Forging the Future: Pioneering Approaches in Business, Management and Economics Engineering to Overcome Emerging Global Challenges - 2024

https://doi.org/10.24867/FUTURE-BME-2024-123 Original scientific paper

INTEGRATING ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS IN SUSTAINABLE HYDROMELIORATION PRACTICES: A CASE STUDY OF THE VOJVODINA REGION

Nevena Živančev[1] [0000-0002-5434-5210], Maja Petrović[2] [0000-0003-3423-6559], Zorica Mirosavljević[3] [0000-0002-1551-0180], Nemanja Stanisavljević[4] [0000-0001-9484-1166]

Abstract

Environmental and Social Management Plans (ESMP) play a crucial role in promoting sustainable environmental practices within hydromelioration systems. By integrating environmental conservation and development objectives, these plans help mitigate adverse impacts and ensure the long-term sustainability of water resource management initiatives. This paper critically analyzes the ESMP implemented for a hydromelioration project in the Vojvodina region, aimed at minimizing ecological, societal, and cultural impacts during the reconstruction and operation of pumping stations. The ESMP emphasizes sustainable environmental practices to mitigate pollution and preserve biodiversity. It addresses occupational health and safety risks, as well as public health concerns. Socio-economic considerations encompass temporary disruptions to livelihoods and social-economic activities, localized primarily around the pumping station sites, workforce presence, machinery deployment, organizational protocols, and technological applications. The study highlights effective strategies for harmonizing developmental imperatives with environmental and social priorities in hydromelioration projects.

Key words: *environmental and social management plans, hydromelioration, sustainable practices, biodiversity conservation, socio-economic impacts*

[1] University of Novi Sad, Faculty of Technical Sciences, Serbia, nevenazivancev@uns.ac.rs
[2] University of Novi Sad, Faculty of Technical Sciences, Serbia, majadjogo@uns.ac.rs
[3] University of Novi Sad, Faculty of Technical Sciences, Serbia, zoricamirosavljevic@uns.ac.rs
[4] University of Novi Sad, Faculty of Technical Sciences, Serbia, nemanjastanisavljevic@uns.ac.rs

1. Introduction

Hydromelioration systems, particularly agricultural land drainage, play a significant role in modifying landscapes and influencing environmental conditions. These interventions, designed to manage water resources for agricultural productivity, can lead to profound environmental and social changes (Tlapáková et al. 2013). Spaling and Smit (1995) emphasized that drainage systems alter the water regime, influencing not only the spatial distribution of pollutants but also increasing their concentrations and facilitating their transfer from agroecosystems to aquatic ecosystems. Such activities often result in changes to the landscape structure, leading to spatial fragmentation and ecological degradation.

One of the most critical impacts of drainage activities is on wetlands, where large-scale interventions, such as straightening river courses, have led to the degradation of bank ecosystems. The transformation of these areas into simplified and unstable aquatic environments, as observed in the western south-central USA, highlights the need for sustainable management and restoration efforts (Huang et al. 2009). Similarly, Langhammer and Vilímek (2008) identified systematic drainage as a key indicator of landscape changes, with implications for biodiversity, water quality, and ecosystem health.

In Europe, the Water Framework Directive of the European Union underscores the necessity of achieving good surface water status by emphasizing the interconnectedness between catchment development and water quality. However, historical hydromelioration measures, particularly those implemented in the mid-20th century, often prioritized drainage and watercourse training, neglecting long-term ecological sustainability (Tlapáková et al. 2013). Sustainability is of key importance in managing water resources, soil health, and environmental protection. There is a growing demand for modernization and rehabilitation of aging hydromelioration systems in order for them to adapt to climate change, increased water scarcity or other extremes, like flooding, and ecosystem degradation.

AP Vojvodina, covering 2.1 million hectares in northern Serbia, lies within the Pannonian Basin and is bordered by the Sava and Danube rivers. According to the 2022 census, it has a population of 1.74 million. The region's hydrographic potential is dominated by the Danube and its tributaries, with an extensive canal system (Danube-Tisza-Danube Hydrosystem, DTDHs) supporting irrigation, drainage, and transportation.

Vojvodina's economy is largely based on agriculture, utilizing 84% of its surface area for arable land. Around 0.5 million hectares of this land are drained, enhancing productivity on areas originally marshy. The province has 1,460 km of reconstructed flood embankments, safeguarding against flooding along major rivers like the Danube, Tisza, and Sava. However, 204 km of flood embankments remain unconstructed. Additionally, about 1.78 million hectares are drained, with over 20,000 km of drainage canals and 155 pumping stations to support the system.

Approximately 80% of Vojvodina is at risk from inland waters, affecting both directly endangered and partially endangered areas. Remediation efforts are

ongoing, particularly with about 100 structures along the flood embankments needing rehabilitation.

