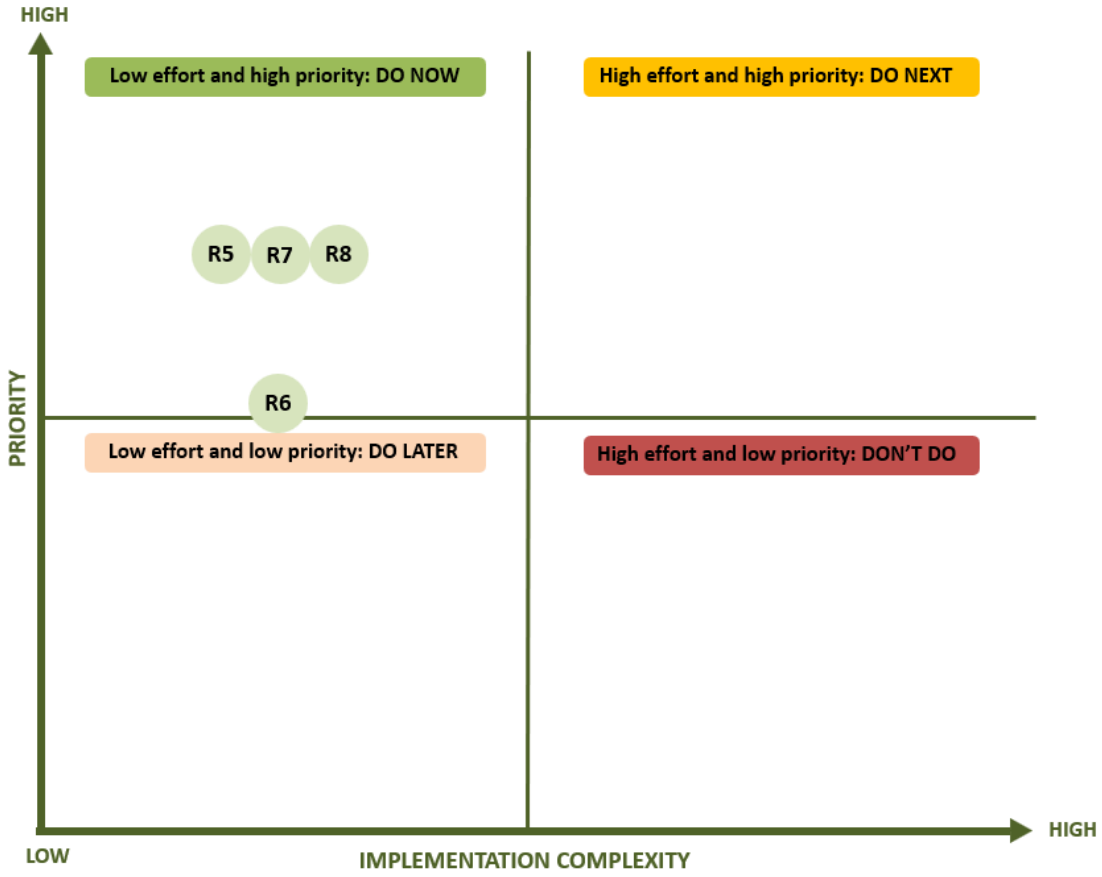

Figure 5 Priority Matrix: Recommendation Implementation in Lithuania, Lielupe river basin

It outlines a prioritized path forward, initiating with actions that are both significantly impactful and straightforward to carry out. The analysis of the four recommendations for the Lithuanian part of the Lielupe river basin highlights a strategic path forward, characterized by relatively low implementation complexity across all recommendations, making them easier to execute. Three of these recommendations—establishing a cohesive coordination framework among national ministries, municipal governments, and private sector stakeholders (R5), providing enhanced financial and technical support for small and medium-sized farms (R7), and fostering closer collaboration between research institutions (R8)—are identified as high priorities. Their placement in the same quadrant of the prioritization matrix underscores their strategic importance and readiness for immediate action.

Implementing these recommendations first will lay a solid foundation for sustainable development in the region. The establishment of a cohesive coordination framework (R5) is pivotal, as it will facilitate more efficient and synchronized efforts across various sectors, enhancing policy coherence and resource allocation. Enhanced support for small and medium-sized farms (R7) is crucial for ensuring equitable growth, addressing disparities, and boosting the agricultural sector's competitiveness. Closer collaboration between research institutions (R8) promises to elevate the quality and impact of scientific research, driving innovation and improving the region's global scientific standing.

Following these, the integration of digital monitoring tools, such as precision agriculture and remote sensing technologies (R6), should be addressed. Although rated as a medium priority, these technologies hold considerable promise for optimizing resource use and improving yield predictability, aligning with broader national and EU agricultural strategies.

By implementing these actions in the right order, Lithuanian stakeholders can effectively harness the existing resources to foster sustainable development and innovation, addressing both immediate needs and laying the groundwork for future advancements in nutrient management. This strategic approach not only leverages existing strengths but also positions the region to respond dynamically to evolving challenges and opportunities.

3.6. Evaluation of recommendations for Lielupe river basin (Latvia and Lithuania)

The following sub-chapters provide analysis of recommendations that were set in D2.4 for Lielupe river basin as a whole and includes actions for both countries – Latvia and Lithuania and proposes collaboration from stakeholders on both sides of the national border.

3.6.1. Establishment of a transboundary coordination platform in Lielupe river basin (R9)

The establishment of a transboundary coordination platform for the Lielupe river basin is a very high-priority recommendation, critical for managing shared river resources effectively. The Lielupe river's transboundary nature necessitates a coordinated approach, as Latvian stakeholders often lack detailed insights into pollution sources from the Lithuanian side of the river. Additionally, Lithuania's fertile agricultural lands within the basin lead to divergent national interests, complicating unified management efforts. The Water Framework Directive is designed to address water management at the river basin level, yet such platform doesn't exist yet and the solutions can't be operatively implemented.

The recommendation is rated as very hard to implement. The implementation of a transboundary coordination platform is exceedingly challenging due to the unclear pathways for establishing a functioning body. While both countries are linked through EU policies and bilateral agreements, the mechanisms for creating and operating such a body effectively are not clearly defined. This ambiguity poses significant challenges in terms of governance, legal authority, and operational coordination. There is a lack of clear strategies of implementation, despite longstanding recognition of the need. While the platform could serve as a consultative management body, without legal authority, its success heavily depends on political will and enthusiasm. Current disparities in interest levels between Latvia and Lithuania further challenge the initiative's feasibility.

Several other obstacles impede implementation. Motivation among stakeholders can be lacking, and without decision-making power, the platform risks becoming merely a discussion forum. Financial backing remains uncertain, adding to the complexity. Politically, a lack of prioritization and limited regional and local coordination capacity are significant barriers. Legally, regulatory incompatibilities and data privacy issues impede cross-border cooperation. Socially, low local participation or awareness can reduce the platform's perceived relevance. Economically, funding gaps and over-reliance on EU funds without national co-financing threaten sustainability.

The platform should focus on water and nutrient management issues. To overcome the challenges, addressing them at the ministerial level is crucial. Political context plays a pivotal role, necessitating high-level bilateral meetings, development of a joint governance framework, and creation of an inter-ministerial working group. Applying for EU-funded technical support can provide necessary resources. Key players include Lithuania's Ministries of Environment, Agriculture, and Interior Affairs, and Latvia's Ministry of Climate and Energy, Ministry of Agriculture, and Latvian Environment, Geology and Meteorology Centre (LEGMC), with EU programs offering additional support.

To effectively establish a transboundary coordination platform between Latvia and Lithuania for the Lielupe river basin, a multifaceted approach is essential. This includes drafting a bilateral agreement that clearly defines governance structures and responsibilities, leveraging EU frameworks and programs like Interreg for support, and developing joint governance models with equitable representation from both countries. Initiating pilot projects can help refine coordination mechanisms, while robust stakeholder

engagement ensures diverse perspectives are integrated into the decision-making process. Furthermore, adopting transparent data-sharing agreements will address regulatory differences and enhance trust. By implementing these strategies, the platform can effectively manage shared resources and address common challenges (Figure 6).

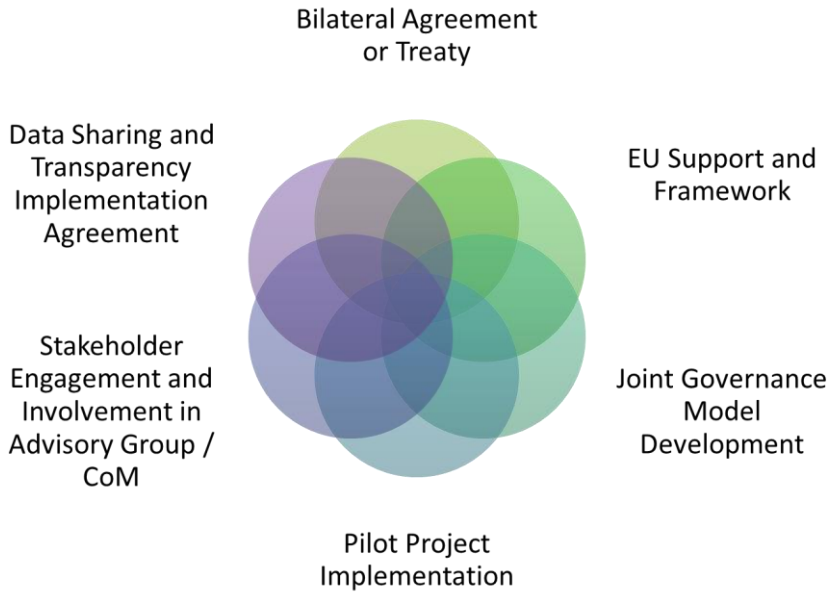

Figure 6 Potential elements of creating a transboundary coordination body for nutrient and water management in Lielupe river basin

Although these entities potentially could feasibly implement the platform, potential resistance could arise due to concerns about governance clarity, the necessity for early stakeholder engagement, and ensuring adequate funding. Next steps should include arranging high-level bilateral meetings to align national interests, framing the platform as a strategic tool aligned with EU priorities, and securing initial funding from Latvian, Lithuanian, and EU sources. Designing the platform's structure and setting up the secretariat are subsequent critical tasks.

