Sustainable Development Assessment of Existing Hydraulic Structures Through the IHA Protocol

Doctoral thesis – Abstract
for obtaining the scientific title of doctor at
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Abstract

One of the major concerns of contemporary society is the issue of sustainability and, implicitly, sustainable development, having as its fundamental objective the long-term maintenance of natural, social and economic resources, without compromising the ability of future generations to meet their own needs.
From an ecological perspective, sustainability aims at the responsible use and exploitation of natural resources, by protecting ecosystems and biodiversity, thus avoiding environmental degradation.

By adopting the 2030 Agenda for Sustainable Development, Romania has committed to integrate the principles of sustainability into national policies, promoting sustainable economic development and a fair, prosperous and environmentally responsible society. This doctoral thesis aims to identify practical solutions that will contribute to the achievement of part of the Sustainable Development Goals (SDGs), as assumed by our country within the framework of the "2030 Agenda for Sustainable Development", such as: SDG 6 – Clean Water and Sanitation, SDG 11 – Sustainable Cities and Communities and SDG 13 – Climate Action.

The central objective of this research is to develop a methodology for evaluating existing hydrotechnical structures from a sustainability perspective to optimize their operation and management. This approach will strengthen Romania's capacity to respond to climate change impacts and contribute to mitigating effects on water resources and population well-being. The evaluation framework represents a critical first step in transforming hydrotechnical projects into sustainable infrastructure aligned with European standards.

The methodological framework of the thesis is based on the hydropower project assessment protocol, developed by the International Hydropower Association (IHA), adapted and developed in a modified version (mHSAP), applicable to existing hydropower structures in Romania. The implementation of this modified protocol allows for a clear assessment of the current state of the infrastructures, the identification of deficiencies in operation and management, as well as the formulation of solutions for optimizing their operation and alignment with the principles of sustainability.

Summary

This thesis is structured in seven main chapters, followed by references and appendices.
Chapter 1 "Introduction" presents the conceptual framework underpinning the motivation and the need to develop a tool for evaluating hydrotechnical constructions from a sustainability perspective. This section summarizes the fundamental concepts that are the basis for the research topic, such as sustainability and sustainable development ([31],[21],[14]), the Sustainable Development Goals (SDGs) ([24]), as well as the Hydropower Sustainability Assessment Protocol (HSAP), developed by the International Hydropower Association (IHA).

Romania, as a member state of the European Union (EU), is legally bound to implement the legislation adopted at the community level, transposing European directives and regulations into the national framework. In the field of water resources protection and mitigating climate change, the European Union has adopted a series of essential policies and legislative instruments, such as: the EU Commission White Paper "Adapting to Climate Change: Towards a European Framework for Action" ([35]), the European Green Deal ([36]) and the Water Framework Directive (2000/60/EC). Within the framework of the Green Deal, initiatives such as "Clean, Affordable and Secure Energy", the European Climate Law, as well as the new European Strategy for Adaptation to Climate Change outline the European regulatory framework assumed by Romania. At the national level, the strategic framework is complemented by the National Strategy on Climate Change Adaptation for the period 2022-2030 with a 2050 perspective (SNASC) and the National Action Plan for the implementation of SNASC (PNASC) ([37]). National legislation also includes Law no. 259/2010 on safety and Water Law no. 107/25.09.1996 – with subsequent amendments and supplements, both normative acts with an essential role in defining the applicable legislative framework at the time of the development of this research.

Chapter 1 analyzes the current situation of Romania from a sustainable development perspective. The progress recorded by our country in achieving the Sustainable Development Goals (SDGs), measured by percentage trend indicators, is presented in the Sustainable Development Report for the year 2024, Romania ranking 40th out of 167 countries, with a score index of 76.70, as shown in the country dashboard of Romania for the year 2024 (Figure 1 [33]), increased in value, hence better, as compared to the year 2000 (Figure 2). Country report constitutes a global assessment of the annual progress of countries towards the SDGs. It can be seen that, at the global level, the score for SDG 6 - Clean water and sanitation - is increasing, while progress regarding SDG 13 - Climate action - is in a stagnation phase.

