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ECO-HYDROLOGICAL CHARACTERISTICS OF THE SEDNIV SHP ON THE SNOV RIVER (UKRAINE) AND RATIONALE FOR AQUATIC ECOSYSTEM MONITORING

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ABSTRACT

The article presents a comprehensive eco-hydrological characterization of the Sedniv Small Hydropower Plant (SHP) on the Snov River. Built in 1951 and restored in 1999, this facility represents a unique model of long-term interaction between hydro-technical structures and a high-purity river ecosystem. The technical specifications of the 40-meter wicket dam, which creates a 2.25-meter hydraulic head, are analyzed alongside the morphometric parameters of the 13.5 km long reservoir. The study highlights the formation of distinct hydrodynamic gradients that influence sedimentation processes and the structure of aquatic biota. Special attention is given to the preservation of the relic species *Salvinia natans* L. in the upstream section, emphasizing the need for scientifically grounded water level management. The authors provide a rationale for establishing a systematic seasonal monitoring program, including the use of algae as rapid bioindicators and macrophytes for assessing long-term habitat stability. The proposed framework for an ecological digital passport aims to ensure the sustainable coexistence of renewable energy production and the biodiversity of the Polesie region.

KEYWORDS: Sedniv SHP, Snov River, small hydropower, ecological monitoring, hydro-environmental gradient, *Salvinia natans* L., bioindication, ecological passport, water level regulation.

INTRODUCTION

The modern global energy transition emphasizes the strategic importance of small-scale hydropower plants (SHPs) as a key component of sustainable "green" energy. In Ukraine, SHPs play a dual role: ensuring local energy security and potentially impacting fragile freshwater ecosystems (Stefanyshyn & Vlasiuk, 2021).). The Sedniv Hydroelectric Power Plant, established on the Snov River in 1954, represents a unique historical and technical object that has functioned for decades under a stable hydrological regime.

The Snov River is recognized as one of the cleanest and most floristically diverse small rivers in northern Ukraine, characterized by a high degree of preservation of natural biotopes. However, the presence of a dam with a 2.25-meter head creates a significant ecological gradient between the upstream and downstream sections. Despite the long history of the Sedniv SHP, there is a profound lack of systematic monitoring data regarding its long-term impact on primary producers, specifically microalgae and macrophytes (Reshetchenko, 2022). Under the current challenges of global climate change and anthropogenic pressure, establishing an ecological monitoring system for such "old-generation" hydro-structures is crucial for maintaining the natural balance and biodiversity of the Polesie region's aquatic ecosystems (World Commission on Dams, 2000).

CHARACTERISTICS OF THE SEDNIV HYDROELECTRIC POWER PLANT

The Sedniv Hydroelectric Power Plant (SHP), located on the Snov River, is one of the oldest operating energy facilities in the Chernihiv region. Its construction, spanning from 1948 to 1951, marked a significant era of regional electrification. During its early years, the station operated autonomously, equipped with high-quality Austrian "Voith" turbines (three units of 85.7 kW each) and 1950-issue "Siemens-Schuckert" generators. To compensate for increasing loads and maintain reliability during spring floods, a 150 kW diesel power plant was integrated into the system in 1959. Although the station was successfully automated in 1960 and connected to the national grid in 1962, the shifting priorities of the 1980s towards large-scale energy projects led to its decommissioning and conservation in 1981 (Chernihivoblenergo, n.d.).

After nearly three decades of inactivity, the station was revived through a meticulous restoration effort by Chernihivoblenergo specialists, resuming operations on October 24, 1999. Currently, the Sedniv SHP has an installed capacity of 235 kW and generates approximately 1 million kWh of electricity annually, operating ten months per year. Beyond its energy contribution, the plant plays a crucial environmental role: the 40-meter-long and 3-

meter-high dam maintains a stable water level of approximately 2.5 meters in the Snov River, with a head difference of 2.25 meters between the upstream and downstream sections. This hydraulic regulation has fostered a unique ecological balance, transforming the area into a sanctuary for rich aquatic flora and fauna (Fig. 1). Since 2010, the station has operated under the "green" tariff, and its historic building now houses the Energy Museum of the Chernihiv region, preserving the legacy of local energy development (Chernihivoblenergo, n.d.).

Fig. 1 – Panorama of the Snov River channel below the SHP dam: integration of hydro-technical structures with natural floodplain ecosystems.

Technical Specifications and Structural Features of the Hydropower Node

The Sedniv hydropower node, designed by the "Ukrsilenerhoproekt" institute in 1954, is a complex run-of-river engineering system situated on a watercourse with a drainage area of 8,515 км^2. The main building of the SHP is a pressure-bearing structure with a total above-ground area of 195.44 м^2 (including a 126.1 м^2 engine room). Its architecture reflects the mid-20th-century industrial style, featuring brick upper walls and a durable reinforced concrete underwater foundation. The hydraulic integrity of the upper reservoir is ensured by a

120-meter blind earth dam constructed from fine-grained sand. This dam features a drainage prism and is reinforced with stone riprap in wicker cages on the upstream slope and continuous sodding on the downstream slope, maintaining stable 1:1.5 gradients (Chernihivoblenergo, n.d.).

The water discharge system is a sophisticated assembly consisting of a 40-meter collapsible wicket dam with seven tilting frames and 124 flat wooden shields (0.8 x 1.11 m each), arranged in four tiers. This configuration provides a discharge capacity of 175 m^3/sek and maintains a 2-meter head on the gates. The water intake is facilitated through an open reinforced concrete flume equipped with three 5.0 x 5.0 m wooden gates and rack-and-pinion hoists with a 10-ton capacity. Given the average annual water discharge of 32.4 m^3/sek , these technical specifications allow the plant to effectively regulate water levels for energy production while managing seasonal fluctuations, including peak flood discharges (Chernihivoblenergo, n.d.).