Re-evaluating the implementation possibilities, the complexity remains high. Major risks include unequal commitment between Latvia and Lithuania, insufficient long-term funding, and bureaucratic delays. Nonetheless, addressing shared problems through shared solutions can yield significant economic and social benefits, aligning with EU objectives for cohesion, climate, and cooperation, while strengthening bilateral trust and regional security.

3.6.2. Basin-wide monitoring system, supported by a shared data platform (R10)

Establishing a basin-wide monitoring system supported by a shared data platform for the Lielupe river basin is rated as a very high priority due to the fragmented nature of current monitoring efforts and the necessity for coordinated management of this transboundary water resource. Such a system is vital for effectively protecting shared water resources, enhancing environmental and public health, and improving flood and drought management, thereby building trust and cooperation between Latvia and Lithuania.

The implementation is rated with medium complexity, primarily because it requires stable and sufficient funding. While institutions like LEGMC already conduct sampling in shared rivers and existing data can be utilized, challenges lie in the harmonization and sharing of this data between Latvia and Lithuania. The initiative is perceived as more beneficial for Latvia, where flood risks are higher, compared to Lithuania, where interests may not be as aligned. This disparity underscores the need for balanced engagement and benefits to ensure both countries are equally invested in the system's success.

Several other barriers could impede implementation. Institutional and legal challenges arise from differing national regulations and standards on water monitoring and data management, leading to potential incompatibilities. Technical challenges include divergent monitoring methodologies, equipment, and technologies, complicating harmonization efforts. Financial constraints pose a significant barrier, with potentially insufficient sustainable funding for the setup, operation, and maintenance of monitoring stations and IT systems. Additionally, engaging stakeholders and ensuring effective coordination remains a critical challenge.

To address these challenges, bilateral agreements and joint committees should be established to foster cooperation. Joint training sessions and common guidelines can mitigate technical disparities, while blended funding models and long-term budgeting can address financial constraints. Ensuring robust stakeholder engagement and coordination is essential for success. National agencies can lead technical and operational tasks, with ministries providing political backing and policy alignment. Local governments and stakeholders should be involved for field-level support and community engagement, while EU and academic partners can offer funding, expertise, and legitimacy.

Overall feasibility is high, supported by existing frameworks and EU incentives. Resistance may stem from resource concerns, political will, and data governance fears, but these can be managed with clear communication, adequate funding, and inclusive processes. Initial steps should include initiating high-level bilateral dialogues, setting up a joint working group, conducting a feasibility study, and exploring funding opportunities. Subsequently, developing common monitoring protocols, designing the shared data platform, implementing pilot monitoring, and engaging stakeholders should follow. Regular assessments and adjustments will be crucial to ensure the system meets evolving needs and challenges in the region.

Re-evaluating the implementation possibilities now suggests the complexity is between easy and medium. Risks such as institutional changes, financial shortfalls, technical incompatibilities, and stakeholder

disengagement could undermine efforts, yet the importance of this system in protecting shared resources and fostering cooperation cannot be overstated.

The introduction of a basin-wide monitoring system for the Lielupe river basin presents an opportunity to significantly enhance environmental management and cooperation between Latvia and Lithuania. By addressing institutional, technical, and financial challenges through strategic planning and collaboration, the system can serve as a model for transboundary water management. Regular assessments and adaptive management will be key to ensuring the system's relevance and effectiveness in meeting evolving regional needs.

3.6.3. Initiation of collaborative research endeavours between academic institutions of Latvia and Lithuania (R11)

The recommendation to initiate collaborative research endeavours between academic institutions in Latvia and Lithuania is rated as a medium priority. This initiative is considered easy to implement due to existing academic frameworks and potential EU support yet requires strategic alignment and resource allocation to maximize effectiveness.

Though rated as easy to implement, various challenges could impact implementation. Economic aspects are to be taken into account, as universities and research institutions must often provide co-financing for EU funded projects. This requirement can strain budgets and necessitates securing diverse funding sources. There are perceptions that cooperation might not be effective due to competition for students and funding, although this competition is more intrinsic within each country.

Key obstacles include the need for economic resources, differing national procurement laws, and disparities in institutional capacities. While political circumstances seem neutral, legal challenges arise from procurement laws that complicate joint purchasing. Economically, unequal resource allocation and infrastructural disparities can hinder collaboration, while social responsiveness shows no significant hurdles.

To overcome these challenges, diversifying and securing funding sources is crucial. Joint applications for EU grants and establishing bilateral research funds can provide financial backing. Promoting institutional synergies and creating research consortia and centres of excellence across borders would foster collaboration. Simplifying cross-border procedures and standardizing budget planning tools can mitigate legal and administrative barriers. Highlighting the economic benefits and strengthening institutional capacity are key strategies for success.

Key stakeholders, including the Ministries of Education, Science and Sports, the Ministries of Finance, academic institutions, and EU bodies, play vital roles. With the right incentives and frameworks, these entities are both capable and likely to agree to collaborative efforts.

Immediate steps could include launching a pilot joint research project, establishing a bilateral working group, drafting a bilateral agreement, and developing common procurement guidelines. Following these,

evaluating the pilot, formalizing the framework for long-term collaboration, expanding participation, and seeking long-term funding are essential. Building visibility and influence will further strengthen regional competitiveness and drive knowledge and innovation.

Re-evaluating the implementation complexity solidifies the assessment as easy. The importance of this initiative lies in strengthening regional competitiveness, driving knowledge and innovation, reducing duplication, aligning with EU policies, and building long-term collaboration. Making this sustainable will require continued alignment with funding trends and strategic partnerships. This approach not only promises academic benefits but also fosters diplomatic and economic ties between the two countries, paving the way for broader regional integration.

3.6.4. Strengthening of stakeholder engagement in Latvia and Lithuania through the incorporation of local communities, farmers, and environmental organisations in decision-making processes (R12)

The recommendation to augment stakeholder engagement by incorporating local communities, farmers, and environmental organizations in decision-making processes is rated as a medium priority. While not perceived as crucial for cross-border cooperation in Latvia, it holds significant importance at the national level for both countries. However, strengthening stakeholder involvement on river basin level also could prove useful for fostering a common vision and improving cooperation in national policy-making.

The implementation is rated as medium complexity due to existing frameworks like CoM, which have established some possibilities but require further development. The challenge lies in aligning diverse stakeholder interests and ensuring effective participation at both national and regional levels.

Institutional and administrative barriers are prominent, such as the lack of institutional capacity and unclear stakeholder roles. Socially, inter-group trust remains a challenge, particularly between groups like farmers and environmentalists or rural communities and urban planners, who may hold differing values. Economically, the costs associated with engagement can be a hindrance, necessitating dedicated funding over time.

To effectively overcome these obstacles, it's essential to build capacity in local stakeholders and simplify and decentralize decision-making processes. Securing and allocating dedicated funding is crucial to support these efforts. National ministries can provide funding and strategic alignment, while local governments, universities, and NGOs facilitate engagement and offer practical support. EU institutions can lend legitimacy and additional resources to these initiatives.

Most actors, including national ministries, local governments, stakeholder groups, and academic institutions, can lead these efforts. However, resistance is likely unless the process is well-designed, adequately resourced, and politically supported.

Initial steps involve identifying all key stakeholders (already done within NENUPHAR CoM-related tasks), ensuring official support, and providing financial and practical assistance. Subsequently, developing national or regional guidelines for stakeholder engagement, expanding engagement across more regions or sectors, and integrating these processes into formal policy cycles are necessary. Establishing permanent funding mechanisms and strengthening partnerships among governments, universities, NGOs, and communities are crucial to sustaining these efforts. Using success stories to advocate for more ambitious participatory governance at national and EU levels can further enhance these initiatives.

The importance of this recommendation lies in building trust in institutions, balancing economic, environmental, and social needs, fostering community ownership and long-term commitment, and strengthening resilience in rural areas. The risks, such as stakeholder conflict, resource strain, miscommunication, and decision-making delays, should be carefully managed to ensure successful implementation.

3.7. Priorities for Lielupe river basin

By evaluating the recommendations set for the whole Lielupe river basin through the lens of priority and implementation complexity, each has been strategically positioned within the prioritization matrix (Figure 7). As a result, a clear roadmap for execution has emerged, prioritizing actions based on their effectiveness and ease of implementation.