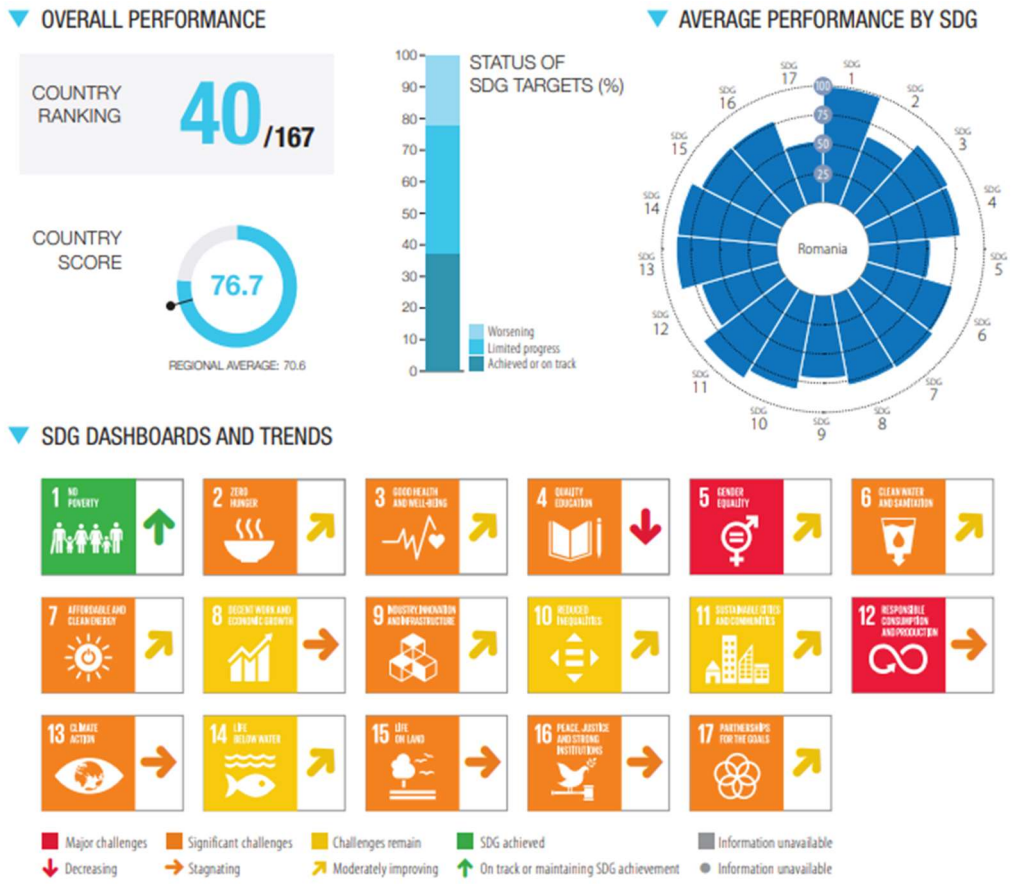

Figure 1.Romania Country Dashboard for year 2024, in comparison with world level of SDG implementation (source: dashboard.sdgindex.org, last checked on 21.03.2025)

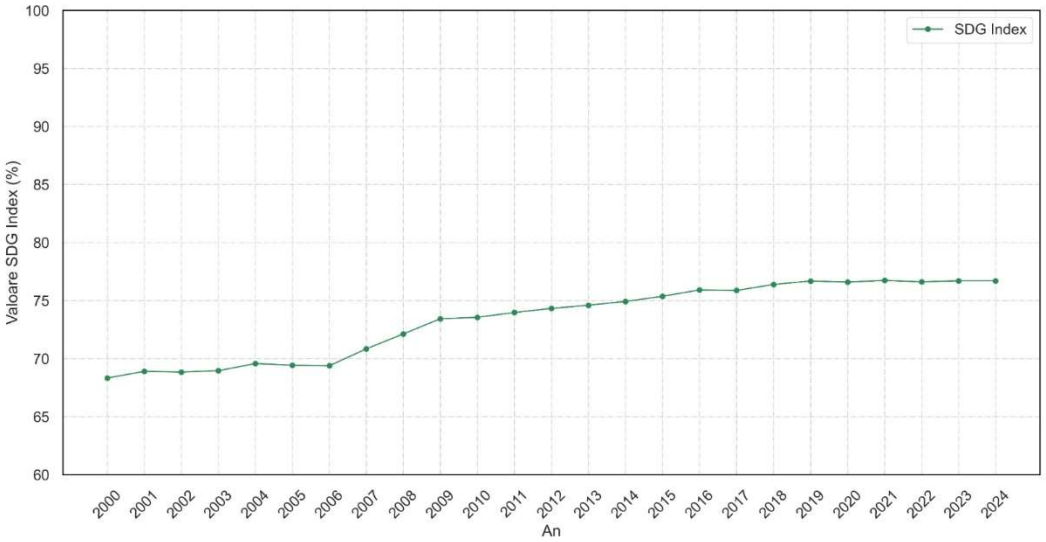

Figure 2.Progress of Romania's overall SDG score index for the period 2000-2024

The subject of water-related natural disasters is at the forefront of international research, being recognized as one of the major challenges nowadays. Hydrological hazards – floods and droughts generated by climate change – are the subject of extensive studies and analyses ([1], [2], [4], [8], [12], [18], [25], [26], [32]). Globally, most large dams in Europe and North America were built between the 1920s and 1970s, and subsequently this type of investment entered a downward trend ([6]), resulting from limited suitable locations and growing environmental and social pressures. In contrast, the construction of new hydropower dams continues in river basins such as the Amazon, Congo or Mekong, where the need for energy takes precedence over socio-economic and environmental problems ([7], [31]). However, scientific literature confirms the possibility of planning and operation of dams in a sustainable manner ([11],[30]) adapted to the specifics of each river basin and the level of development of the countries involved ([8], [10], [13], [28],[29]). Achieving these objectives requires close collaboration between public authorities, local communities, academia and non-governmental organizations, in order to minimize the negative impact and maximize the social and ecological benefits of these projects [3], [15], [19], [27]. Achieving these objectives requires close collaboration between public authorities, local communities, academia and non-governmental organizations, in order to minimize the negative impact and maximize the social and ecological benefits of these projects ([3], [15], [19], [27]).
In Romania, most dams were built in the 1970s and 1980s. After 1990, no large dams were built in the country, mainly because of lack of necessary funds. Demographic and economic changes, along with the modification of hydrological regimes, as a result of climate change, as well as the adaptation to new European regulations, have generated new challenges in the sustainable exploitation of existing dams and other hydrotechnical constructions, such as defense dikes ([5]). According to the "Romania Water Diagnostic Report" (2018), climate change will lead, in the future, to the intensification of floods and flash floods in Romania, but also to the increase in the magnitude and frequency of droughts ([20]). In this context, it is necessary to revise and redesign the existing hydrotechnical constructions – especially dams – to increase water storage capacity during droughts and to strengthen their role in flood protection.

