CERIS : Civil Engineering Research and Innovation for Sustainability

EcoPeak4Fish – An Integrated Approach to Support Self-Sustaining Fish Populations Downstream Hydropower Plants

Summary

Climate change foresees an increase on the development of clean energies sources, i.e. wind and solar, and consequently, on hydropower production, due to its capacity to quick replace solar and wind energy when needed. Hydropower is therefore crucial to reduce CO2 emissions and mitigate climate change. However, hydropower production results in negative consequences for the riverine ecosystems, in particular for fish. During daily peaks of energy production, the fish biota is subjected to hydropeaking downstream hydropower plants (HPP), due to extreme and short-duration fluctuations with consequences at individual, population and community levels. The need to increase hydropower production while supporting the development of self-sustainable fish populations in a cost-effective way, protect biodiversity and restore water-related ecosystems is urgent and recognized in the UN Agenda 2030 (Goals 6&15) and in the recently launched European Green Deal.

Despite the growing awareness of hydropeaking impacts, it is still largely unknown how fish react under peak events, especially cyprinids, the most common group of freshwater fish in Europe. Fish may move laterally to "recolonize" abandoned habitats, or may seek out short-term refuge rendering them to stranding. The wide spectrum of fish responses due to specific ecological requirements and habitat characteristics restricts an understanding of the effects of hydropeaking on fish. Thus, the knowledge to propose effective mitigation measures remains limited.

Flow-refuges such as lateral deflectors are believed to help fish to cope with rapidly hanging flows and high currents. However, very few studies assessed their efficiency and focused mainly in salmonid species, with higher economic value. Although recent studies have assessed the utility of flow-refuges for cyprinids in controlled experimental conditions, field evidence of fish responses to hydropeaking and the use of flow-refuges in peaking rivers remains, to our knowledge, unknown. Studies involving the movement and behavior of fish in peaking conditions, both in the field and in experimental conditions, are rather needed to understand what triggers fish movements to further recommend mitigation measures.

Another option is adapting the hydropower operation scheme to improve fish habitat during daily cycle or during important key life-cycle stages (e.g. spawning). These measures may have a significant impact on the HPP profits thus affecting its viability. Including habitat in models of HPP optimal management is usually done by means of adding restrictions regarding minimum flows. The feedbacks between available habitat and profit are not explicitly modeled. Including a description of how the available habitat changes with water flow can help estimate trade-offs between profit maximization and habitat preservation as well as inform the development of flow restrictions that better account for both profit and habitat availability.

Three main questions will be addressed by EcoPeak4Fish: How do fish react under hydropeaking conditions? Are flow-refuges an effective measure to mitigate impacts and contribute to the self-sustainability of fish populations? How to find the hydropower operation scheme that maximizes profits and power production while maximizing the suitable habitat for fish populations?

EcoPeak4Fish intends to answer these questions in a multidisciplinary approach, only achievable by a team of researchers with complementary backgrounds and different perspectives, from ecology, economy and civil engineering and with the support of a hydropower company. Thus, EcoPeak4Fish stands in 4E's: Ecology, Engineering and Economics in the profit of the Ecosystem protection. This project aims to assess the effects of hydropeaking in cyprinid species, propose a flow-refuge prototype and assess its cost-effectiveness, and develop a framework to adapt the HPP operation scheme to maximize profits and environmental benefits for a sustainable use of hydropower energy.

Two major outputs of this proposal are: 1) a prototype of a flow-refuge to be applied in peaking rivers; and 2) a framework to assess the trade-offs between hydropower profits and habitat preservation focused on fish biota. These goals will enable us to identify the bottlenecks to achieve cost-effective energy production and self-sustained fish populations in peaking rivers. The knowledge gained will help policy makers to regulate hydropeaking helping to prevent biodiversity loss and tackle the environmental challenges of hydropower development to cope with climate change. Hydropower managers will benefit from easy-to-use tools and guidelines to implement flow-refuges and to adapt the operational HPP scheme to reduce the impacts on aquatic ecosystems without compromising hydropower profits and production. Thus, we believe EcoPeak4Fish will have a significant impact, both at local, national and international scales, and at academic and policy levels.

EcoPeak4Fish

Project Reference

PTDC/EAM-AMB/4531/2020

Leading Institution

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal)

Partners

Hidroerg – Projectos Energéticos, Lda (Portugal), ISA – Instituto Superior de Agronomia (Portugal), UNL – Universidade Nova de Lisboa (Portugal)

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CERIS

205 986.25€

Project Website

ecopeak4fish.com

Figure 1. Fish habitat use assessment downstream Covas do Barroso HPP.

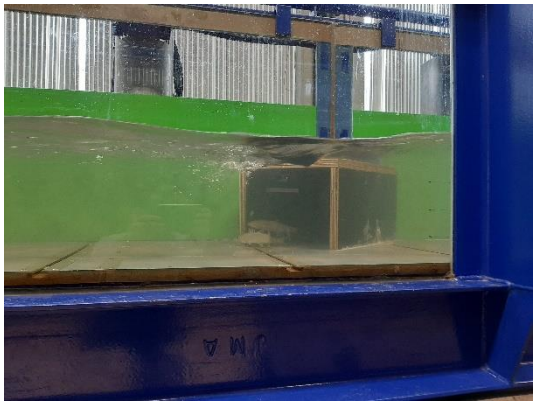

Figure 2. Testing one flow-refuge configuration in the artificial channel at Laboratory of Hydraulics in IST.