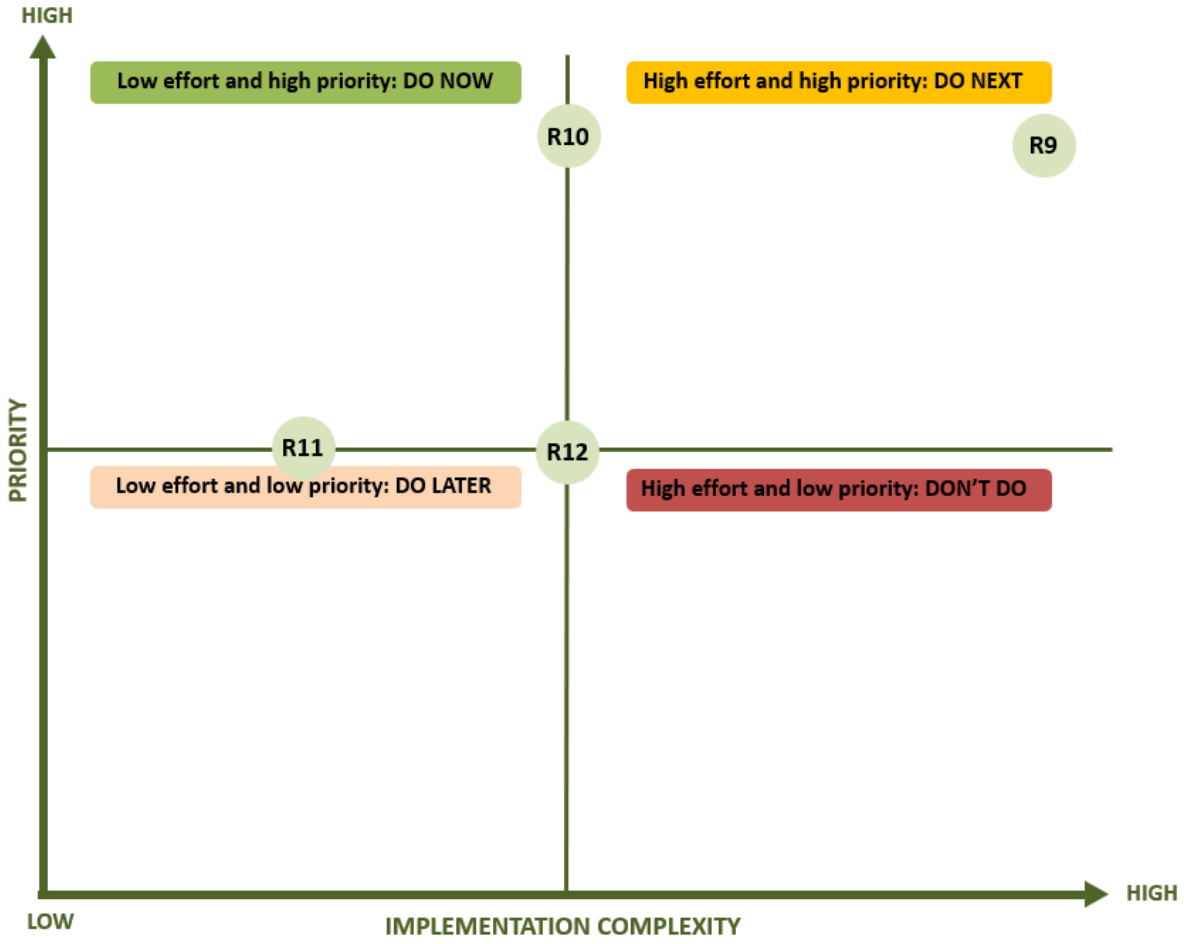

Figure 7 Priority Matrix: Recommendation Implementation in Lielupe river basin

The positioning of the recommendations within the matrix suggests a strategic approach to implementation. Initially, the introduction of a basin-wide monitoring system, supported by a shared data platform in the Lielupe river basin (R10), is categorized as a "do now" action. This is due to its foundational role in enhancing water management and its relatively manageable implementation complexity. Following this, the establishment of a transboundary coordination platform (R9) is placed in the "do next" category. However, given that the coordination platform could significantly facilitate the implementation of the joint monitoring system, there is a compelling case for addressing both initiatives flexibly and possibly concurrently. It's important to note that while the coordination platform, especially at the ministerial level, might pose greater challenges than the monitoring system, both can be effectively addressed within CoM meetings, laying fresh grounds for implementation. Implementing R9 and R10 simultaneously could maximize synergies and expedite progress, leveraging the strengths of both initiatives.

Next, the initiation of collaborative research endeavours between academic institutions in Latvia and Lithuania (R11) should be prioritized. Positioned close to the "do now" category, this initiative can be implemented with relative ease, fostering innovation and strengthening academic ties. Finally, strengthening stakeholder engagement by incorporating local communities, farmers, and environmental organizations in decision-making processes (R12) should be addressed. This initiative is also linked to CoM and can be tackled within its meetings, focusing on overcoming obstacles and enhancing collaboration and engagement post-project.

Addressing these recommendations in sequence, with room for flexibility, ensures a strategic allocation of resources and efforts. Utilizing future CoM meetings as a platform for discussion and coordination can enhance collaboration and stakeholder buy-in. Overall, emphasizing collaborative research and stakeholder engagement will build capacity and foster long-term sustainability and resilience.

4. Lessons learnt and path forward: Danube river basin

The Danube river basin is the second largest in Europe. It supports a significant population and economy that is heavily reliant on agriculture, particularly in Hungary and Slovakia. However, decades of nutrient runoff from agricultural activities, including the dairy industry, necessitate effective waste treatment solutions. This chapter analyses recommendations for nutrient management governance within this transboundary region, considering the unique political and economic contexts of Hungary and Slovakia.

4.1. Context

As analysed in D2.4, Slovakia faces a key challenge in balancing agricultural productivity with water quality. Inadequate wastewater treatment, particularly in smaller municipalities, and diffuse pollution from agriculture contribute to high nutrient levels in water bodies. While progress has been made with EU funding, compliance with the Urban Wastewater Treatment Directive (UWWTD) and Nitrates Directive remains a challenge. This necessitates the adoption of Best Available Technologies (BAT), stricter enforcement, and improved stakeholder coordination. Strengthening advisory services and farmer participation in agri-environmental programs is also crucial. The complex governance structure, while comprehensive, can hinder communication and coordination. Improving collaboration between the public sector, academia, private enterprises, and civil society is essential for achieving more sustainable water resource management. Hungary's governance system for nutrient management also faces challenges. Citizen and organizational participation in policy formulation is moderate, with a highly centralized system limiting the influence of local levels and hindering effective horizontal cooperation. The food industry, dominated by SME, struggles with competitiveness, low corporate governance, and limited awareness of nutrient cycling and circular economy principles. The country faces the challenge of balancing agricultural productivity with water resource protection, necessitating stronger enforcement of environmental regulations, broader adoption of BAT, improved stakeholder coordination, and increased financial support for research and advisory services. However, opportunities exist through collaborative governance models that integrate public institutions, academia, industry, and civil society to enhance knowledge sharing, policy effectiveness, and innovation in nutrient management.

Subsequently, the following recommendations were set out in D2.4 for Danube river basin region:

- Establishing a dedicated multi-stakeholder platform in Slovakia where representatives from the public sector, academia, the private sector and civil society can work together (R1)
- Creating a joint database of water and nutrient resources available for different stakeholders in Slovakia (R2)

- Improving policy coherence by aligning agricultural, environmental and economic policies in Slovakia (R3)
- Promote stakeholder engagement through participatory decision-making processes in Slovakia (R4)
- Establishing investments in research and technological innovation to develop cost-effective and environmentally friendly nutrient management solutions in Slovakia (R5)
- Improving monitoring and data-sharing mechanisms to increase transparency and accountability in Slovakia, including establishing a centralised database of nutrient pollution data and management efforts (R6)
- Integrating sustainable nutrient management into business operations in Hungary by increasing companies' knowledge of innovative technologies and develop their management skills and the training of employees (R7)
- Raising awareness on sustainability and nutrient pollution and cooperation between all the stakeholders in Hungary (R8)
- Networking of actors to strengthen professional relationships and for a more efficient flow of information in Hungary (R9)
- Ensuring effectively functioning coordinating bodies in Hungary (R10)
- Using positive incentives instead of or alongside sanctions by the government to prevent nutrient pollution, provide the financial resources needed for the necessary investments in Hungary (R11)
- Creating more constructive relations with public authorities to ensure better access to authorities and a more supportive attitude from their side in Hungary (R12)
- Improving dissemination of scientific results and reference/model systems in Hungary (R13)
- Create public databases based on high-level monitoring and real data in Hungary (R14)
- Introduce technology and business services based on the market needs of agri-food companies provided by advanced service providers in Hungary (R15)
- Ensuring more effective technology and knowledge transfer in Hungary (R16)
- Identifying and demonstrating social innovations for the stakeholders in Hungary (R17)

Addressing the challenges of nutrient management within the Danube river basin requires a coordinated approach that enhances stakeholder collaboration and aligns policies across sectors in both Slovakia and Hungary. Slovakia's focus on creating dedicated platforms and joint databases, alongside policy coherence and technological innovation, sets a robust foundation for sustainable practices. In Hungary, raising corporate awareness, fostering stakeholder cooperation, and deploying positive incentives are essential

strategies. By integrating sustainable practices and reinforcing professional networks, both countries can advance toward a more resilient and environmentally sound future. This collaborative effort promises not only environmental gains but also strengthened economic and social resilience. In the following sub-chapters all five recommendations were analysed for Slovakia (all of the aforementioned), combining two of them thematically and five top priority Hungarian recommendations were picked for deep analysis, placing all of the recommendations in priority matrixes (Figure 8 and Figure 9).

4.2. Evaluation of recommendations for Slovakia

All six recommendations set out in D2.4 were analysed for Slovakia, but first and second recommendations are joined because these are to be implemented together.

4.2.1. Establishing a dedicated multi-stakeholder platform (R1) and creating a joint database of water and nutrient resources available for different stakeholders (R2) in Slovakia

These initiatives are currently of high priority because they aim to build an inclusive governance model that can address nutrient management challenges effectively. Establishing a collaborative platform and a shared database will enable stakeholders to identify barriers, explore opportunities, and develop strategic plans, ultimately enhancing resource management and policy alignment.

Both recommendations are rated as hard to implement due to several factors. The complexity arises from institutional inertia and the need for significant alignment across sectors. Overcoming different levels of involvement and varying interests between institutions further complicates the process.

Obstacles for implementation include various challenges:

1. Cooperation challenges: there is insufficient willingness to cooperate, especially between public and private sectors. Stakeholders often view each other as competitors rather than collaborators
2. Data management issues: Existing databases are managed independently with differing formats, and GDPR constraints limit data sharing
3. Political challenges: Communication between the Ministry of Environment and the Ministry of Agriculture is complicated, impeding collaborative efforts
4. Legal challenges: Regulatory uncertainty, inflexible subsidy schemes, and limited integration into regional planning laws pose significant hurdles
5. Social and economic challenges: Weak public awareness and economic disparities between "small" and "large" players hinder progress

To overcome these challenges, it's crucial to foster a culture of collaboration over competition. Teaching stakeholders cooperation skills and incentivizing participation through pilot permits and fast-track categories can enhance engagement. Recent unofficial information suggests a willingness to harmonize water management databases, which is a promising start.

Regarding stakeholder involvement, the private sector, public sector, and academia are pivotal, with the private sector holding critical datasets. Involvement from a broader spectrum of stakeholders, including NGOs and dairy farmers, is necessary to share and utilize data effectively. Resistance, particularly from the public sector, is expected. The resistance could stem from entrenched bureaucratic practices and a lack of perceived benefit from collaboration.