Although the existing hydrotechnical infrastructure is of strategic importance and is generally cost-effective, few projects can be considered fully sustainable. Consequently, obtaining a real and current assessment of the degree of sustainability of hydrotechnical constructions in Romania requires the use of assessment tools adapted to the legislative framework, the economic context and current social particularities. The optimization of these infrastructures can decisively influence Romania's capacity to respond to the effects of climate change, while also constituting a central element in protecting water resources and, implicitly, in ensuring the quality of life of the population.

The main objective of this research is to develop a protocol for evaluating existing hydrotechnical constructions, starting from the existing protocol for evaluating hydropower projects, a protocol developed by IHA, known as Hydropower Sustainability Assessment Protocol (HSAP). Its adaptation in a modified version (mHSAP) and application to the hydrotechnical infrastructures in Romania will allow obtaining a clear picture of the current situation, identifying deficiencies and formulating solutions to optimize operation. In this way,

the aim is to increase Romania's capacity to achieve the Sustainable Development Goals assumed by joining the 2030 Agenda.

Chapter 2, entitled "Sustainability Assessment of Hydropower Projects and Related Hydrotechnical Structures", describes the existing HSAP developed by IHA. It presents how it was developed and how it has been updated to address climate change resilience and mitigation, ensuring its continued relevance and applicability in the face of current environmental challenges ([34], [9]).

The assessment includes over twenty criteria directly related to the sustainability of the project under study. These criteria cover environmental, technical, economic and social aspects, including topics such as biodiversity, water quality, climate change, financial viability, working conditions, impact on communities, rights of indigenous peoples and others.

The protocol includes 4 sections intended to reflect the 4 different stages of development of a project: inception, preparation, implementation and operation, each stage assuming its own set of evaluation criteria. Figure 3 illustrates the 4 stages of a hydropower project and the main decision points related to them.

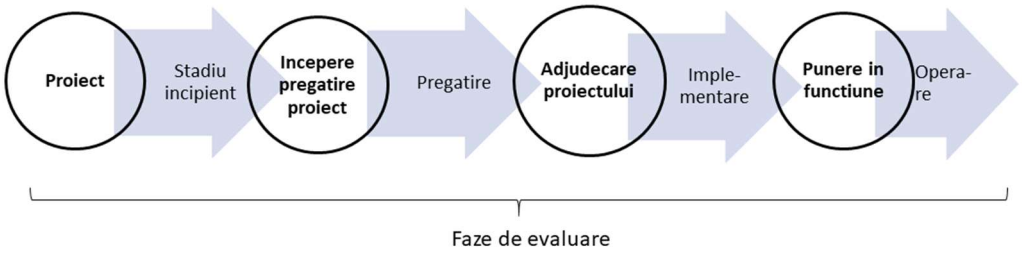

Figure 3.Stages of a hydrotechnical project

According to each stage of a project, the performance criteria are evaluated and represented by a rosette, with five ranking levels for each evaluated criterion, as can be seen in the example rosette in Figure 4.

The scores given to the evaluated criteria range from level one - for low performance, to level five - for the highest performance. Level three is designated as the initial viable level for sustainability, and to be considered sustainable, an infrastructure must reach at least level 3 in all criteria.

After the detailed description of the project, Chapter 2 continues with concrete examples of its applicability, at an international level, and with the presentation of the conclusions of these assessments.

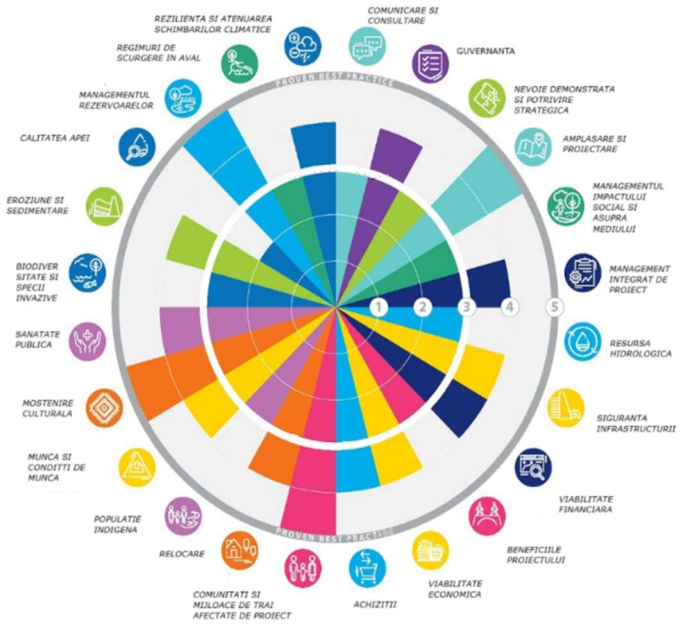

Figure 4.Example of a rosette produced following an assessment (source: https://www.hs-alliance.org/)

Chapter 3, the "mHSAP Modified Protocol for the Assessment of Existing Hydrotechnical Constructions" presents in detail the modified protocol that is the central subject of this research.
This thesis proposes the adaptation of the HSAP protocol to existing hydrotechnical constructions, such as dams and dikes, without them necessarily being part of a hydropower project. This modified protocol aims to assess these constructions from the point of view of sustainability, the potential to become sustainable (where they do not already fall within this criterion) and the identification of concrete optimization solutions from a sustainability perspective.