HYDROLOGICAL REGIME AND MORPHOMETRIC PARAMETERS OF THE RESERVOIR

The operation of the Sedniv SHP is determined by a daily regulation of the water flow, which shapes a unique hydrological environment within the 13.5 km long reservoir. With an average width of 40 meters and a total surface area of 50 hectares, the reservoir accumulates a full volume of 1.5 million m^3. The bathymetric characteristics near the dam show an average depth of 3.2 meters, reaching a maximum of 3.5 meters, which promotes the development of specific deep-water aquatic vegetation. Under normal operating conditions, a stable head is maintained with a water level of 109.5 m in the upstream section and 107.5 m in the downstream section, creating a 2-meter difference.

The hydraulic gradient varies from a minimum of 1.8 m to a maximum of 2.2 m, ensuring a calculated water discharge through the turbines of 15.4 m^3/sek. During peak flood periods, the levels in both sections can rise to a maximum of 111.8 m, temporarily leveling the hydraulic head. This dynamic yet regulated regime, characterized by stable water levels in the upper pool, is a decisive factor for the sustainability of local aquatic ecosystems and the formation of diverse phytocenoses (Chernihivoblenergo, n.d.).

RATIONALE FOR MONITORING EFFORTS: HYDRO-ENVIRONMENTAL GRADIENTS

Establishing a systematic ecological monitoring program for the Sedniv hydropower node is necessitated by the complex interplay of technical and biological factors. The primary hydrodynamic factor is the significant head difference of 2.25 meters and the resulting shift in flow velocity. In the upstream section, the stabilization of the water level at 2.5 meters promotes sedimentation and silting, which fundamentally alters the composition of the benthos. Conversely, the downstream section experiences increased turbulence, affecting the distribution of bottom-dwelling organisms. Furthermore, the thermal and gas regime is significantly modified as the water passes through the dam's structures. The mechanical movement of water through the spillway and turbines enhances aeration in the downstream section, which can lead to localized changes in dissolved oxygen levels and temperature, directly influencing the metabolic rates of aquatic biota.

From a biological diversity perspective, monitoring is crucial for tracking rare indicator species, such as submicrotherms and cryophytes, which are sensitive to the thermal fluctuations caused by the dam's operation. The monitoring methodology integrates two complementary approaches. First, the use of algae as rapid bioindicators allows for the immediate assessment of water quality through saprobity indices, reflecting the ecosystem's response to short-term changes. Second, the analysis of higher aquatic plants (macrophytes) serves as a reliable tool for evaluating the long-term stability of the riverbed and banks. The structural changes in macrophyte communities provide evidence of the reservoir's aging process and the overall ecological health of the Snov River (World Commission on Dams, 2000).

MONITORING PERSPECTIVES AND ENVIRONMENTAL MANAGEMENT STRATEGY

The long-term sustainability of the Snov River ecosystem in the area of the Sedniv SHP depends on the transition from episodic observations to a systematic data management framework. A key perspective in this direction is the creation of a comprehensive digital database that will serve as the foundation for the ecological passport of the Sedniv Hydroelectric Power Plant. This database should integrate long-term hydrophysical and biological parameters, allowing for a dynamic assessment of the station's impact on the river’s health. A critical component of the management plan must be the scientific regulation of water levels. Maintaining a stable hydrological regime is vital for the preservation of

spawning grounds and the protection of rare plant communities. Of particular importance is the relic species *Salvinia natans* L., which is found in the upstream section. This floating fern forms unique communities that are highly sensitive to sudden water level fluctuations; therefore, ensuring a stable "upper pool" level is a priority for biodiversity conservation (World Commission on Dams, 2000).

Furthermore, the effectiveness of ecological management relies on mandatory seasonal monitoring of both the chemical composition of the water and the species structure of the algal flora. Comparative analysis of samples taken before and after the dam throughout the year (spring high water, summer low water, and autumn-winter periods) is necessary to track the transformation of nutrient loads and the dynamics of saprobity indices. Such a multifaceted monitoring approach will not only ensure the protection of the Snov River's unique flora but also provide the operator with a scientifically grounded roadmap for minimizing environmental risks while maintaining energy production (Chernihivoblenergo, n.d.).

CONCLUSION

The study of the Sedniv Hydroelectric Power Plant as a structural element of the Snov River ecosystem allows for several key conclusions. First, this facility is not only a historical monument to regional electrification but also a functional model of a small-scale hydropower plant that has maintained a relatively stable ecological balance for decades. The technical specifications of the 40-meter wicket dam and the 2-meter hydraulic head create distinct environmental gradients, forming specific habitats for diverse aquatic biota. Second, the presence of the relic species *Salvinia natans* L. in the upstream section confirms the high natural value of the regulated area and necessitates strict water level management to protect unique phytocenoses.

Finally, the transition to a systematic seasonal monitoring of the chemical composition and species structure of the algal flora is an essential requirement for the sustainable operation of the SHP. Implementing a digital ecological passport and a scientifically grounded management plan will ensure the preservation of the Snov River's biodiversity – one of the cleanest watercourses in Ukraine. Thus, the Sedniv SHP demonstrates that under conditions of professional maintenance and environmental responsibility, small hydropower can effectively coexist with the natural environment, serving as a basis for further hydro-ecological research and "green" energy development.

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