Next steps for the stakeholder platform creation include:

1. Joint lobbying by academia and the private sector at ministries, led by the Ministry of Economy, with support from the Ministry of Environment and the Ministry of Agriculture
2. Creating a collaborative community accepted by the public sector with participation from academia, NGOs, and dairy farmers

Next steps for the database creation include:

1. Hosting a stakeholder meeting initiated by the Ministry of Environment and the Ministry of Agriculture, involving academia, NGOs, and dairy farmers
2. Compiling a comprehensive list of available databases and datasets
3. Defining criteria for the new database and determine data sharing parameters for various stakeholder groups

After re-evaluation, implementation remains hard due to persistent institutional and bureaucratic challenges. Additional challenges include the lessened interest from government representatives and the potential impacts of future government changes.

Despite widespread recognition of the need for collaboration and data sharing, these initiatives represent long-term efforts with potential setbacks if government priorities shift. To ensure progress, it's vital to sustain forward movement and establish a resilient framework that can adapt to political changes. Sustainability could be achieved by embedding these initiatives within existing institutional frameworks and ensuring continuous stakeholder engagement and support.

4.2.2. Improving policy coherence by aligning agricultural, environmental and economic policies in Slovakia (R3)

This is a key recommendation to ensure a holistic approach to nutrient management and that agricultural subsidies are aligned with environmental objectives. This would involve strengthening inter-ministerial coordination and ensuring that all policies consider nutrient sustainability objectives (D2.4).

Improving policy coherence by aligning agricultural, environmental, and economic policies in Slovakia is of very high priority because aligning these policies is essential for a holistic approach to nutrient management and ensuring that agricultural subsidies support environmental objectives. The urgency is underscored by the increasing environmental pressures and the need for sustainable agricultural practices that also bolster economic growth. However, the implementation is considered hard due to the entrenched nature of sectoral policies and the historical lack of coordination between ministries. Each ministry operates within its own environment, making integrated policy development challenging. Possible frequent leadership changes further complicate continuity and long-term planning.

The obstacles are diverse. Cooperation issues arise as ministries function independently with distinct priorities, and there's limited policy alignment, especially outside election cycles. Legally, existing regulations may set conflicting goals, and there is no legal mandate for cross-ministerial coordination or joint impact assessments. Furthermore, stakeholders may distrust integrated policies, viewing them as bureaucratic or imposed by the EU. Fragmented funding further inhibits cohesive policy execution.

To overcome these obstacles, several strategies are proposed. Establishing cross-sectoral working groups is crucial to foster dialogue and policy integration. Leveraging EU pressure and funding conditionalities can encourage national ministries towards coordination. Proposing harmonization clauses in regional legislation can ensure integrated planning, while using soft law tools like Memoranda of Understanding (MoUs) can foster coordination where binding laws are absent. Additionally, developing integrated communication tools is essential to facilitate policy coherence and bundle funding sources. Enhancing transparency and accountability can build trust and encourage stakeholder engagement.

Key stakeholders include the public sector, particularly ministries of Agriculture, Environment, and Economy. These bodies, while currently limited in capacity, are essential for driving inter-ministerial coordination. Immediate ability is limited due to institutional capacity constraints. While technical staff may show openness to integration, political-level engagement is unlikely without external pressure.

Next steps for implementation include:

1. Setting up a cross-sectoral coordination working group, initiated by regional self-government, which should include representatives from various sectors, focusing on dialogue and trust-building.
2. Developing a joint funding proposal in collaboration with research institutes, NGOs, and farmers' organizations is vital to demonstrate cross-sector integration benefits.
3. Organizing a policy roundtable with national ministries and EU representatives is also crucial to align strategies and objectives.

After analysis, the complexity remains high due to persistent institutional and bureaucratic hurdles. Political inertia and funding fragmentation pose significant challenges. Sustainability can be achieved through institutionalizing cross-sectoral coordination and ensuring continuous support from EU bodies and funding mechanisms. To conclude, achieving policy coherence is a long-term goal that requires

persistent effort and collaboration across sectors. While the path is challenging, the potential benefits in terms of sustainable development and resource management justify the investment.

4.2.3. Promoting stakeholder engagement through participatory decision-making processes (R4)

Promoting stakeholder engagement through participatory decision-making processes is a key aspect of nutrient management, requiring active involvement from farmers, industry, researchers, and environmental organizations. This engagement is crucial for shaping regulatory measures, incentives for sustainable practices, and innovative solutions to nutrient-related challenges.

The priority for this recommendation is high, as it fosters inclusivity and ensures that diverse perspectives are considered in policy development. The urgency is further highlighted by the need to adapt to evolving environmental and economic contexts.

The implementation complexity is rated as medium due to potential obstacles such as stakeholder reluctance to engage in participatory methods, a typical post-socialist phenomenon reflecting actors' lack of confidence in the impact of their participation. Politically, a top-down governance culture and low incentives for inclusion could hinder engagement, while local politics and power imbalances could add further complications. Legally, there is no clear obligation for participation, and enforcement mechanisms are weak, limiting local dialogue. Socially, unwillingness and mistrust of stakeholders, coupled with public apathy, pose significant challenges. Economically, the lack of resources to facilitate participation and opportunity costs for stakeholders, without direct financial incentives, complicate efforts.

Overcoming these obstacles requires constant advocacy among stakeholders and highlighting successful examples of participatory methods. Demonstrating tangible benefits and fostering a culture of collaboration can gradually shift perceptions and enhance engagement. Key stakeholders include civil society and academia, which can play a crucial role due to their expertise and ability to facilitate dialogue. While ministries often cooperate with expert advisors, a broader spectrum of stakeholders is needed to ensure diverse input.

Next steps for implementation involve organizing meetings to showcase best practices and case studies, led by academia and including decision-makers and civil society. Exploring existing guidelines and frameworks for participatory governance can provide additional support. As the implementation complexity is reassessed, it is found to be easier than initially thought, due to the potential for leveraging existing networks and resources effectively.

Challenges persist, such as overcoming entrenched apathy and mistrust, but the implementation can be made sustainable by embedding participatory processes into policy frameworks and ensuring ongoing support and resources. To conclude, fostering a participatory approach in decision-making not only enhances policy outcomes but also builds trust and resilience within the community.

4.2.4. Establishing investments in research and technological innovation to develop cost-effective and environmentally friendly nutrient management solutions in Slovakia (R5)

Establishing investments in research and technological innovation is crucial for developing cost-effective and environmentally friendly nutrient management solutions in Slovakia. This initiative is a very high priority because it addresses the urgent need for sustainable agricultural practices that align with environmental goals. The potential for innovation to drive economic growth and enhance competitiveness further highlights its importance.

The implementation complexity is rated as medium, primarily due to bureaucratic and administrative obstacles that slow down the national research and innovation strategy, RIS3. These obstacles hinder the efficient use of allocated resources, which is compounded by strong industrial lobbying and weaker representation from farmers.

Political circumstances pose challenges, with not enough funds allocated for research and innovation for the Food Competitiveness and Climate Resilience Domain of RIS3. Also, strong lobbying by industrial actors opposing the weak lobbying by farmers poses challenges. Legal barriers include complex public procurement rules and limited support for public-private partnerships. Socially, there is low public awareness of the value of innovation and limited stakeholder engagement in research design, which can stifle progress. Economically, low investment from the private sector in "non-market" innovation and limited access to innovation funds further complicate efforts.

To overcome these obstacles, simplifying public procurement rules for innovation is essential. Involving end-users early in research design can ensure relevance and practicality. Awareness campaigns highlighting real-world benefits can increase public support, while regional innovation funds and co-financing schemes can bolster financial backing. Strengthening partnerships between universities, businesses, and municipalities will foster a collaborative environment conducive to innovation. The private and public sectors play key roles, with collaboration between these stakeholders essential for driving progress.

Stakeholders' ability and willingness to implement the recommendation vary, with the private sector showing more readiness to engage actively. Next steps include identifying regional innovation priorities based on local needs, mapping available funding opportunities and support programs, and establishing a "Living Lab" or regional innovation partnership to pilot innovative solutions in real-world settings. Challenges such as maintaining momentum and ensuring continuous engagement must be addressed.

Opportunities lie in leveraging Slovakia's strategic position in Europe to attract international collaboration and investment. Sustainability can be achieved by embedding innovation initiatives within existing frameworks and ensuring ongoing stakeholder involvement and resource allocation. While establishing investments in research and innovation presents challenges, the long-term benefits of enhanced sustainability and economic growth justify the effort.

4.2.5. Improving monitoring and data-sharing mechanisms in Slovakia (R6)

Improving monitoring and data-sharing mechanisms to increase transparency and accountability in Slovakia is of high priority. Establishing a centralized database of nutrient pollution data and management efforts is crucial for supporting evidence-based policymaking and facilitating more effective enforcement. The initiative's urgency is highlighted by the need for reliable data to guide sustainable environmental practices and enhance policy outcomes. The implementation complexity is medium, partly due to existing experience with technical infrastructure, though challenges remain in aligning data-sharing standards and protocols.

Potential obstacles include coordination difficulties and low interest from higher levels of the public sector, which can hinder progress. Different interpretations of data sensitivity and the long process required to obtain data further complicate efforts, particularly concerning the collective data of specific groups like dairy farmers. Politically, there is a lack of priority on transparency and data integration, coupled with limited coordination between regional and national levels. Legally, unclear or restrictive data-sharing regulations, absence of formal mandates or standards, and lack of frameworks to ensure open access present significant hurdles. Socially, there is low trust in data accuracy or motives behind data collection, and stakeholders may be reluctant to share proprietary or sensitive information. Economically, funding for modern monitoring technologies and data platforms is insufficient, and maintaining and updating databases incurs high costs.

To overcome these obstacles, transparency should be promoted as a political asset. Developing clear data-sharing protocols and agreements, establishing open data policies, and engaging stakeholders early are vital strategies. Providing training and user-friendly tools can facilitate adoption, while cost-sharing models between agencies and stakeholders can address financial constraints. The public sector is a key stakeholder, given its role in policymaking and data management.

Stakeholders are partially able to implement the recommendation, though significant limitations exist regarding technical capacity, additional skills, resources, and IT infrastructure. Next steps include setting up a task force to design data-sharing protocols, conducting a needs assessment to identify infrastructure gaps, developing a pilot project for data integration, and organizing workshops to engage stakeholders and build trust. After reevaluating the implementation complexity, it is considered hard due to persistent coordination and regulatory challenges.