The adaptation involves the selection of relevant indicators for each case and the development of a sustainability profile by assessing performance in relation to them. Each evaluation is personalized for the specific case study considered. The scores assigned to the indicators are established based on available data regarding the structure's objectives and on information accessible to the public or institutions regarding current performance.

The methodology has four main stages:

1. Review of the HSAP protocol literature and its application
2. Definition of a modified HSAP protocol: mHSAP, applied to hydrotechnical structures with more than 35 years of operation
3. Data collection and processing and application of mHSAP to case studies
4. Definition of the mHSAP protocol criteria to be used in each specific case studied (dam or dike)

In the first phase, a detailed analysis of the existing HSAP protocol, currently used in the evaluation of hydropower projects, was carried out, in all four stages, from the design to the commissioning stage. Based on the conclusions drawn from this analysis, the research proposes a refined protocol, called mHSAP. This modified protocol includes the evaluation of structures built 50-60 years ago, in order to obtain relevant information about the practices used in the past, while taking into account the current state of operation of these structures. In addition, mHSAP aims to estimate the future performance of hydropower projects, in the context of climate change. The methodology focuses on developing an efficient tool for evaluating hydropower structures from a sustainability perspective, in line with European standards and global directions regarding water resources management.

The current research adapts the protocol to specifically assess existing dams and dikes. The objective is to retain relevant indicators applicable to hydrotechnical infrastructures that have been operational for a long period, over 35 years. This approach aims to build a comprehensive sustainability profile, adding additional information to the regular structural feasibility studies carried out periodically. Sustainability assessment is generally valid for any infrastructure in operation, however each case study comes with its own particularities that will ultimately be reflected in the final assessment report. The scoring of the indicators is based on available data regarding the objectives of the structure, on publicly available information and on information gathered on its current performance. The protocol is called mHSAP (modified HSAP).

Although the mHSAP specifically analyses the criteria for operational Romanian structures, it can be used for any structure in any country. The proposed MHSAP adapts some of the criteria of the early phase to the re-evaluation for the next 5 years of operation of a structure, starting from the moment of completion of the mHSAP assessment. The method selects 17 of the 26 criteria to evaluate old flood protection structures.

Those retained in the assessment are presented in Table 1.

Table 1. mHSAP criteria and their relationship to sustainability aspects

	Project Phases		**Sustainability Aspects**	**Criteria Acronyms**
Subject/Criteria	***HSAP***	***mHSAP***		
Policies and Plans	ES3	5Y1	Integrated	C1
Institutional Capacity	ES5	5Y2	Economic and Financial	C2
Risks (tehnical, social, environmental)	ES6, ES7, ES8	5Y3	Tehnical, social and environmental	C3

Comunications and Consultation	P1, I1, O1	OP1	Social	C4
Gouvernance	P2, I2, O2	OP2	Integrated	C5
Social and Environmental Impact Assessment	P5, I5, O5	OP3	Environmental and social	C6
Integrated Project Management	P6, I6	OP4	Integrated	C7
Hydrological Resource	P7, O7	OP5	Technical	C8
Infrastructure Safety	P9, I9, O9	OP6	Technical	C9
Project Benefits and Financial Viability	P10, P11, I10, I11, O10, O11	OP7	Economic and financial	C10
Labor and Working Conditions	P17, I17, O17	OP8	Social	C11
Public Healt	P19, I19, O19	OP9	Social	C12
Biodiversity and Invasive Species	P20, I20, O20	OP10	Environmental	C13
Erosion and Sedimentation	P21, I21, O21	OP11	Environmental	C14
Water Quality	P22, I22, O22	OP12	Environmental	C15
Downstream Flow Regimes	P25, I25, O25	OP13	Environmental	C16
Climate Change Resilience and Mitigation	P26, I26, O26	OP14	Integrated	C17

The proposed mHSAP uses the same consistent scoring principles on a scale of 1 to 5. On this scale, 1 represents the lowest score, while 5 represents the highest, assessing best practices related to a specific sustainability concern. The breakdown of the scoring levels is as follows:

- Level 1 – Significantly lacking core good practices, poor performance with significant gaps in sustainability measures
- Level 2 – The most relevant aspects of core good practices have been implemented, but there is a notable deficiency.
- Level 3 – Delineates that core good practices are present on a specific sustainability theme.
- Level 4 – All core good practice elements have been executed and, in some cases, exceeded, but there is a significant deficit in meeting the criteria for the established best practices. The structure has adequate and effective management, operation and outlook and has only a few gaps in the interrelationships between relevant sustainability issues.
- Level 5 – Characterizes proven best practices on a specific sustainability issue.

The chapter concludes with the definition of the 17 performance indicators included in the mHSAP protocol.

Chapter 4, "Application of the mHSAP protocol in the Cincis dam-Hunedoara county study" is based on the published article: Popescu, I., Teau, C., Florescu, C., & Constantin, A. (2023). Modified methodological framework for sustainability evaluation of existing hydraulic structures in Romania: the case study of Cincis dam, Hunedoara. GeoEcoMar Scientific Journal ([16]).

