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ASSESSING THE IMPACT OF HYDROPOWER CONSTRUCTIONS ON FUNCTIONING OF DNIESTER AND PRUT RIVERS ECOSYSTEMS WITHIN THE HYDROECONEX PROJECT

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Abstract. The article reflects on the main issues, research methodologies and achievements of the project HydroEcoNex, a transboundary project carried out by a consortium of research institutes, NGO and a university – Institute of Zoology, International association of river keepers "Eco-Tiras" (Republic of Moldova), "Dunărea de Jos" University of Galați (Romania), as well as Ukrainian Scientific Center of Ecology of the Sea and Hydrometeorological Center for Black and Azov Seas. Among the main obtained results are the development of a common methodology with various set of indicators for assessing hydropower impact and climate change, assessment of lost ecosystem services, sharing of generated knowledge to students and researchers, endowment of the research laboratories with advanced research equipment.

Introduction

Sustainable joint usage of transboundary water resources under the impact of hydropower, climate change, are common challenges for a number of rivers of the Black Sea Basin (BSB), including the Dniester River, which is shared by Ukraine and Republic of Moldova as well as Prut river shared by Ukraine, Romania and the Republic of Moldova. At the European level, hydropower, particularly small hydropower constructions are promoted at a wide level, as these do not contribute to CO₂ emissions thus being a climate friendly way of producing energy and the multiple benefits from the hydropower reservoirs, for example the water storage for drinking and irrigation, drought-preparedness, flood control, fish farming and recreational opportunities, having at the same time the negative impacts on water biodiversity and river hydromorphology. At the same time, large hydroelectric dams have an enormous adverse impact on the environment, due to significant modifications, with serious consequences on aquatic communities as well as at ecosystem level. Monitoring of the status of Dniester and Prut rivers under the impact of hydropower are very relevant, considering the role of these rivers as a major source of water for agriculture, industry and drinking water supply for the Republic of Moldova, Ukraine and Romania.

HydroEcoNex is an international project, implemented by a consortium of five partners: Institute of Zoology, International Association of River Keepers "Eco-Tiras" (Republic of Moldova), "Dunarea de Jos" University of Galați (Romania), Ukrainian Centre for the Ecology of Sea and Hydrometeorological Centre for Black and Azov Seas (Ukraine). The project HydroEcoNex aims at developing a unified system of innovative environmental monitoring for

the provision with data and information essential in the transboundary and sustainable long-term monitoring of observed transformations in Black Sea Basin's river ecosystems, caused by hydropower operation under climate change. On the Dniester River, the project focuses on areas located downstream and upstream of the Dniester Hydro-energetic Complex, including the station no. 1 (HPP-1), and Hydro Power Plant No. 2 (HPP2), built directly on the Dniester River and the Hydroenergetic Station of Accumulation via Pumping (CHAP), constructed on the right bank of the Dniester River and feeding from the buffer reservoir (located between HPP- 1 and HPP-2) and the built-up reservoir on the river bank and on the Prut River in Stâncă - Costești, on the both banks (Romania and the Republic of Moldova).

The current article makes an overview of the main objectives, methodology of work and achievements of the consortium partners of HydroEcoNex during 2018-2021.

Materials and methods

In order to assess the hydropower and climate change impact on transboundary rivers Dniester and Prut, the HydroEcoNex consortium used the following methods of investigation:

Research expeditions. These were carried out downstream and upstream of Dnestrovsk and Stâncă-Costești Hydro-energetic complexes, including those with joint participation of several partners (Institute of Zoology - Ukrainian Scientific Center of Ecology of the Sea – Hydrometeorological Centre for Black and Azov Seas; Institute of Zoology - International Association of River Keepers “Eco-Tiras” – Hydrometeorological Centre for Black and Azov Seas; International Association of River Keepers “Eco-Tiras” – Hydrometeorological Centre for Black and Azov Seas) or individual expeditions of each partner team. The set of principal parameters were analyzed: a) physico-chemical parameters, including temperature and oxygen regimes, sediments, salinity and turbidity, water quality (main ions, nutrients, COD, BOD); b) Biological parameters (bacterio, phyto- and zooplankton, zoobenthos, fish and fish parasites; c) hydrological parameters (annual and seasonal water stocks in the investigated rivers, water level); c) climatic parameters (variability of the air temperature and precipitation). A comparison was made of the actual data with the historic data (pre-disturbance phase - before the beginning of HPP construction and operation). Laboratory analysis. The partners used the existing technical base and acquired new equipment within the project for complex assessment of water quality. The Institute of Zoology purchased modern equipment, those related to chromatography analysis as well as field equipment such as a multi-sensor measuring instrument, for measuring dissolved H₂S/total sulphide in water sample under pH and temperature control and free dissolved carbon dioxide concentration directly in the water, also for the determination of the biochemical oxygen demand (BOD) under laboratory conditions, a VELP Scientifica Cooled Incubator FOC 120E with sets of VELP Scientifica Wireless BOD EVO Sensor System were purchased. The “Dunarea de Jos” University of Galati has procured in 2019 the equipment for direct analysis of solid samples through high-resolution continuum source atomic absorption spectrometry (HR CS AAS), graphite furnace technique (GF-AAS), allowing a fast analysis of trace elements in different environmental samples (soils, silts, hydrobionts, etc.) at low