Challenges such as ensuring data accuracy and maintaining stakeholder engagement must be managed carefully. Sustainability can be achieved by embedding data-sharing practices within existing institutional frameworks and securing ongoing funding and support from EU bodies. Despite the challenges in enhancing monitoring and data-sharing mechanisms, the significant advantages of increased transparency and accountability in managing environmental resources make this initiative worthwhile.

4.3. Priorities for Slovakia

By evaluating the recommendations set for Slovakian part of Danube river basin through the lens of priority and implementation complexity, each has been strategically positioned within the prioritization matrix (Figure 8). It outlines a prioritized plan, initiating with actions relatively more impactful and straightforward to carry out.

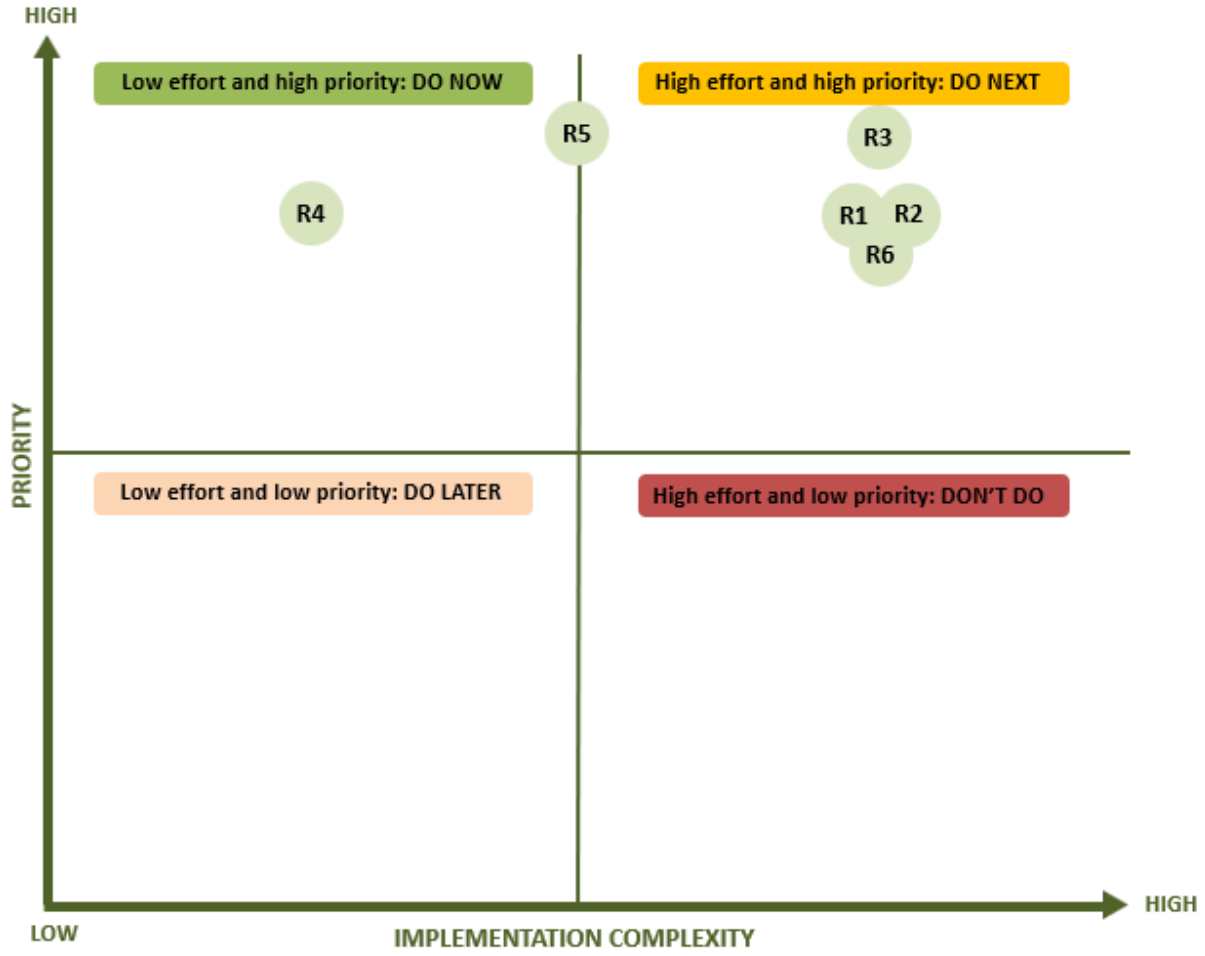

Figure 8 Priority Matrix: Recommendation Implementation in Slovakia, Danube river basin

The strategic implementation of recommendations for Slovakia should begin with R4 - Promoting stakeholder engagement through participatory decision-making processes. This action is prioritized due to its high importance and relatively low complexity, making it a feasible starting point. By encouraging active involvement from farmers, industry, researchers, and environmental organizations, Slovakia can

create a more inclusive decision-making environment that supports sustainable practices and innovative solutions to nutrient-related challenges.

Following this, focus should shift to R5 - Establishing investments in research and technological innovation. This step is crucial for developing cost-effective and environmentally friendly nutrient management solutions. By supporting pilot projects and fostering knowledge transfer between research institutions and industry stakeholders, Slovakia can accelerate the adoption of best practices and drive technological advancements in nutrient management.

Next, attention should be directed towards R3 - Improving policy coherence by aligning agricultural, environmental, and economic policies. This recommendation involves strengthening inter-ministerial coordination to ensure that all policies consider nutrient sustainability objectives. By aligning these policies, Slovakia can create a more holistic approach to nutrient management, ensuring that agricultural subsidies are in line with environmental goals.

Finally, the implementation should address R1 and R2, along with R6. R1 and R2 involve establishing a dedicated multi-stakeholder platform in Slovakia and creating a joint database of water and nutrient resources. These initiatives are closely related and should be implemented together to foster collaboration and data sharing among the public sector, academia, the private sector, and civil society. R6 - Improving monitoring and data-sharing mechanisms is logically positioned here as well, as it complements R2 by increasing transparency and accountability through a centralized database of nutrient pollution data and management efforts.

This phased approach ensures a strategic allocation of resources and efforts, maximizing the impact of each initiative while building a robust framework for sustainable nutrient management in Slovakia. It is important to note that the suggested implementation sequence serves as a prioritization guideline. While all recommendations are intended to be executed, the sequence simply indicates the order in which attention could be allocated. Thus, if resources allow, all recommendations could potentially be implemented simultaneously.

4.4. Evaluation of recommendations for Hungary

Considering that significant number of recommendations were previously set for Hungary, in this Deliverable, just priority actions were analysed in detail.

4.4.1. Integrating sustainable nutrient management into business operations by increasing companies' knowledge of innovative technologies and develop their management skills and the training of employees (R7)

Integrating sustainable nutrient management into Hungarian business operations is a very high priority, with the goal of increasing companies' knowledge of innovative technologies and improving their management and employee skills. The implementation complexity is assessed as medium, but several obstacles must be addressed to ensure successful integration.

These obstacles include financial constraints, resistance to change, insufficient support and regulatory barriers as well as communication problems. Limited financial resources, particularly for SMEs, to adopt innovative nutrient management technologies includes the high upfront costs of new equipment and technologies, as well as the uncertainty regarding a clear return on investment. Many smaller businesses lack access to the funding needed to make this transition. Low awareness or resistance to change among company leaders and employees, hindering the adoption of new practices. This resistance can stem from a lack of understanding of the benefits of sustainable practices, a preference for established methods, or a fear of disrupting existing workflows.

Also, lack of access to practical, localized training programs and expert support to guide businesses through the transition. This includes the need for tailored training that addresses specific business needs and contexts, as well as readily available expert advice and mentorship to support implementation.

Complex or unclear regulations, a lack of enforcement, and insufficient alignment with EU sustainability directives create uncertainty and discourage adoption is an obstacle. Streamlining regulations, improving clarity, and ensuring consistent enforcement are necessary to encourage businesses to invest in sustainable practices.

Finally, a lack of effective collaboration between businesses, research institutions, and policymakers hinders the development and dissemination of best practices. This includes the need for collaborative platforms and networks that facilitate the exchange of information and expertise, as well as coordinated policy initiatives that support sustainable nutrient management.

Overcoming these obstacles requires a multi-pronged approach. Politically, stronger policy alignment, clear incentives, and enhanced inter-ministerial cooperation are crucial. Legal reforms should simplify regulations, improve enforcement, and harmonize with EU standards. Socially, targeted training and awareness-raising campaigns are essential to promote a culture of sustainability. Economically, financial support, tax incentives, and accessible funding mechanisms, especially for SMEs, are needed.

Key stakeholders include Ministries of Agriculture, Environment, and Innovation; agribusiness companies; environmental NGOs; universities; and research institutes. Success depends on cross-sectoral

collaboration. While capacity exists, particularly in public institutions and larger firms, willingness varies. Financial concerns, lack of awareness, and fear of increased regulation may hinder adoption by SMEs. Incentives, clear benefits, and local solutions are key to overcoming resistance.

Next steps include developing supportive policy frameworks and financial incentives, simplifying legal regulations, designing targeted training programs, and promoting success stories and multi-sector collaboration (Table 2).

Table 2. Action plan for first recommendation in Hungary (AKI)

Integrating sustainable nutrient management into business operations			
Action	**Responsible stakeholder**	**Participating stakeholders**	**Notes**
Develop supportive policy frameworks and financial incentives, Secure accessible funding, especially for SMEs	Public sector (Ministries of Agriculture, Environment, Finance)	Academia, NGOs, enterprises	Align policies with EU standards, offer subsidies, tax breaks, and grants for sustainable nutrient management investments
Simplify and modernize legal regulations	Public sector	Ministries, regulatory bodies	Update legislation, reduce bureaucracy, and improve enforcement mechanisms
Design and deliver targeted training and awareness programs	Academia, Civil society, Private sector	Academia, Civil society, Private sector	Create practical workshops, e-learning platforms, and demonstration projects tailored to company sizes and sectors
Promote success stories and pilot projects, Facilitate multi-sector collaboration platforms	Public sector, Academia, Civil society	Public sector, Academia, Civil society	Create working groups, partnerships, and conferences to connect companies, researchers, and policymakers

While achieving this is not easy, it is achievable with strong political will, clear incentives, and practical solutions, particularly for smaller businesses. The key lies in creating multi-sector partnerships and making the business case for sustainability visible and profitable.

