Interreg Latvija–Lietuva
European Regional Development Fund

EUROPEAN UNION

Trans WAT

Joint management of Latvian – Lithuanian trans-boundary river and lake water bodies (TRANSWAT) LLI-533

LIST OF THE MOST EFFECTIVE MEASURES FOR HEAVILY REGULATED RIVER WATER BODIES

2022

LVĢMC

UNIVERSITY OF LATVIA

BIOR

TABLE OF CONTENTS

1. INTRODUCTION 3
2. MAIN HYDRO- MORPOLOGICAL IMPACT OF HPP 4
3. MITIGATION ACTIONS 5
3.1. Flow regulations 5
3.2. Migration corridor constructing 5
3.3. Sedimentation measures constructing 6
3.4. Fish/environmentally friendly turbine technology and fish screens 7
3.5. Restocking 7
4. LIST OF THE MOST EFFECTIVE MEASURES FOR HEAVILY REGULATED RIVER WATER BODIES 8
REFERENCES 10

ABBREVIATIONS

E-Flow	Ecological Flow
EU	European Union
FFH	Flora Fauna Habitat Directive or the Habitat Directive 92/43/EWG
HMWB	Heavily modified water bodies in accordance with HWWB
HPP	Hydropower Plant
WFD	Water Framework Directive

This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of Latvian Environment, Geology and Meteorology Centre and can under no circumstances be regarded as reflecting the position of the European Union.

1. INTRODUCTION

In the frame of the “Joint management of Latvian – Lithuanian trans-boundary river and lake water bodies” project (TRANSWAT) LLI-533 financed by the Interreg V-A Latvia–Lithuania Programme 2014-2020, the most effective measures for the water bodies regulated by hydropower plants have been collected.

Hydropower plays a key role in implementing of the Renewable Energy Directive 2009/28/EC and contributing to the EU energy targets for 2020-2030. At the same time, hydropower must meet the requirements of EU environmental law, which has been introduced to protect and restore Europe’s rivers and lakes. The construction and operation of hydropower plants cause specific hydrological and morphological alterations, which lead to significant negative ecological impacts and the risk of not achieving the environmental objectives of Natura 2000 (FFH and Birds Directive) and Water Framework Directive (water bodies’ good ecological status or potential). Therefore, the need of mitigation measures for the water bodies regulated by hydropower plants is critical.

2. MAIN HYDRO- MORPOLOGICAL IMPACT OF HPP

The main impacts of HPP might be divided into three groups:

1) on river hydrological regime upstream and downstream of HPP;

2) on river morphology;

3) on river continuity.

Hydrological alterations. Dam construction affects the hydrological regime upstream of HPP, where the ponding reduces the flow velocity and changes the water level amplitude. Downstream of HPP the pondage operation (hydropeaking), reduced flow quantity and dynamics are observed.

River morphology alterations include river bank fortification, changes of river width and depth as well as structure of bed. All of these alterations lead to changes of river habitat. Disruption of lateral connectivity results in the disconnection of wetlands/floodplains.

River continuity. HPP dam is an interruption of fish migration and sediment movement.

3. MITIGATION ACTIONS

The purpose of environmental mitigation requirements at hydropower plants is to avoid or minimize the adverse effects of development and operation.
The following actions are the most effective:

- Flow regulations;
- Migration corridors constructing;
- Sedimentation measures constructing;
- Fish friendly turbine technology;
- Restocking

3.1. Flow regulations

Flow regulation is one of the promising actions for mitigating such negative impacts of hydropower plants like extreme low flow, extended low flow period and hydropeaking.
In order to make the use of hydropower plants more compatible with the natural life of the rivers, a minimum flow must be released to assure the preservation of the hydrological continuity of the river and the consequent conservation of natural habitat and ecological life.
In accordance with the Guidance document Nr.31 “Ecological flows in the implementation of the Water Framework Directive” [1], E-flow providing downstream of HPP can ensure the ecological life of the river.
For mitigation of the hydropeaking impact, power plant operational measures (e.g., increasing the minimal baseflow, reduction of the flow fluctuation rates, etc.) and constructional measures (e.g., retention basins) can be used/implemented.