An Environmental and Social Management Plan (ESMP), as a part of the Environmental and Social Impact Assessment (ESIA), represents a comprehensive document designed to address the environmental and social impacts associated with development projects, covering both construction and operational phases. In some cases, additional ESMPs may be required for demolition or restoration phases. The ESMP plays a crucial role in identifying potential environmental and social impacts during project formulation and design, outlining strategies to mitigate negative consequences, ensure compliance with regulations, and manage associated risks. The plan also specifies the timing of each mitigation measure, estimates the costs involved, and assigns responsibility for their implementation.

This paper presents how ESMPs can contribute to sustainable environmental practices in hydromelioration system modernization and optimization project in the Vojvodina region, balancing project activities with environmental protection and social well-being.

2. Environmental and social management plan (ESMP)

Environmental and Social Management Plans (ESMPs) have become an essential component in ensuring that mitigation measures identified during Environmental and Social Impact Assessments (ESIAs) are implemented and monitored (Figure 1). Since the 1970s, there has been recognition of the need to link environmental assessment with management and ensure that practices are adaptive (Durning and Broderick, 2018). The use of ESMPs has evolved significantly, particularly since the 1990s, as a way to ensure that outcomes from ESIAs are effectively carried through to project implementation.

A 2011 study by the Institute for Environmental Management and Assessment (IEMA) revealed that 80% of respondents favored making Environmental Management Plans (EMPs) mandatory within Environmental Impact Assessment (EIA) legislation (Durning and Broderick, 2018). Further research by Bennett et al. (2016) found that 95% of UK practitioners regularly worked with EMPs. The growing global use of ESMPs is also driven by International Financial Institutions (e.g., World Bank, EBRD), which require management plans in their project financing policies.

ESMPs have evolved through a "bottom-up approach," shaped by practitioners rather than being strictly governed by top-down legislative frameworks. As a result, the practice is diverse, and terminology varies across contexts. ESMPs can be broad, covering various project stages, or more focused, addressing specific issues like construction or ecological management. They can also exist at strategic or institutional levels and tie into overarching environmental management systems (EMS) (Hui et al., 2001). Despite this diversity, project-level ESMPs follow key principles for ensuring effective implementation and monitoring of mitigation strategies.

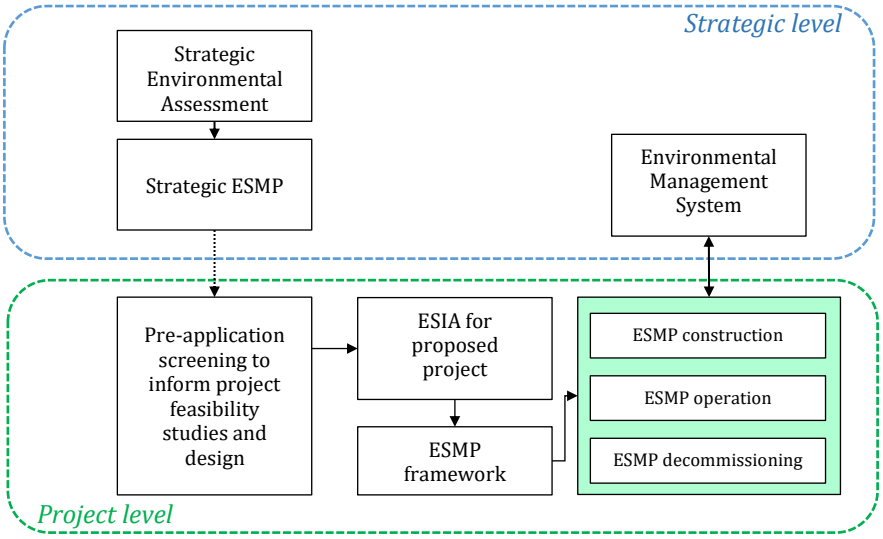

Figure 1: Integration of ESMPs into environmental and management frameworks (Durning and Broderick, 2018)

The key benefits of developing an ESMP are ensuring compliance with legal and environmental standards, fostering better communication among stakeholders, and linking the planning and implementation stages of a project. ESMPs also help establish frameworks for monitoring and mitigating potential risks (IEMA, 2024).

ESMPs serve as a crucial link between desk-based ESIA and the on-the-ground implementation of projects. For ESMPs to be effective, they must be clear, practical, and actionable. This includes using accessible language, defining specific actions, assigning responsibilities, setting measurable indicators for success, and specifying the locations and timelines for mitigation and monitoring efforts.

3. ESMPs in hydromelioration projects

The type of hydromelioration project, whether it is new construction, reconstruction, or modernization, determines the specific environmental risks involved. These risks may include water quality deterioration, soil erosion, and air quality impacts, such as dust generated during construction activities.