4.4.2. Raising awareness on sustainability and nutrient pollution and cooperation between all the stakeholders (R8)

Raising awareness of sustainability and nutrient pollution, and fostering stakeholder cooperation, is rated as a very high priority in Hungary. Effective communication and education are crucial for facilitating the implementation of other recommendations. However, achieving this in Hungary presents a medium level of implementation complexity due to fragmented governance, limited public awareness, and competing economic interests, particularly within agriculture and industry. Despite these challenges, opportunities exist through EU directives, civil society initiatives, and progressive local governments. Scaling these efforts nationally, however, necessitates stronger political will and cross-sector coordination.

Potential hindrances include low public awareness, conflicting economic priorities, weak enforcement of regulations, limited funding, and insufficient coordination between government, NGOs, and private stakeholders. Political obstacles include centralized decision-making, limited stakeholder dialogue, and a prioritization of economic growth over environmental concerns. Legal challenges involve weak enforcement of existing EU-aligned frameworks, bureaucratic hurdles, and slow implementation. Socially, limited public awareness, civic engagement, and commitment to sustainability vary locally. Economically, agricultural and industrial interests resist stricter regulations, and funding for environmental initiatives is limited, with a focus on short-term gains.

Overcoming these obstacles requires a multi-faceted approach. Politically, establishing multi-stakeholder dialogue platforms and leveraging EU pressure and funding incentives to prioritize sustainability are key. Legally, simplifying procedures and strengthening enforcement, along with providing clear guidelines, is necessary. Socially, targeted awareness campaigns, school programs, and support for community-led projects are essential. Economically, financial incentives and subsidies for sustainable practices, along with promoting green innovation and eco-labelling, are needed to create market demand.

Key stakeholders include various ministries (Ministry of Agriculture, Ministry of Environment), local governments, water management directorates, agricultural chambers, food industry companies, environmental NGOs, community groups, universities, and research institutes. Ideally, a coordinated partnership among all four sectors (public, private, civil society, academia) is needed. While the technical capacity exists, particularly with EU support, coordination and leadership are crucial. The public sector may be supportive if politically prioritized, while civil society and academia are likely to be engaged. However, the private sector, particularly agriculture and industry, may be hesitant without clear incentives. Resistance is expected from those prioritizing economic interests over environmental concerns. Bureaucratic inertia and public apathy could also impede progress.

A coordinated effort from all stakeholders is crucial, starting with establishing a national multi-stakeholder platform led by the Ministries of Environment and Agriculture to define shared goals and strategies. This platform will then work with Water Management Directorates, universities, and NGOs to map key problem areas and identify crucial actors, informing targeted interventions. Simultaneously, NGOs, schools, media, and local governments will launch awareness campaigns to educate the public and

farmers about nutrient pollution and sustainable practices. Next, the Ministries of Agriculture and Finance will develop economic incentives (subsidies) and stronger legal enforcement, including clearer regulations and penalties for violations. Local governments, farmers' associations, NGOs, and research institutions will then pilot practical solutions in high-risk areas, showcasing good practices for broader implementation. Finally, environmental agencies and universities will ensure regular monitoring and transparent reporting to build public trust and demonstrate progress. This phased approach - coordination, awareness, incentives, legal improvements, pilot projects, and ongoing monitoring - is vital for building momentum and achieving lasting positive change.

The success of raising awareness and fostering cooperation hinges on addressing the fragmented governance structure and competing interests. A strong, coordinated effort involving all stakeholders is needed. The phased approach outlined, focusing on building a national platform, mapping problems, and launching targeted campaigns, is crucial. Securing political will and providing clear, tangible incentives are essential for overcoming resistance from certain sectors. Regular monitoring and transparent reporting will build public trust and demonstrate progress. While challenges exist, the existing EU frameworks, expertise, and active civil society offer a foundation for positive change. However, sustained commitment and collaborative leadership are vital for long-term success.

4.4.3. Providing networking of actors to strengthen professional relationships and for a more efficient flow of information (R9)

Establishing effective networking among stakeholders is a very high priority in Hungary, as collaboration and information flow are essential for successful implementation of nutrient management strategies. However, the implementation complexity is considered moderately difficult due to existing sectoral silos and limited trust between stakeholders. The lack of formal communication platforms further hinders information exchange. Despite these challenges, motivated NGOs and academia often act as connectors, and EU support encourages cooperation, suggesting that gradual improvement is possible.

Key obstacles include a lack of trust, weak communication channels, bureaucratic barriers, and limited incentives or resources to sustain active networking. Overcoming these requires a multi-pronged approach. Politically, building trust through transparent dialogue and engaging neutral facilitators is crucial. Legally, clarifying and strengthening laws that support collaboration, along with ensuring enforcement, is essential. Socially, promoting community engagement and demonstrating the benefits of networking will encourage participation. Economically, securing dedicated funding and offering incentives for participation are necessary to ensure long-term commitment.

Key stakeholders are the public sector (Ministry of Environment, local governments, water management authorities), the private sector (agricultural and industrial associations, environmentally conscious companies), civil society (environmental NGOs, community groups), and academia (universities and research institutes). Optimal results will be achieved through coordinated, cross-sectoral collaboration.

While stakeholders possess the necessary capacity and expertise, willingness varies. Civil society and academia are typically eager to participate, the public sector may be supportive if it's a political priority, but the private sector might be hesitant without clear benefits. Resistance is expected from stakeholders fearing loss of control or increased workload, and due to pre-existing trust issues. Overcoming this requires demonstrating clear benefits, addressing concerns, and providing practical support.

The following approach is planned for implementation:

- Mapping key stakeholders and identifying gaps: (Ministry of Environment + NGOs + academia) to understand the existing landscape and pinpoint areas for improvement
- Establishing a formal networking platform: (Ministry of Environment + local governments + civil society leaders) to create a structured mechanism for communication and collaboration
- Organizing trust-building workshops: (NGOs + academia + public sector facilitators) to foster relationships and build confidence amongst stakeholders
- Developing and launching communication tools: (Academia + IT partners + NGOs) such as newsletters and databases to facilitate information sharing
- Securing funding and incentives for participation: (Ministry of Finance + EU funding bodies + private sector partners) to ensure the long-term sustainability of the network
- Regularly monitoring and adjusting the network: (Coordinating body within the Ministry of Environment + academic evaluators) to ensure its effectiveness and responsiveness

Implementation is considered difficult due to trust issues, siloed sectors, and a lack of formal platforms and incentives. While existing expertise and motivated actors offer advantages, consistent political will and funding are crucial for success. Targeted efforts are needed to address the challenges of fragmented stakeholder engagement. Potential challenges to establishing and maintaining a strong stakeholder network include network fatigue if participants don't see immediate benefits, power imbalances that might lead to some voices dominating discussions, and funding shortages that could threaten the network's continuity. However, the potential benefits are significant: stronger collaboration leads to better nutrient pollution management, shared knowledge accelerates innovation and problem-solving, and the network builds trust and long-term partnerships. These benefits are crucial because efficient information flow and cooperation are key to tackling complex sustainability challenges, preventing duplicated efforts and conflicting actions, and fostering a sense of shared responsibility among all stakeholders.

To ensure the network's sustainability, several steps are vital: institutionalize the network within official bodies to provide formal recognition and support; secure steady funding and provide clear incentives for participation to maintain motivation; maintain transparent and inclusive communication to prevent power imbalances and ensure all voices are heard; and regularly demonstrate the network's positive impact to reinforce its value and maintain motivation. By addressing these potential challenges

proactively and implementing these sustainability measures, a strong and effective stakeholder network can be established, paving the way for significant improvements in nutrient management.

4.4.4. Using positive incentives instead of or alongside sanctions by the government to prevent nutrient pollution, provide the financial resources needed for the necessary investments (R11)

Implementing positive incentives for sustainable nutrient management in Hungary is a very high priority, offering a potentially more effective long-term approach than sanctions alone. Securing adequate funding is essential for success. While the implementation complexity is considered medium, several factors could affect its feasibility. The positive incentive approach aligns with farmer and industry interests, potentially increasing acceptance. However, significant government funding and well-managed programs are crucial, which could prove challenging given budget constraints and the need for robust political will and administrative capacity. There's also a risk of misuse or insufficient uptake if incentives aren't attractive or well-targeted. The inherent complexity lies in fairly and sustainably implementing these incentives amidst competing economic pressures and limited resources.

Potential obstacles include limited government budgets, a lack of clear criteria and monitoring mechanisms (increasing the risk of misuse or fraud), stakeholder resistance if incentives are insufficient or overly complex, political changes affecting program continuity, and administrative challenges in managing and evaluating programs. More specifically, sustained political commitment is needed to ensure funding and prioritize positive incentives over other initiatives. Clear legal frameworks, transparent rules, and strong enforcement are vital to build trust and prevent misuse. High public willingness and trust in the fair distribution of incentives are also necessary. Sufficient and sustainably allocated public funding, along with incentives that offer substantial economic benefits to motivate behaviour change, are critical for success.

Overcoming these obstacles requires a multi-pronged strategy. Politically, securing cross-party support and linking incentives to EU funding can ensure program continuity. Legally, simplifying regulations and increasing transparency will build trust and prevent misuse. Socially, outreach programs are needed to educate and build trust with farmers and businesses. Economically, attractive, well-targeted incentives and public-private partnerships can boost funding.

Key stakeholders include various ministries (Agriculture, Environment, Finance), local governments, agricultural agencies, farmers' associations, agricultural businesses, industry groups, environmental NGOs, and universities/research institutes. Collaboration across all sectors is essential. While the capacity to design and implement incentive programs exists, some resistance is anticipated—particularly from those sceptical of government programs or fearing bureaucracy. Political shifts could also reduce support. However, farmers and industry are generally more receptive to positive incentives than sanctions.

