13th Follow-up Meeting of the Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube Region

APPLICATION OF EU STANDARDS IN ECOLOGICAL WATER ENGINEERING

CASE STUDY FROM CROATIA:

REHABILITATION INLAND WATERWAY ON SAVA RIVER (rkm 300 - rkm 329)

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Budapest, September 14-15, 2022.

CASE STUDY PROJECT – LARGE RIVER ECOLOGY SYSTEMS

Possible negative effects of inland waterway development and management activities on habitats and species protected under EU nature legislation

Possible positive effects of inland waterway development and management activities on river ecosystems

CASE STUDY PROJECT

• Rehabilitation of Sava river inland waterway between rkm 300 – rkm 329 (rkm 300 – rkm 312 and rkm 325 – rkm 329)

• Investor:

Ministry of the Sea, Transport and Infrastructure, Croatia, Zagreb (Originally: Agency for Inland Waterways, Croatia, Vukovar)

• Contractors:

a) Conceptual design, preliminary design and main design: INSTITUT IGH Zagreb & Hidrokonzalt projektiranje Zagreb

b) EIA: Elektroprojekt Zagreb & INSTITUT IGH Zagreb

- Financing: THE CONNECTING EUROPE FACILITY (CEF) TRANSPORT SECTOR FUND (EU cofunding)
- Sava River border between Croatia and Bosnia and Herzegovina

APPROACH

- Engineering design and environmental assessment of the alternatives were conducted in parallel
- □ Each alternative was analysed in detail utilizing sophisticated 2D hydraulic and hydromorphological models and carefully studying potential environmental impacts
- □ The final recommended solution is considered to be environmentally optimal while meeting the most important project goals and requirements
- □ Stakeholder invovement through Sava River Forum and environmental proceedings

Stakeholder forum

- The Stakeholders Forum for development of Environmental Impact Assessment Study and Design for the Action: Improvement of the Navigability Conditions of the Sava River from rkm. 300 to rkm. 329
- The Forum consists of members of the Committee and representatives from the non-governmental, civil society and professional organizations and regional and local administration from the territory of the project execution from Bosnia and Herzegovina and

the Republic of Croatia.



Main tasks of the Forum

- Enabling exchange of information about the development of the Environmental Impact Study and Project for the Action: Improvement of the Navigability Conditions of the Sava River from rkm. 300 to rkm. 329;
- Formulation of the Project-related information needs, comments, questions and recommendations to the Project team;
- Elaboration of proposals for required improvements of the activities in different parts of the Project;
- Stimulation of implementation of the principles of the Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin and Manual on Good Practices in Sustainable Waterway Planning;
- Consideration of other relevant recommendations and proposals regarding the Project.



INTRODUCTION

- The most critical part of Sava river inland waterway between Beograd (Serbia) and Sisak (Croatia) is between rkm 320 and rkm 329
- Part of European agreement on main inland waterways of international importance (AGN)
- Currently: Class III
- Intention: Class IV



HYDROLOGICAL ANALYSIS

- Hydrological stations: Slavonski Brod (rkm 378), Slavonski Šamac (rkm 306) and Županja stepenica (rkm 262)
- Stationarity and homogeneity analysis
- Water-level/discharge duration curves
- Adopted duration curves/values





HYDRAULIC ANALYSIS

- 1D (HEC-RAS 5.0.6)
- Length 104 km, 544 cross sections
- Critical values rkm 300 rkm 329
- Critical sections:
 - Jaruge Novi Grad (rkm 320 rkm 329)
 - Slavonski Šamac downstream (rkm 310 rkm 312.2)
- 2D hydraulic analysis (HEC-RAS 5.0.7)











Considered solutions for two-way navigation

- Analysed potential solutions:
 - ✓ Bottom deepening along the waterway
 - Groynes construction along critical sections
 - Combination of bottom deepening and groynes construction
- Multiple-criteria analysis
- Section rkm 300 km 312:
 - ✓ rkm 304.2 rkm 304.7 bottom deepening
 - ✓ rkm 307.3 rkm 307.8 bottom deepening
 - ✓ rkm 308.4 rkm 308.9 bottom deepening
 - 🗸 rkm 310 rkm 312.2 (Slavonski Šamac downstream) 🚽
 - combination of bottom deepening + groynes



Considered solutions for two-way navigation

Section rkm 315 - km 329

- rkm 316 rkm 317: bottom deepening
- rkm 320 rkm 329 (Jaruge – Novi Grad): combination of bottom deepening and groynes construction



CONCLUSION FOR TWO-WAY NAVIGATION

Bottom deepening and construction of a relatively large number of groynes for two-way navigation, which includes the construction of groynes in the river bank - 75 groynes on the upstream section and 13 groynes on the downstream section in the length of about 10 km in part of riverbed of the Sava River are large and unacceptable impacts from the point of environmental protection of the Sava River.

ENVIRONMENTAL SOLUTIONS FOR ONE-WAY NAVIGATION

Due to the need to reduce the large impact on the aquatic environment of the Sava riverbed, it was proposed to conduct an analysis solution for one-way navigation. This way, the deepening of the riverbed to 40 m width on critical sections (about 40% less excavated material) and three variants of groynes were considered:

Variant J1 - construction of inclined groynes with cuts/overflows connected in the river bank



ENVIRONMENTAL SOLUTION FOR ONE-WAY NAVIGATION

> Variant J2 - construction of declined groynes with cuts/overflows connected in the river bank



ENVIRONMENTAL SOLUTION FOR ONE-WAY NAVIGATION

> Variant J3 - construction of declined detatched (to river bank) groynes.