Mitigation strategies should be tailored to each identified risk and corresponding project activity, outlining both the impacts and the proposed mitigation measures. For effective implementation, responsibilities should be clearly assigned to facilitate monitoring and compliance. Mitigation strategies can be categorized according to different project phases, such as planning, design, communication and stakeholder engagement, and execution of works. Assigning a

preliminary cost for each mitigation measure helps in ensuring that resources are allocated properly to manage these risks.

The bulk of mitigation measures for the hydromelioration system modernization and optimization in Vojvodina region are typically needed during the execution phase, where most environmental impacts occur. These measures, which are largely the responsibility of the contractor, include:

- Dust control to prevent degradation of vegetative cover
- Emission control from earth material deposits and truck traffic on unpaved roads
- Management of gas and particle emissions from construction vehicles and machinery
- Noise reduction during heavy machinery operation
- Water turbidity control due to construction activities
- Prevention of water and soil pollution from improper storage, handling, or disposal of materials
- Land and water contamination prevention from fuel and lubricant leaks during construction machinery maintenance
- Proper disposal of municipal, inert, and hazardous waste to avoid water and land pollution
- Safe disposal of sanitary wastewater from construction sites to prevent contamination
- Traffic management to reduce congestion and minimize the risk of accidents in construction areas
- Worker safety measures to mitigate the risk of work-related injuries
- Community health and safety precautions to protect local residents
- Procedures for the discovery of archaeological sites, if encountered
- Processes to address employee and local residents' complaints

Addressing these aspects with diligence allows the ESMP to effectively mitigate the environmental and social risks associated with the hydromelioration project, thereby ensuring compliance with regulations and maintaining long-term project sustainability.

3.1 Successful ESMP implementation for the Vojvodina region

Effective stakeholder engagement is essential for successful ESMPs. It is important to incorporate participatory approaches that actively include local communities in decision-making processes. This ensures that their concerns and needs are addressed, particularly regarding potential impacts on their livelihoods, access to water, and cultural practices. Transparent communication and consultation throughout the project cycle can build trust and improve the acceptance and effectiveness of the proposed mitigation strategies (Langsdale & Cardwell, 2022).

Incorporating innovative technologies such as smart irrigation systems, water-saving techniques, and real-time monitoring tools can greatly enhance the environmental sustainability of hydromelioration projects (Djalilov et al. 2024; Klychova et al. 2022). These innovations help in optimizing resource use and reducing environmental footprints, making it easier to achieve compliance with ESMPs. The adoption of best practices from other successful projects can serve as models for future initiatives, facilitating knowledge exchange and improving overall project efficiency.

For ESMPs to be truly effective, their scope should extend beyond project completion. This includes setting up long-term environmental and social monitoring systems that track the impacts of the project on local ecosystems and communities over time. Continuous monitoring will help ensure that the implemented mitigation measures remain effective and that any emerging issues are promptly addressed. Such a commitment to long-term sustainability reinforces the project's overall contribution to environmental protection and social well-being.

4. Conclusions and future considerations

This paper demonstrates that Environmental and Social Management Plans (ESMPs) play a crucial role in fostering sustainable environmental practices in the modernization and optimization of hydromelioration systems in the Vojvodina region. By integrating project activities with environmental protection and social well-being, ESMPs contribute to achieving a balance that is essential for long-term sustainability.

The ongoing operation of pumping stations in the Vojvodina region has significantly disrupted the natural balance in their surroundings. The habitats in these areas are subject to continuous human influence, which poses threats to the local fauna. The challenges associated with advancing ESMP practices stem from the necessity of maintaining an adaptive approach, particularly in large and complex projects like hydromelioration system modernization.

Increased human activity during construction phases can exacerbate these challenges, leading to potential habitat destruction, degradation, and fragmentation. Construction activities may also result in pollution—both chemical and physical—along with heightened noise and light disturbances that further threaten local ecosystems.

To mitigate these impacts, it is essential to apply environmental protection measures grounded in robust legal frameworks and aligned with World Bank environmental management guidelines. Through diligent application of ESMPs, stakeholders can minimize adverse effects and promote environmental sustainability, ultimately fostering resilience within the hydromelioration systems of Vojvodina and contributing positively to the region’s ecological and social fabric.There is an urgent need for improved integration of ESMPs in water resource management projects, particularly as these projects face modern environmental challenges like climate change, water scarcity, and biodiversity loss. Strengthening

ESMPs in hydromelioration systems would ensure that they not only address immediate environmental concerns but also anticipate long-term impacts. It is important to have adaptive management practices that can evolve as conditions change, including better incorporation of climate resilience strategies and biodiversity conservation measures. By aligning ESMPs more closely with sustainability goals, they can become powerful tools for both environmental protection and the enhancement of agricultural productivity.