Next steps involve assessing funding needs and sources, designing transparent incentive schemes, piloting programs in selected regions, launching awareness campaigns, establishing monitoring and evaluation systems, and finally scaling up successful pilots with secured funding. These actions should be undertaken by a collaborative effort involving the relevant stakeholders mentioned previously.

Re-evaluating the implementation complexity, it is considered very hard due to issues such as the risk of misallocation or misuse of funds, low participation if incentives are unattractive or complex, and the potential for political changes leading to funding cuts. However, the potential benefits—increased adoption of sustainable farming practices, reduced pollution, and strengthened trust between government and stakeholders—are substantial. To ensure sustainability, incentive programs should be integrated into long-term policy frameworks, with transparent monitoring, regular impact reporting, and adjustments based on feedback and evolving needs. Combining incentives with education and community engagement is also vital.

4.4.5. Creating public databases based on high-level monitoring and real data (R14)

Creating publicly accessible databases based on high-level monitoring and real-time data is a very high priority in Hungary, given the existence of fragmented and inaccessible data. While technically feasible due to existing monitoring systems and digital tools, implementation presents a medium level of complexity. Challenges include integrating data from diverse sources, ensuring data quality, fostering inter-agency cooperation, investing in IT infrastructure and training, and securing the political will and mandates for transparent data sharing. The core challenge is overcoming institutional silos and establishing open data policies.

Potential obstacles include data fragmentation and standardization issues, reluctance to share data due to privacy or political concerns, insufficient funding for IT infrastructure and training, limited technical capacity in some institutions, and bureaucratic resistance to transparency and change. More specifically, limited political priority on transparency, potential resistance from agencies fearing scrutiny, incomplete or unclear data-sharing regulations (including GDPR implications), bureaucratic hurdles, low public awareness of environmental data, limited skills to access or interpret data, insufficient budgets for IT infrastructure and maintenance, and lack of investment in staff training and technical support all pose significant challenges.

Overcoming these obstacles requires a multifaceted approach. Politically, building consensus and demonstrating the benefits of transparency are crucial. Legally, updating and clarifying data-sharing laws and streamlining approval processes are necessary. Socially, public awareness campaigns and user-friendly data access tools are essential. Economically, securing dedicated funding (potentially via EU grants) and investing in staff training and IT upgrades are needed.

Key stakeholders include the Ministry of Environment, environmental protection agencies, water management authorities, IT departments of relevant ministries, tech companies (for database

development and maintenance), environmental NGOs (for advocacy and data utilization), and universities and research centres (for data analysis and quality assurance). Cross-sector collaboration is paramount. While the technical and professional capacity exists, particularly within public agencies and academia, resistance is expected from agencies concerned about transparency or data misuse, and from those wary of increased workloads.

A phased approach is recommended:

1. assessing existing systems and data sources
2. developing a legal framework for data sharing and public access
3. securing funding for IT infrastructure and training
4. designing and building a user-friendly database platform
5. launching a pilot phase
6. promoting public awareness and user training
7. implementing regular monitoring and evaluation.

This collaborative effort should involve the key stakeholders mentioned previously.

Re-evaluating implementation complexity is considered very hard due to potential data misuse or misinterpretation, technical failures, and low user engagement. However, the potential benefits—improved transparency, better-informed decisions, enhanced cross-sector collaboration—are significant. To ensure sustainability, database management must be embedded in institutional mandates, with long-term funding, regular updates, and ongoing education and outreach.

4.5. Priorities for Hungary

By evaluating the recommendations set for Hungarian part of Danube river basin through the lens of priority and implementation complexity, each has been strategically positioned within the prioritization matrix (Figure 9). It outlines a possible plan for moving forward, starting with actions that are of higher priority and lower implementation complexity.

The prioritized implementation sequence for Hungary, as outlined in the matrix, begins with a cluster of high-priority actions. The logic behind this sequence is to address foundational elements first, which will create a solid base for subsequent initiatives. Initially, the focus should be on R7 - Integrating sustainable nutrient management into business operations by enhancing companies' knowledge of innovative technologies and improving management skills and employee training. This foundational step is crucial as it directly impacts how businesses operate and manage nutrients sustainably. Simultaneously, R8 - Raising awareness on sustainability and nutrient pollution and fostering cooperation among stakeholders is essential to build a common understanding and commitment to sustainable practices. Additionally, R11 -

Using positive incentives alongside or instead of sanctions to prevent nutrient pollution and ensure financial resources for necessary investments should be implemented early to facilitate compliance and encourage proactive environmental management. R14 - Creating public databases based on high-level monitoring and real data completes this high-priority cluster, providing the necessary transparency and data-driven insights to support evidence-based decision-making.

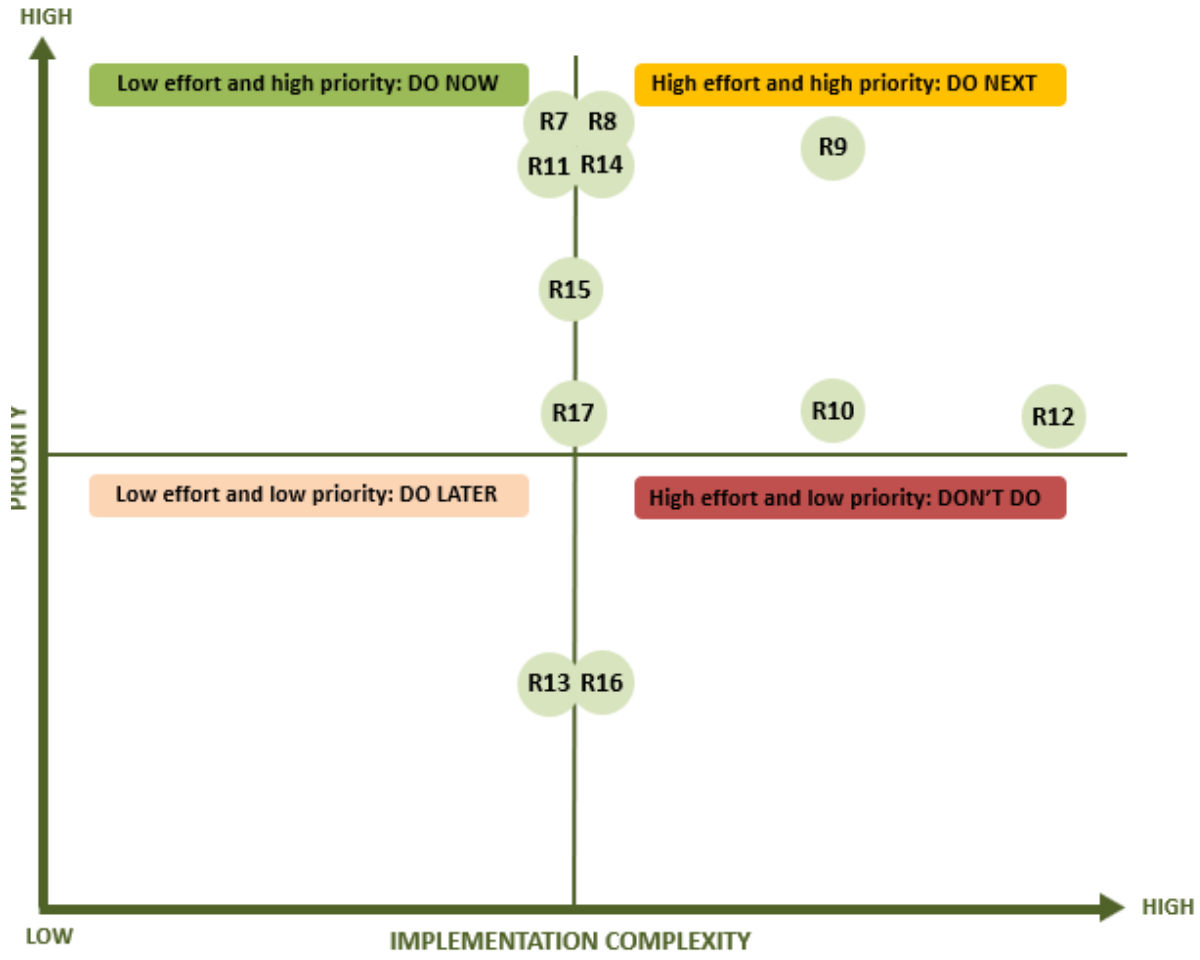

Figure 9 Priority Matrix: Recommendation Implementation in Hungary, Danube river basin

Following these initial actions, attention should shift to R9 - Networking of actors to strengthen professional relationships and improve the flow of information. This step builds on the initial cluster by enhancing communication and collaboration among stakeholders, which is vital for sustaining momentum and ensuring cohesive efforts.

Once resources permit, the focus can move to R15 - Introducing technology and business services tailored to the market needs of agri-food companies, provided by advanced service providers. This step leverages the groundwork laid by earlier initiatives, fostering innovation and competitiveness in the agri-food sector. Subsequently, R17 - Identifying and demonstrating social innovations for stakeholders should be carried out, ensuring a supportive environment for innovation.

Subsequent steps include R10 - Ensuring effectively functioning coordinating bodies, followed by R12 - Creating more constructive relations with public authorities to enhance access and foster a more supportive attitude. These steps are crucial for institutionalizing the changes and ensuring long-term governance support. Finally, R13 - Improving dissemination of scientific results and reference/model systems, together with R16 - Ensuring more effective technology and knowledge transfer, could be addressed simultaneously to maximize impact and ensure that all actors have access to the latest research and innovations.

By strategically clustering and staggering these initiatives, Hungary can efficiently allocate resources and efforts to maximize impact, ensuring a robust approach to sustainable nutrient management.

5. Conclusions

The Ebro river basin, spanning Aragon and Catalonia, faces significant nitrate pollution challenges. A strategic focus on enhancing nutrient management through integrated governance, data integration, and stakeholder collaboration is key. Establishing a joint governance body can streamline decision-making and improve nutrient strategies, while a common data platform is essential for tracking pollution sources and supporting informed policymaking. Emphasizing stakeholder collaboration through multi-stakeholder advisory groups and regular workshops ensures diverse perspectives and promotes best practices. Encouraging a circular economy with manure valorisation and recycling systems aligns with sustainability goals, offering long-term benefits. Providing financial incentives and support, especially for small and medium-sized farms, is crucial to adopting responsible nutrient management practices. The priority matrix indicates that most recommendations are ready for immediate implementation, promising environmental improvements and enhanced economic and social resilience.