sensitivities and an accessory used for direct solid sample analysis by using the ContrAA 700 spectrometer, avoiding in this way the need for time costly preliminary sample preparation; in 2020 the infrastructure for environmental investigations was improved by acquiring a mercury analyzer at trace level. Modeling. Model calculations were carried out, using the numerical model RegCM4.7 for the Dniester catchment area. Such model calculations allow assessing the long-term impact of climate change on runoff parameters and the state of surface fields of temperature, humidity and precipitation and forecasting river runoff for a period of up to 10 years in according to the climatic factors. Three-dimensional spatial structure maps were developed on the distribution of the dissolved oxygen, turbidity of the fields, TDS, salinity and temperature of the water area of the Dniester estuary. A thorough statistical analysis was carried out based on a comparison of the Dniester runoff at its several representative sections in two time intervals comparable in duration, reflecting the runoff volume before the start of construction of this complex and after its commissioning. Economic valuation. The proposed methodology developed by International Association of River Keepers “Eco-Tiras” can be used at different scales – the catchment (basin) scale allow quantifying processes related to water cycle and for the implementation of monitoring plans, at the water body scale – specific functions of ecosystems, supporting certain services are analyzed. The methodological guide developed provide a theoretical description of the approach complemented by examples of evaluating the impact of hydropower and climate change in the context of Dniester River environment [1]. These estimations were based on the results of physical and biochemical parameters, identified in the framework of HydroEcoNex project. Based on these approaches, the authors of these articles tried to make an overview of the published results of the experts involved in HydroEcoNex project as well as other relevant studies tried to reveal the current changes occurring at ecosystem level which will help to identify common methods for Moldova and Ukraine for diminishing the impact.

Results and discussions

On the Prut river, the comparative analysis of the flow on the Prut’s riverbed in 1961–1990 and 1991–2018 – before and after global warming, and in 1950–1975 and 1980–2017, before and after the construction of the Costesti -Stanca hydropower plant (HPP) demonstrated no significant impact on the total water discharge downstream, but only the seasonal distribution of the river’s streamflow [1]. Hydropower constructions on Dniester river have caused dramatic deteriorations at ecosystem level, Such changes are for example fragmentation of river continuity, deterioration of the self-purification capacity of the river [2-3], loss of ecosystem services [4], big fluctuation of the water flows and levels [5], alteration of temperature and oxygen regimes [6], bedrock structural changes and annual stock of suspended particles [7], the rate of mineralization and dynamics of the main ions [8], penetration and distribution of alien and parasitic species [9-10]. Monitoring of the status of Dniester river under the impact of hydropower is very relevant, considering that the river is a major source of water for agriculture, industry and drinking water supply for both Moldova and Ukraine. These changes have had

negative consequences on hydrobionts. In order to develop common methods of transboundary monitoring, HydroEcoNex project was developed, which united together experts from the Republic of Moldova, Ukraine and Romania for identifying the indicators of impact and propose methods of mitigation. Various tools developed during the project were systematized and presented on the project website and could be downloaded freely by different stakeholders involved in water resource management, but also the general public who care about the future of Dniester river. The project partners have made an overview of the specialized literature and own data on the impact of hydropower on freshwater ecosystems and have elaborated the set of impact indicators. The overview of historical data in comparison to the current scientific results collected by the project partners indicated that the construction of hydropower plants and the reservoirs on Dniester river led to considerable changes at ecosystem level. The research results were reflected in individual and collective research papers published by the experts of the consortium members of HydroEcoNex projects at international conferences and in various journals, including peer-reviewed high impact journals.

The project activities have led to the following main results:

- Development of a common methodology for monitoring of impacts of hydropower on transboundary river ecosystems were developed based on agreed physico-chemical, biological and climatic indicators and available best international practices, also a comprehensive methodology on economic valuation of lost ecosystem services was also elaborated;
- Capacities and awareness among key stakeholders on integrated water resource management in light of impacts caused by hydropower (HP) and climate change were increased. Several knowledge transfer workshops and public seminars were organized for various stakeholders in Odessa, Chisinau and Galati for didactic staff and students of universities, research staff, and representatives of ministries. The information and knowledge on the project results were disseminated not only to the scientific public, but also to the general public, national and local public authorities, students, interest groups and NGOs during different project activities: launching, Steering Committee Meetings, press conferences, public events, radio and TV interviews, a youth summer school, summer kayaks higher students expedition on Dniester, knowledge transfer workshops, public seminars and by means of developed communication tools - the brochure, calendars, leaflets, banners, the website (<http://hydroeconex.com>).
- A policy instrument (a strategy for bilateral water cooperation on joint monitoring of transboundary rivers affected by hydropower) on integrated monitoring for rivers affected by HP was developed;
- Access to technical and scientific reports, data and methodologies on transboundary monitoring of river ecosystems affected by HP was increased. The project HydroEcoNex developed various tools for mitigation the hydropower and climate change impact including a methodology for economic evaluation of lost ecosystem services, a strategy for transboundary water management, identified set of indicators for assessing the impact,

a project website, which updates the main project results including most recent publications on the main impacts assessed (www.hydroeconex.com), which serve as a platform for knowledge management and dissemination.

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