Future research should focus on developing more robust, context-specific ESMP frameworks for water management infrastructure. This includes creating adaptable plans that account for local environmental variations and address emerging issues such as climate variability, extreme weather events, and ecosystem restoration. The research should investigate how ESMPs can more effectively engage stakeholders and ensure compliance through improved monitoring and feedback mechanisms. Governments and international organizations must prioritize policies that support the sustainable use of water resources. This can be achieved by incorporating ESMPs into legislative frameworks, enforcing stronger regulations, and incentivizing best practices in water resource management. Such policy support will be critical in promoting sustainable development and protecting water ecosystems for future generations.

Acknowledgments

This research has been supported by the Ministry of Science, Technological Development and Innovation (Contract No. 451-03-65/2024-03/200156) and the Faculty of Technical Sciences, University of Novi Sad through project "Scientific and Artistic Research Work of Researchers in Teaching and Associate Positions at the Faculty of Technical Sciences, University of Novi Sad" (No. 01-3394/1).

REFERENCES

[1] Bennett, S., Kemp, S., & Hudson, M. D. (2016). Stakeholder perceptions of Environmental Management Plans as an environmental protection tool for major developments in the UK. *Environmental Impact Assessment Review, 56*, 60-71. http://doi.org/10.1016/j.eiar.2015.09.005

[2] Djalilov, A., Nazarov, O., Sobirov, E., Gayipov, I., Abdunabiev, D., & Urolov, S. (2024). Research of ultrasonic sensors for measuring water flow in hydromelioration objects. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1390, No. 1, p. 012023). IOP Publishing. http://doi.org/10.1088/1755-1315/1390/1/012023

[3] Durning, B., & Broderick, M. (2018). Environmental and social management plans. In Therivel, R., & Wood, G. (Eds.) *Methods of Environmental and Social Impact Assessment* (4th ed., pp. 678–702). Routledge. http://doi.org/10.4324/9781315626932-20

[4] Huang, J. C., Mitsch, W. J., & Zhang, L. (2009). Ecological restoration design of a stream on a college campus in central Ohio. *Ecological engineering*, *35*(2), 329–340. http://dx.doi.org/10.1016/j.ecoleng.2008.07.018
[5] Hui, I. K., Chan, A. H., & Pun, K. F. (2001). A study of the environmental management system implementation practices. *Journal of cleaner production*, *9*(3), 269–276. http://dx.doi.org/10.1016/S0959-6526(00)00061-5
[6] IEMA (2024). *Implementing the Mitigation Hierarchy from Concept to Construction* https://www.iema.net/media/oone2qce/iema-mitigation-in-eia-guidance-final.pdf
[7] Klychova, G., Zakirova, A., Ullah, R., Khismatullin, M., Khismatullin, M., & Nekrasova, E. (2022). The Role and Place of Irrigated Agriculture in Agricultural Production and Its Economic Efficiency. In *International Scientific Conference on Agricultural Machinery Industry "Interagromash"* (pp. 2694–2706). Springer International Publishing. http://doi.org/10.1007/978-981-16-3844-2
[8] Langhammer, J., & Vilímek, V. (2008). Landscape changes as a factor affecting the course and consequences of extreme floods in the Otava river basin, Czech Republic. *Environmental monitoring and assessment*, *144*, 53–66. http://doi.org/10.1007/s10661-007-9941-6
[9] Langsdale, S. M., & Cardwell, H. E. (2022). Stakeholder engagement for sustainable water supply management: what does the future hold?. *AQUA—Water Infrastructure, Ecosystems and Society*, *71*(10), 1095–1104. http://doi.org/10.2166/aqua.2022.041
[10] Lochner P. 2005. Guideline for Environmental Management Plans. CSIR Report No ENV-SC2005-053 H. Cape Town, Republic of South Africa: Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning. https://d7.westerncape.gov.za/eadp/sites/eadp.westerncape.gov.za/files/atoms/files/deadp_emp_guideline_june05.pdf
[11] Spaling, H., & Smit, B. (1995). A conceptual model of cumulative environmental effects of agricultural land drainage. *Agriculture, ecosystems & environment*, *53*(2), 99–108. https://doi.org/10.1016/0167-8809(94)00566-W
[12] Tlapáková, L., Karásek, P., & Stejskalová, D. (2013). Retrospective Evaluation of the Extent and Spatial Changes of Realized Hydromelioration Systems. *Polish Journal of Environmental Studies*, *22*(6), 1855–1862. https://www.pjoes.com/Retrospective-Evaluation-of-the-Extent-and-Spatial-r-nChanges-of-Realized-Hydromelioration,89155,0,2.html