The **analysis of the Ebro river basin presents several avenues for policy recommendations** aimed at improving nutrient management and fostering sustainable practices in the region:

1. **Adaptive management strategies**: Implementing adaptive management strategies stands out as a top priority. This policy allows for flexibility and responsiveness to real-time data and environmental changes, particularly important given the climate variability impacting nutrient transport. By enabling adjustments based on ongoing feedback, such a strategy ensures that nutrient management remains effective under changing conditions.

2. **Inter-regional policy learning**: Facilitating inter-regional policy learning is another crucial recommendation. By exchanging knowledge and best practices with regions that have successfully tackled similar challenges, Aragon and Catalonia can accelerate their learning curve and apply proven strategies. This collaborative approach can lead to more effective and innovative solutions tailored to regional needs.

3. **Digital innovation for stakeholder engagement**: Leveraging digital platforms for continuous stakeholder engagement is essential. By moving beyond traditional methods and incorporating virtual advisory groups or forums, stakeholders can maintain ongoing dialogue, ensuring that inclusivity and responsiveness are enhanced. This approach can also reach a wider audience, fostering greater collaboration and input from diverse perspectives.

These strategies offer innovative ways to build on existing initiatives and drive progress in nutrient management.

The Lielupe river basin, shared by Latvia and Lithuania, presents distinct challenges in nutrient management due to its transboundary nature. The analysis underscores the importance of establishing coordinated governance frameworks to manage shared resources effectively. A transboundary coordination platform is crucial to align efforts, given the basin's diverse agricultural practices and regulatory frameworks. Similarly, implementing a basin-wide monitoring system, supported by a shared

data platform, is prioritized for immediate action to enhance transparency and cooperation in water management.

Stakeholder engagement and capacity building are vital for successful nutrient management. Strengthening institutions like LRATC can facilitate knowledge transfer and support sustainable practices among farmers. Engaging local communities, farmers, and environmental organizations in decision-making processes fosters inclusivity and innovation, helping to address complex challenges collaboratively.

Promoting a **circular economy** through initiatives like sewage sludge composting aligns with sustainable nutrient management goals. Expanding support for small and medium-sized farms in Lithuania ensures equitable growth and competitiveness in the agricultural sector.

The strategic implementation sequence for the Lielupe river basin begins with impactful actions, setting a foundation for subsequent initiatives. While priorities are clear, flexibility allows for simultaneous implementation where resources permit. This comprehensive approach promises environmental improvements and a strengthening of economic resilience and social cohesion across the region.

To improve the policy in the Lielupe river basin, top actions shall include:

1. **Integrated governance**: Support establishing a transboundary coordination platform and basin-wide monitoring system to manage shared resources effectively.
2. **Stakeholder engagement**: Encourage policies that integrate diverse stakeholder engagement into decision-making processes, fostering collaboration among local communities, farmers, and environmental organizations.
3. **Circular economy initiatives**: Provide incentives for circular economy practices, such as composting and nutrient recycling, aligning with sustainability goals.

These policy recommendations align with the identified priorities and aim to promote long-term sustainability in the Lielupe river basin.

The Danube river basin, Europe's second-largest river basin, is pivotal for sustainable nutrient management, particularly in Slovakia and Hungary, where agriculture plays a significant economic role. The analysis of recommendation implementation across these countries reveals essential patterns for advancing nutrient management. Collaborative governance models are emphasized, integrating public institutions, academia, industry, and civil society. Slovakia focuses on establishing multi-stakeholder platforms and joint databases, while Hungary prioritizes networking actors, underscoring the need for coordinated efforts and data sharing to tackle nutrient challenges effectively.

Improving policy coherence by aligning agricultural, environmental, and economic policies is crucial for both countries. Slovakia's holistic approach aims to align policies, while Hungary focuses on integrating sustainable nutrient management into business operations. These strategies highlight the importance of cross-sectoral coordination and alignment with EU directives. Investments in research and innovation are

prioritized in both nations, with pilot projects and knowledge transfer fostering cost-effective nutrient management solutions. Leveraging EU funding and aligning with regional strategies further enhances innovation and competitiveness.

Keeping in mind the analysis, there are pathways for policy improvement in Danube river basin:

1. **Enhance policy coherence**: Align agricultural, environmental, and economic policies to support nutrient reduction goals, using cross-sectoral working groups and EU funding conditions to drive integration.
2. **Promote innovation and best practices**: Support investments in research and pilot projects to encourage the adoption of BATs and sustainable practices. Incentivize these through positive incentives and funding for demonstration projects.
3. **Increase transparency and accountability**: Improve monitoring and data-sharing mechanisms with centralized databases, enhancing evidence-based policymaking and meeting EU Water Framework Directive requirements.

These recommendations are designed to strengthen economic and social resilience, promising environmental gains for the region.

The comprehensive analyses of nutrient management recommendations across the Ebro, Lielupe, and Danube river basins highlight several overarching strategies critical for advancing sustainability and resilience in these regions. Central to this effort is the establishment of integrated governance frameworks that facilitate coordinated action and streamline decision-making across borders and sectors. Implementing joint governance bodies and centralized data platforms will enhance transparency, accountability, and data-driven policymaking, crucial for managing nutrient levels and pollution sources effectively.

Stakeholder engagement emerges as another foundational element. Embedding participatory decision-making processes within policy frameworks ensures that diverse perspectives are included, fostering collaboration among local communities, farmers, and environmental organizations. This approach not only builds trust but also encourages the adoption of best practices and innovative solutions to nutrient-related challenges.

Promoting a circular economy through incentives for composting and nutrient recycling aligns with sustainability goals and offers long-term environmental and economic benefits. By supporting these practices, regions can transform waste into valuable resources, thereby reducing environmental impact and enhancing resource efficiency.

The importance of aligning agricultural, environmental, and economic policies is underscored across all regions, emphasizing the need for cross-sectoral coordination and alignment with EU directives. Supporting investments in research and technological innovation is prioritized to foster cost-effective nutrient management solutions, leveraging EU funding to enhance competitiveness and innovation.

The policy recommendations for enhancing nutrient management across the Ebro, Lielupe, and Danube river basins focus on establishing integrated governance structures and centralized data platforms to streamline decision-making and enhance transparency. By embedding **participatory decision-making processes into policy frameworks, these regions can ensure diverse perspectives and foster collaboration among stakeholders**. Promoting circular economy initiatives, such as composting and nutrient recycling, aligns with sustainability goals and enhances economic resilience. These strategies collectively address the unique challenges of each basin while supporting long-term environmental and economic sustainability.

6. References

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7.Annexes

ANNEX 1 Template: Questions for recommendation evaluation

D5.3 Lessons learnt and recommendations to the main regional clusters (first version)
RECOMMENDATION ASSESMENT QUESTIONS

Instructions

1) First section of this document contains **all the recommendations** that were provided for **[Country]** in D2.4 **Please rate their priority!** This will help placing these in priority matrix.
2) The second section contains the **TOP recommendations** you prioritized. The same set of questions are used for all of them. **Please give answers – your opinion based on your experience within the Task 5.2., other NENUPHAR tasks (like CoM meetings etc.) and general overall experience.**
3) We have also **added a recommendation "The implementation of the NENUPHAR technology "[Recommendation to implement the NENUPHAR technology of the region]" on a large scale".** This is done to see what you have learned so far about future possibilities of your technology in **[Country]**. Please answer the same set of questions about this. Feel free to rephrase the recommendation, if needed.

Rating of all recommendations

Please rate the Priority of all the recommendations set for **[Country]** in D2.4:

"[Recommendation] How would you rate the priority of this recommendation on a scale from 1 to 5, where 1=not a priority at this time at all and 5=very hight priority at this time?

1	2	3	4	5
Not a priority at this time at all				Very high priority right now

Why?

_____
_____
_____

Assessment of recommendations

[Recommendation]

A Implementation

A 2 How would you rate the implementation possibilities of this recommendation? How easy or hard is it to implement it in current situation? Why?

1	2	3	4	5
Very easy	Easy		Hard	Very Hard

B Obstacles

B 1 What could hinder the implementation of the Recommendation?

Please mention answers from the top of your head!

_____
_____
_____

B 1a PROBING QUESTIONS for: What could hinder the implementation of the Recommendation?

Political circumstances:

_____
_____
_____

Legal aspects:

_____
_____
_____

Social aspects (e.g. responsiveness):

_____
_____
_____

Economic aspects:

_____
_____
_____

C Overcoming obstacles

C 1 How could these obstacles be overcome?

Please mention answers from the top of your head!

These should relate to the obstacles mentioned in Section B!

_____
_____
_____

C 2 Who should do it?

What organisations / institutions?

_____
_____
_____

If not sure – what sector should do it, in your opinion?

- Public sector?
- Private sector?
- Civil society?
- Academia?

C3 Would they be able to do it? Would they agree to do it?

Is resistance to be expected?

_____
_____
_____

Would they agree to do it?

_____
_____
_____

D Next steps

D 1 What would be the next steps?

What to start with? What to do next?

Please mention ideas from the top of your head! What steps should be taken and by who in order to implement this? Keep in mind the answers to the obstacle question!

_____
_____
_____

If possible, fill a table with actions, responsible parties, participating parties and notes (if needed).

Action	*Responsible*	*Participating*	*Notes*
E.g. Set a stakeholder meeting	*Ministry of XXX*	*Academia, NGOs, dairy farmers*	*The initiative needs to come from public sector, sending an official invite to demonstrate the interest*

E Think again

E 1 Keeping in mind all we talked about; how would you rate the implementation possibilities of this recommendation now? How hard is it to implement?

1	2	3	4	5
Very hard	Hard		Easy	Very easy

Why?

_____
_____
_____

E2 Anything to add?

Any risks? Any possibilities? Why is this important? How could this be made sustainable? Etc.

_____
_____
_____