This chapter presents the first case study of the thesis: the sustainability assessment of the Cinciș dam by applying the mSAP concept. The chapter includes an introductory part, describing the project, which presents data about its location, the functions it performs as well as the specific characteristics of the development. The chapter continues with the actual evaluation of each objective in particular and their scoring. During the evaluation, face-to-face interviews were conducted with employees of Apelor Române, the documentation provided by them was analyzed, field trips were carried out on site and the norms in force for the operational structures were analyzed. A number of 17 criteria were analyzed, each area was assigned a score, in accordance with the observations made and the professional expertise accumulated by the author in the field.

The assessment was not assisted by automated algorithms, but reflects a qualitative analysis based on the available data. In cases where a sufficient amount of relevant information could not be obtained, the

respective criterion was excluded from the analysis, without assigning a score. The results obtained were centralized, as presented in Table 2, and obtained sustainability profile is presented in Figure 5.

Table 2. Results of the Cinciș Dam Assessment

Nr.crit	Policies and Plans	Score
C1	Institutional Capacity	3
C2	Risks	2
C3	Communications and Consultation	-
C4	Governance	4
C5	Social and Environmental Impact Assessment	3
C6	Integrated Project Management	4
C7	Hydrological Resource	4
C8	Infrastructure Safety	3
C9	Project Benefits and Financial Viability	4
C10	Labour and Working Conditions	1
C11	Public Health	3
C12	Biodiversity and Invasive Species	5
C13	Erosion and Sedimentation	4
C14	Water Quality	2
C15	Downstream Flow Regimes	5
C16	Climate Change Resilience and Mitigation	4
C17	Policies and Plans	1

The application of the mHSAP methodology to the Cinciș dam revealed a mixed functional profile, with both consolidated areas, managed in accordance with current legal and technical requirements, and vulnerable areas requiring specific interventions. The analysis demonstrated that, although the objective benefits from a stable operational framework and practices that ensure the protection of public health, water resources and biodiversity, there are significant limitations in terms of integrating the risks associated with climate change. This aspect highlights the need to develop and implement a proactive strategy for adapting to new hydroclimatic conditions.

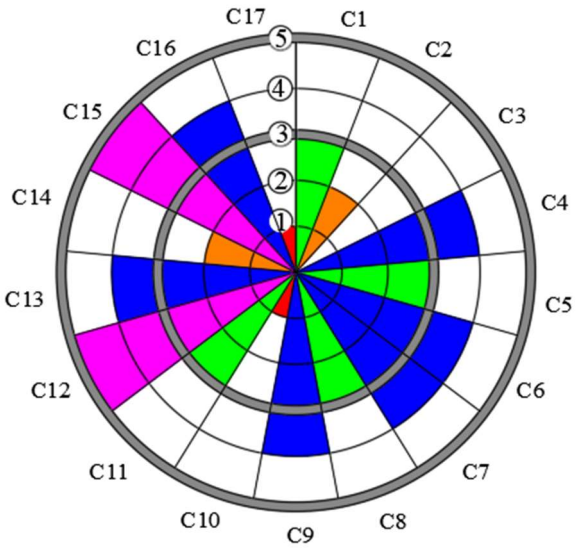

Figure 5. Assesment Rosette of the Cinciș Dam

The application of the mHSAP methodology to the Cinciș Dam highlighted a mixed functional profile, in which both consolidated areas, managed in accordance with current legal and technical requirements, and vulnerable areas requiring specific interventions are highlighted. The analysis demonstrated that, although the facility benefits from a stable operational framework and practices that ensure the protection of public health, water resources and biodiversity, there are significant limitations in terms of integrating the risks associated with climate change. This aspect highlights the need to develop and implement a proactive strategy for adapting to new hydroclimatic conditions.
Therefore, the assessment carried out through the mHSAP not only provides an overview of the current performance of the Cinciș Dam, but also serves as a strategic support tool for decision-makers, providing clear guidelines for increasing the long-term sustainability of the structure. The results can form the basis of a coherent, phased and integrated action plan, aligned both with international good practices and local specificities.

Chapter 5, "Application of the mHSAP protocol in the study of the Deva dike, Hunedoara county", analyzes the possibility of using the proposed protocol in the assessment of the sustainability of hydrotechnical structures with a flood protection role, by applying it in the study of the Deva dike.
The chapter is based on the article [17] Popescu, I., Teau, C., Moisescu-Ciocan, C., Florescu, C., Adam, R., & Constantin, A. T. (2023). Evaluating the sustainability of longtime operating infrastructure for Romanian flood risk protection. Journal of Environmental Sustainability, 15(3), 211-229 ([17]).

To carry out the assessment, field visits, interviews and documentation activities were carried out at the headquarters of the Hunedoara Water Management System, and the results of the assessment were centralized in a table in Table 3, presenting the scores for each analyzed criterion.

Table 3. Results of the Deva dam assessment

Nr.crit	Policies and Plans	Score
C1	Institutional Capacity	3
C2	Risks	3
C3	Communications and Consultation	-
C4	Governance	3
C5	Social and Environmental Impact Assessment	3
C6	Integrated Project Management	4
C7	Hydrological Resource	2
C8	Infrastructure Safety	-
C9	Project Benefits and Financial Viability	3
C10	Labour and Working Conditions	4
C11	Public Health	4
C12	Biodiversity and Invasive Species	5
C13	Erosion and Sedimentation	-
C14	Water Quality	3
C15	Downstream Flow Regimes	4
C16	Climate Change Resilience and Mitigation	5
C17	Policies and Plans	2

Following the assessments for each criterion, a sustainability profile was obtained for the Deva dike, as shown in Figure 6.