3.2. Migration corridor constructing

The HPP dam acts as a barrier to upstream and downstream fish migration.
The construction of fishpasses and bypass channels is the only way to facilitate the migration of the species in the streams. The most effective fishpass matches natural.

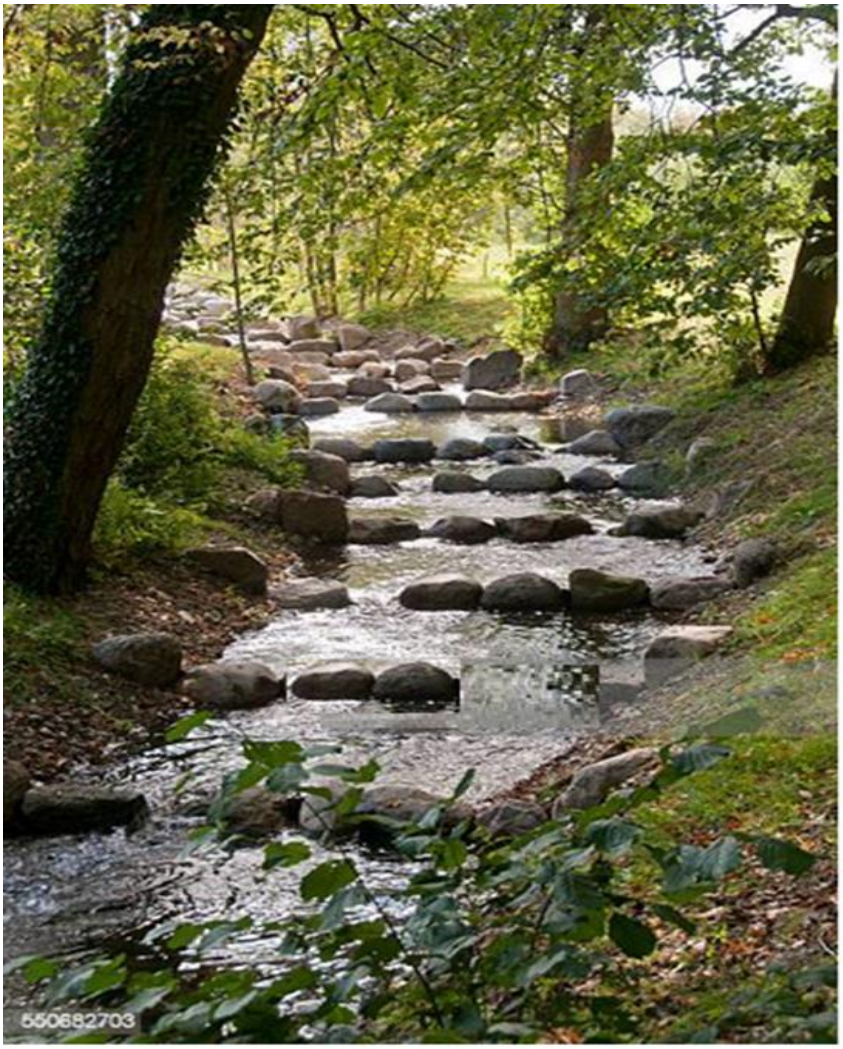

Figure 3.2.1. Bypass channel in Estonia

3.3. Sedimentation measures constructing

The problem of disruption of sediment migration that causes sedimentation in the surroundings of the hydropower plant and sediment washout and river bed armouring downstream of the dam can be mitigated by constructing sedimentation measures such as the construction of small-scale weirs to trap the sands and the particles that later can be manually removed and re-introduced downstream of the dam

A direct approach to reduce sediment accumulation is to mechanically remove the sediments by periodical dredging and re-introducing them downstream of the dam.

3.4. Fish/environmentally friendly turbine technology and fish screens

This technical measure includes replacing existing HPP turbines with Archimedes screw type of turbines in order to reduce mortality of fish that pass through them when migrating downstream. This option does not solve other hydro-morphological issues caused by the HPP dam. It is an emerging technology that provides a safe approach for fish passing through the turbines by minimizing the risk of injury or even death.