OPTIMAL ENVIRONMENTAL SOLUTION FOR ONE-WAY NAVIGATION

Based on the analysis that compares the most important environmental criteria which includes:

- > fish migration,
- benthic macroinvertebrate fauna,
- > aquatic flora,
- hydromorphology
- ➢ water level
- terrestial habitats
- > watersupply

Environmental elements in riverbed

Environmental elements outside river channel (riparian zone)

The variant J3 which includes **declined detatched (to river bank) groynes** was selected as most favorable environmental variant for improving the navigation of the Sava River on the observed section.

OPTIMAL ENVIRONMENTAL SOLUTION FOR ONE-WAY NAVIGATION





Water velocity section two



Water velocity section one

ECOSYSTEM SERVICES











Application of eco-engineering according to the Platina document in this Project

Good practice examples (mitigation measures) in project includes :

- ✓ Return of dredged sediment to upstream reaches on suitable locations
- ✓ Construction of declined detatched (from river bank) groynes allows:
 - migration of fish in the zone closer to the river bank,
 - reducing sedimentation around the groynes and
 - reducing of creating terrestrial habitats in the part of the riverbed between groynes

Application of eco-engineering according to the Platina document in this Project

Good practice examples (mitigation measures) in project includes :

- ✓ Behind every 3 or 4 groynes set large woody debris.
 Large woody debris helps:
 - create more diverse aquatic habitat.
 - create cover and hiding places for fish and other aquatic organisms
 - water flows over and around large wood, localized scouring of the bed and banks creates pools that provide additional shelter and act as resting areas for fish

exposed logs are also used as basking and perching sites for reptiles and birds.



Environmental requirements for the recommended alternative

Impacts on water levels

- By its technical characteristics, this project must not significantly affect the water level of the Sava itself. This means that the water levels, which is important for the supply of agricultural habitats in the territory of the Republic of Croatia and wetland areas and agricultural lands in the territory of Bosnia and Herzegovina, should remain preserved.
- □ The project must not affect the regional water pumping station Istočna Slavonija (Sikirevci groundwater extraction through deep wells), i.e. the water levels and flows in the Sava River, from which the aquifers in the area of the pumping station are fed to the greatest extent, must not be changed.

Environmental requirements for the recommended alternative

>Impacts on the hydromorphology of the Sava River

- □ The implementation of works on the deepening of the kinete of the Sava riverbed must not have a significant impact on the morphology of the river, and the construction works in the affected area must not cause significant changes in the habitat conditions for the flora and fauna in the Sava riverbed.
- Regarding the morphodynamic changes that will occur during and after the works, the relevant flows and water levels should continue to ensure the same substrate (silt, sand and gravel) in the affected area, that is, there should be no significant changes in habitat conditions.
- □ In sections of the river with bottom velocities that enable intensive sediment transport, the morphology of the bottom changes very quickly, and with it the characteristic habitats. In deeper and flat sections, sediment transport is weaker, and with it, the bottom morphology changes.
- In the specific case of the Sava River, areas with intensive and weak sediment transport should be marked on the route of the waterway. All interventions in the deepening and shaping of the riverbed located in the area of intense sediment transport will very quickly stabilize and take on the previous morphology and characteristic habitats.

Environmental requirements for the recommended alternative

Impacts on the fauna (fish)



The groynes should be installed in a gravitationally lower position from the middle to maximum water levels of the Sava River, which will enable the fish to move naturally in the water body between the groynes and to the open course of the Sava River. Considering the objectives of the Project, the navigability of the Sava River even at lower water levels will provide fish with normal amounts of water for their life, i.e. their habitat that provides them with a sufficient amount of food and conditions for reproduction in the river



egarding the morphodynamic changes that will occur during and after the works, the relevant flows and water levels should continue to provide the same substrate (silt and gravel) in the affected area for the population of rheophilic, eurytopic and stanophilic fish species that have been recorded or confirmed

Environmental requirements for the recommended alternative

> Impacts on the fauna (benthic invertebrates and fish)

Process of sedimentation will occur between the constructed groynes and part of the coast. By leaving a passage between the groyne and the coast, space is created for the movement of fish fry and sedimentation in the area between the groynes is reduced, and the formation of identical substrates and habitat types such as benthos communities will be enabled and fish have even now in the Sava river upstream and downstream of the project site, which means that there must not be significant long-term changes in the ecological conditions for fish populations and the benthos community.

The deepening of part of the riverbed on the route of the waterway, due to the greater maximum water depth on the profiles of the other sections, should actually be a redistribution of the bottom of the riverbed within the profiles themselves (the excavated material will be able to be deposited locally on the deeper parts of the profile/depressions) should be increased and expanded the habitat for fish and communities bottom with the aim of their greater distribution and better survival conditions without significantly changing the substrate of the habitat.

The combination of deepening the bottom and building a weir along the section higher than the water level for 95% of the time should enable the long-term stability of the fish community and avoid the stress (ABC diagram) that exists on the fish community today, in this state of the river in this section. Minor changes in the water level regime and in water bodies contribute to the stability of the fish community.

Example of application of recommended mitigation measure in EIA proceedings:

- PLATINA Recommendation regarding deposition of dredged sediments is to deposit the material in upstream reaches (depressions or other suitable lovcation)
- > In this project the dredged sediment will be deposited in reaches upstream of the most upstream groyne, i.e. from km 333 +120 to km 335+400 and from km 343+350 to km 346+520, into larger depressions, in the area of cca 2,6 ha.





Deposition in the reach km 343+350 to km 346 + 520

CONCLUSION

THE PROPOSED DESIGN MEETS ALL THESE ENVIRONMENTAL REQUIREMENTS (impacts on water levels, fauna and other environmental resources)

> This was achieved by developing a technical solution which follows all EU standards and recommendations, through an interdisciplinary approach to engineering design and environmental optimization