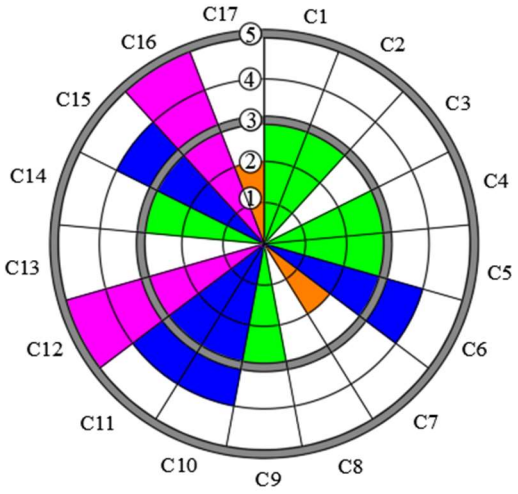

Figure 6. Rosette resulting from the assessment of the Deva dike

This visual representation allows the ABA Mureș administrator to quickly identify areas where interventions for improvement are needed, as well as those aspects of the dike management that are functioning perfectly. The methodology applied, although predominantly qualitative, provides a coherent and comprehensive picture of the structure's performance from a sustainability perspective. The assessment was not assisted by automated algorithms, but reflects a qualitative analysis based on available data and the author's professional expertise in this field. The possibility of periodically repeating this assessment also allows for dynamic monitoring of the dike's condition and may signal the appropriate time to initiate in-depth technical investigations.
The profile obtained is a useful tool for decision-makers, providing a rational basis for prioritizing investments, updating technical documentation, and developing long-term adaptation strategies. The evaluation thus contributes to strengthening sustainable and proactive governance in the management of regional hydrotechnical infrastructure.

Chapter 6 "Applicability of mHSAP in the assessment of existing hydrotechnical constructions" highlights the role that the mHSAP protocol can have in complementing the Romanian Legislative Framework, by creating a voluntary and integrated framework for re-evaluating the way in which existing hydrotechnical constructions in our country are managed and modernized, bringing added coherence, efficiency and sustainability to the administration of these objectives. In the absence of dedicated norms for adapting infrastructure to climate change, the protocol provides a functional framework for assessing, in addition to safety and economic efficiency, the ecological impact, adaptation to climate change and project governance risks and for taking adaptation measures.
The developed modified protocol, mHSAP, promotes modernizations that are directly related to both operational efficiency and biodiversity conservation, ensuring ecological flow and environmental conservation. The protocol can be used as a guide to good practices by authorities (e.g. Apele Române), operators, consultants and beneficiaries of European funds. In contrast to current, often formal practices, mHSAP encourages the real involvement of stakeholders, including local communities and non-governmental organizations, thus constituting a means of stimulating transparency and public participation.

The chapter also presents how the mHSAP protocol can contribute to the reauthorization process of an existing dam and the authorization/reauthorization of an operating dike. The national reauthorization model is currently based on traditional technical expertise, mainly focused on sectoral analyses (e.g. static analysis, verification of dam elements, filling behavior, etc.). Although this approach provides a solid technical basis, it sometimes proves insufficiently flexible and interdisciplinary to respond to new challenges, such as the increase in the frequency of external climate phenomena, the integration of the SDGs and compliance with the European Green Deal, or the requirements related to transparency and public communication regarding risks.

Following the application of this protocol in the concrete assessment of two existing hydrotechnical constructions, its potential for improvement can be observed. It can evolve over time to become more

inclusive, more quantitative and objective, and better integrated into the governance process. To reduce the subjectivity of the assessment, more quantitative measures and tools can be integrated, such as advanced modeling and simulation techniques that can complement the expert assessment by forecasting the results in various scenarios. The development of decision support software programs around mHSAP (for example, tools that automatically generate part of the evidence needed for scoring from the existing database or remote sensing) could significantly increase the credibility of such a protocol and significantly decrease the time and costs of implementation.

The link between the mHSAP protocol and the growth of the SDGs is made by assessing how hydrotechnical infrastructure (dams, dikes) contributes to achieving these global objectives.
The mHSAP protocol evaluates projects based on economic, social and environmental sustainability criteria, which makes it directly applicable in the context of the SDGs, which have a similar structure. Sustainable management of Romania's hydrotechnical infrastructure can directly contribute to increasing the national score on the Sustainable Development Goals.

Chapter 7 presents the conclusions and personal contributions. The research conclusions presented in this thesis, together with the results of the evaluations carried out, suggest the need for a more flexible, evidence-based, and participatory sustainability assessment model. Such a model not only provides an overview of the current performance of projects, but also constructively guides them towards continuous improvement.

The two case studies presented in this thesis demonstrate the applicability of the modified mHSAP protocol for non-energy structures, revealing that a structured sustainability audit can identify both vulnerabilities and opportunities for improvement of the analyzed infrastructure. In addition, the mHSAP assessment stimulates the consideration of aspects often ignored in the past, such as biodiversity conservation, climate change adaptation, or community involvement.

The mHSAP framework can support the alignment of local and regional authorities' strategies with the UN Sustainable Development Goals, in particular by encouraging an integrated approach to sustainability in the processes of maintenance, operation and modernization of existing infrastructure. In conclusion, mHSAP represents a significant methodological innovation, which extends the applicability of HSAP principles beyond the hydropower sector.