Many of such turbine technologies are under development now or in testing phase. Another option is to install fish screens to prevent fish from getting into the turbines. Fish screen can also serve as a structure that directs fish into a bypass channel.

3.5. Restocking

This measure can also reduce the negative effects of hydropower projects on the aquatic fauna. It involves the artificial management of fertilisation, hatching, growth and release of aquatic fauna, especially salmonid fish.

Introducing artificially reared fish to protect endangered species or reintroducing species that have disappeared may be of great benefit to the environment and biodiversity. But the priority is to create the conditions for natural reproduction. Restocking is, therefore, a last resort when all other means fail or are not possible to apply.

4. LIST OF THE MOST EFFECTIVE MEASURES FOR HEAVILY REGULATED RIVER WATER BODIES

The mitigation measures can be selected from a national or European mitigation measures library on information about the water category and water body type, the nature of the physical modification, its effects on hydromorphological (and physico -chemical) supporting elements and their effects on the biological quality elements [2]. Table 4.1 includes information about the most effective measures for the heavily regulated river water bodies by HPP cascades that might be used in Latvia and Lithuania. It should be mentioned that the fish pass construction is not required for water bodies designed as the heavily modified water bodies (HMWB) like the project pilot River Varduva and one of the Ciecere River water bodies. However, when the migration barrier is the main obstacle to the achievement of good ecological potential of the HMWB, the installation of a fish pass may become mandatory.

Table 4.1. Most effective measures for rivers regulated by HPP cascades

PROBLEM	MITIGATION MEASURES
HYDROPEAKING[4]	● Power plant operational measures: increasing the minimal baseflow, reduction of the flow fluctuation rates, amplitudes and frequency. ● Constructional measures: retention basins to increase the minimal baseflow, to reduce the flow fluctuation rates, to reduce the flow fluctuation amplitudes; hydropeaking drainage via side channels; hydropeaking diversion to new hydropower plants; side channels with more stable flow.
EXTREME/EXTENDED LOW FLOWS [3]	● Ensure releasing below the dam at least the same amount of water that flows into the reservoir ● Providing ecological regime downstream the dam
ABSENCE OF VARIABLE FLOWS [3]	
BARRIERS FOR FISH UPSTREAM MOVEMENT[5]	● Construction of fish passes, bypass channels, fish elevators with attraction flow or leaders to guide fish to fish pass; ● Capture and transport of fish upstream.
BARRIERS FOR FISH DOWNSTREAM MOVEMENT[3]	● Installing the fish-friendly turbines; ● Installing fish screens, avoidance systems upstream the power plant; ● Management of flow regime or spillway during downstream movement of migratory fish;

	● Construction of bypass channels, fish passes;
RESERVOIR SEDIMENTATION, AND SEDIMENT WASHOUT AND BED ARMOURING BELOW OF THE DAM[4]	● Adequate protection of banks and natural vegetation in the catchment area; ● Extraction of coarse material from the riverbed; ● Dredging of sediment deposits and re-introduction downstream of dam; ● Use of gated structures for flushing sediment with flow conditions comparable to natural conditions; ● Use of sediment trapping devices; ● Use of bypassing facilities to divert floodwaters.

REFERENCES

1. Guidance document Nr.31 “Ecological flows in the implementation of the Water Framework Directive”, 2015: https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20%28final%20version%29.pdf

2.Guidance document No 37 “Steps for defining and assessing ecological potential for improving comparability of Heavily Modified Water Bodies”, 2019. Mitigation Measures Library: https://circabc.europa.eu/ui/group/9ab5926d-bed4-4322-9aa7-9964bbe8312d/library/67f969f9-5abe-4765-a952-2f8e2bf5b664/details

3. Koller-Kreimel, 2015: https://circabc.europa.eu/sd/a/ac0769a7-1365-4902-9d03-f701a8afa190/Presentation-Measures%20to%20mitigate%20%250bimpacts%20of%20hydropower%20use%20%250bon%20aquatic%20environment.pdf

4. Schmutz and Sendzimir, 2018: https://doi.org/10.1007/978-3-319-73250-3

5. Trussart et al., 2002: https://doi.org/10.1016/S0301-4215(02)00087-3