The effective application of mHSAP requires the involvement of multidisciplinary teams, including engineers, hydrologists, economists, sociologists, etc., and it is necessary to promote collaboration between research institutions, universities and public administration. It is also recommended that the application of the protocol be carried out at regular intervals and accompanied by training sessions for technical personnel responsible for the operation and maintenance of dams and dikes.

To date, non-energy hydropower infrastructures, such as dams and dikes, although essential for the safety and functionality of communities, have not benefited from a coherent and systematic framework for sustainability assessment. The mHSAP protocol has the potential to become a reference standard in this field, supporting the rehabilitation process of old infrastructures, strategically targeting investments and aligning public policies with the sustainable development goals in particular SDG6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

This research remains open to further improvements, through continued field validation, interdisciplinary collaboration and expansion at a regional or European scale, in order to strengthen a culture of sustainability in the field of hydropower construction. More academic research and experience in implementing the protocol are needed to refine this method, reduce subjectivity and ensure that sustainability assessments lead to real improvements on the ground.

References

[1] Beevers L, Popescu I, Pregnolato M, Liu Y and Wright N (2022) Identifying hotspots of hydro-hazards under global change: A worldwide review.Front. Water 4:879536. https://doi.org/10.3389/frwa.2022.879536

[2] Collet, LHarrigan, S., Prudhomme, C., Formetta, G., and Beevers, L. (2018). Future hot-spots for hydro-hazards in Great Britain: a probabilistic assessment. Hydrol. Earth Syst. Sci.22, 5387–5401. https://doi.org/10.5194/hess-22-5387-2018

[3] Cortes-Borda, D., Andres Polanco, J., Escobar-Sierra, M. (2022). Social perception assessment of hydropower sustainability: A stepwise logistic regression modelling. Journal of Environmental Science and Policy, 134(8): 108-118. https://doi.org/10.1016/j.envsci.2022.03.026

[4] Dottori, F., Mentaschi, L., Bianchi, A., Alfieri, L. and Feyen, L., (2020) Adapting to rising river flood risk in the EU under climate change, EUR 29955 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-12946-2, doi:10.2760/14505, JRC118425.

[5] Drobot, R., Draghia, A. F., Dinu, C., Sîrbu, N., Chendeș, V., & Mazilu, P. (2024). Adaptive operating rules for flood control of a multi-purpose reservoir. Hydrology, 11(9), 147. https://doi.org/10.3390/hydrology11090147

[6] [19] Emilio F. Moran, Maria Claudia Lopez, Nathan Moore, David W. Hyndman - Sustainable hydropower in the 21st century, Nov 2018, https://doi.org/10.1073/pnas.1809426115

[7] Grill Gunther, Lehner Bernhard, Lumsdon Alexander, MacDonald Graham, 2015: An index-based framework for assessing patterns and trends in river fragmentation and flow regulation by global dams at multiple scales. Environmental Research Letters, http://dx.doi.org/10.1088/1748-9326/10/1/015001

[8] Guido B.I., Popescu I., Samadi V., Bhattacharya B. An integrated modeling approach to evaluate the impacts of nature-based solutions of flood mitigation across a small watershed in the southeast United States (2023) Natural Hazards and Earth System Sciences, 23 (7), pp. 2663 – 2681 DOI: 10.5194/nhess-23-2663-2023

[9] Hydropower Sustainability Assessment Protocol, published by International Hydrpower Association –2020, disponibil la: Hydropower+Sustainability+Assessment+Protocol+07-05-20.pdf (accesată ultima dată în martie 2025)

[10] Jonoski A., Popescu I., Zhe S., Mu Y., He Y.Analysis of flood storage area operations in Huai River using 1D and 2D river simulation models coupled with global optimization algorithms (2019) Geosciences (Switzerland), 9 (12), art. no. 509 http://dx.doi.org/10.3390/geosciences9120509

[11] Karakatsanis, D., Patsialis, T., Kalaitzidou, K., Kougias, I., Ntona, M. M., Theodossiou, N., & Kazakis, N. (2023). Optimization of dam operation and interaction with groundwater: An overview focusing on Greece. Water, 15(21), 3852. https://doi.org/10.3390/w15213852

[12] Mateescu E, Smarandache M, Jeler N, Apostol V (2013) Drought conditions and management strategies in Romania. Initiative on "Capacity Development to Support National Drought Management Policy"(WMO, UNCCD, FAO and UNW-DPC) 600

[13] Patsialis, T., Kougias, I., Kazakis, N., Theodossiou, N., & Droege, P. (2016). Supporting renewables' penetration in remote areas through the transformation of non-powered dams. Energies, 9(12), 1054. https://doi.org/10.3390/en9121054

[14] Pienaar GW, Hughes DA (2017) Linking Hydrological Uncertainty with Equitable Allocation for Water Resources Decision-Making. Water Resources Management 31: 269-282 DOI 10.1007/s11269-016-1523-3

[15] Poff, N. L., & Olden, J. D. (2017). Can dams be designed for sustainability? Dam design on the Mekong River can help to support water, energy, and fisheries needs. Science, 358(6368), 1252–1253. https://doi.org/10.1126/science.aaq1422

[16] Popescu Ioana, Camelia Teau, Constantin Florescu, Albert Constantin - Modified methodological framework for sustainability evaluation of existing hydraulic structures in Romania: the case study of Cincis dam, Hunedoara – GeoEcoMar Scientific Journal, https://doi.org/10.5281/zenodo.14228682

[17] Popescu, I., Teau, C., Moisescu-Ciocan, C., Florescu, C., Adam, R., & Constantin, A. T. (2023). Evaluating the sustainability of longtime operating infrastructure for Romanian flood risk protection. *Journal of Environmental Sustainability, 15*(3), 211-229. https://doi.org/10.3390/su162310573

[18] Prudhomme, C., Giuntoli, I., Robinson, E. L., Clark., D. B, Arnell, N. W., Dankers, R., et al. (2014). Hydrological droughts in the 21st century, hotspots and uncertainties from a global multimodel ensemble experiment. Proc. Nat. Acad. Sci. U S A 111, 3262–7. https://doi.org/10.1073/pnas.1222473110doi: 10.1073/pnas.1222473110

[19] Quaranta, Emanuele, et al. "Assessing the Energy Potential of Modernizing the European Hydropower Fleet." Energy Conversion and Management, vol. 239, 2021, p. 114655, https://doi.org/10.1016/j.enconman.2021.114655.

[20] Romania Water Diagnostic Report (Vol. 2 of 2) : Romania water diagnostic report (English). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/114311530025860150

[21] Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, Bennett EM, Biggs R, Carpenter SR, Vries Wd, Wit CAd, Folke C, Gerten D, Heinke J, Mace GM, Persson LM, Ramanathan V, Reyers B, Sörlin S (2015) Planetary boundaries: Guiding human development on a changing planet. Science 347: 1259855 DOI doi:10.1126/science.1259855

[22] Teau C., Popescu I., Florescu C., Constantin A., Ciocan C.M., Vlaicu V. (2023) Implementation of water related Sustainable Development Goals in Romania: overview of current and future challenges,) IOP

Conference Series: Earth and Environmental Science, 1136 (1), art. no. 012013, http://dx.doi.org/10.1088/1755-1315/1136/1/012013
[23] Teau, C., & Popescu, I. (2024, ianuarie). Use of IHA's Sustainable Development Criteria to Evaluate Existing Permanent Reservoirs: Application to Romanian Case Studies. In Book of Abstracts of the 15th International Conference on Hydro-Environment Engineering and Research. https://doi.org/10.3850/iahr-hic2483430201-125
[24] United Nations (UN). (2015). Transforming our world: the 2030 Agenda for Sustainable Development. https://sdgs.un.org/2030agenda
[25] Van Lanen HA, Tallaksen LM, Rees G (2007) Droughts and climate change. Brussels: Commission of the European Communities; https://geo.uio.no/edc/downloads/droughts_and_climate_change_2007.pdf
[26] Vousdoukas, M., Mentaschi, L., Mongelli, I., Ciscar Martinez, J., Hinkel, J., Ward, P., Gosling, S. and Feyen, L.,(2020) Adapting to rising coastal flood risk in the EU under climate change, EUR 29969 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-12990-5, https://dx.doi.org/10.2760/456870
[27] Watts Robyn, Allan Catherine, 2012: Sustainable dam planning and operations: reflections on innovative international practices. 6th Australian Stream Management ConferenceAt: Canberra, Australia, https://www.researchgate.net/publication/254559294_Sustainable_dam_planning_and_operations_reflections_on_innovative_international_practices
[28] Wyrwoll Paul, grafton Quentin, (2022) Reforming for resilience: delivering 'multipurpose hydropower' under water and energy risks. International Journal of Water Resources Development, 1032-1061, doi: 10.1080/07900627.2021.1944844
[29] Xu, Z., Niu, Y., Liang, Y., Li, Z., & Iftikhor, A. (2020). The Integrated Hydropower Sustainability Assessment in Tajikistan: A case study of Rogun Hydropower Plant. Journal of Energy, Articol ID 8894072. https://doi.org/10.1155/2020/8894072
[30] Zaniolo, M., Giuliani, M., Sinclair, S., Burlando, P., & Castelletti, A. (2021). When timing matters—Misdesigned dam filling impacts hydropower sustainability. *Nature Communications*, *12*, Articol 3056. https://www.nature.com/articles/s41467-021-23323-5
[31] Zarfl, C., Lumsdon, A. E., Berlekamp, J., Tydecks, L., & Tockner, K. (2015). A global boom in hydropower dam construction. Aquatic Sciences, 77(1), 161–170.Disponibil on line: https://doi.org/10.1007/s00027-014-0377-0
[32] Yang, D., Yang, Y., & Xia, J. (2021). Hydrological cycle and water resources in a changing world: A review. Geography and Sustainability, 2(2), 115–122. https://doi.org/10.1016/j.geosus.2021.05.003
[33] https://dashboards.sdgindex.org/profiles/romania
[34] https://www.hs-alliance.org/hsap-tool
[35] https://www.europarl.europa.eu/doceo/document/TA-7-2010-0154_RO.html
[36] https://www.consilium.europa.eu/ro/policies/european-green-deal/
[37] https://mmediu.ro/domenii/mediu/schimbari-climatice/adaptarea-la-schimbarile-climatice/strategia-nationale-privind-adaptarea-la-schimbarile-climatice-pentru-perioada-2022-2030-cu-perspectiva-anului-2050-snasc-si-a-planului-national-de-actiune-pentru-implementarea-strategiei-nationale-pr/