16th Meeting on the Follow-up of the
Joint Statement on Guiding Principles on the Development of Inland Navigation and Environmental Protection in the Danube River Basin

Border Section Croatia - Serbia – CEF Study “Preparing FAIRway 2 works in the Rhine Danube Corridor" - final project results

Budapest, 22 October 2025

Republika Hrvatska
MINISTARSTVO MORA,
PROMETA I INFRASTRUKTURE

Ministarstvo građevinarstva,
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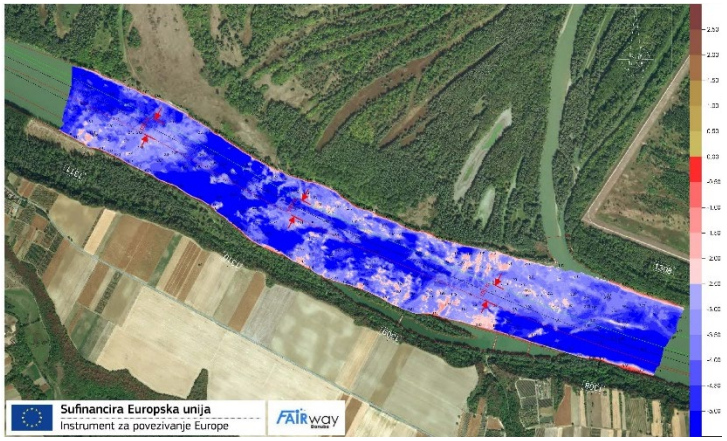
Co-financed by the Connecting Europe Facility of the European Union

Croatian-Serbian common Danube section

2
Croatia

Monitoring of the Croatian/ Serbian Danube common section (river-km 1433,1 - 1295,5)

01/10/2020



Monitoring of hydrological, hydraulic, & morphological characteristics

→ focus on navigational parameters and bottlenecks

31/12/2024

Catalogue of biodiversity components

→ focus on enviro characteristics for the ichthyofauna, ornithofauna, river bottom types (benthos) and floodplain habitats

OBJECTIVES

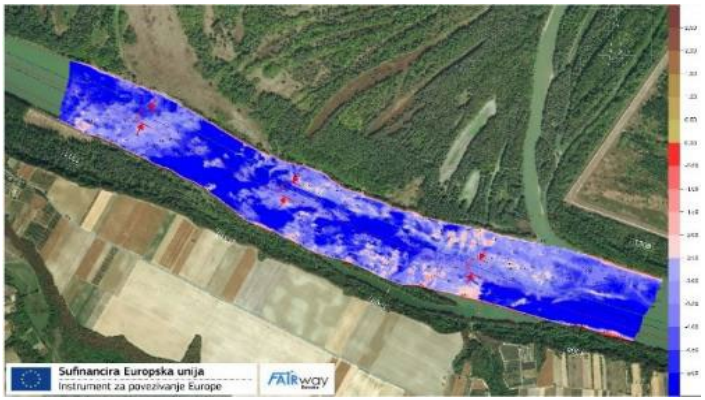
- Set up an inventory of **navigational** & **environmental** characteristics of the HR/RS common Danube section (rkm 1433,1 - 1295,5)
- Use collected data …
  - … for navigation purposes - to identify possible variants for future infrastructure related measures
  - … to support the environmental authorities in the definition of the conservation objectives of the River Basin Management Plans in Croatia

2
Croatia

Monitoring of the Croatian/ Serbian Danube common section (river-km 1433,1 - 1295,5)

01/10/2020

31/12/2024



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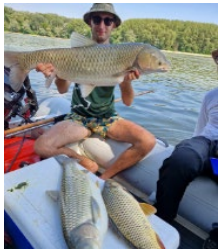


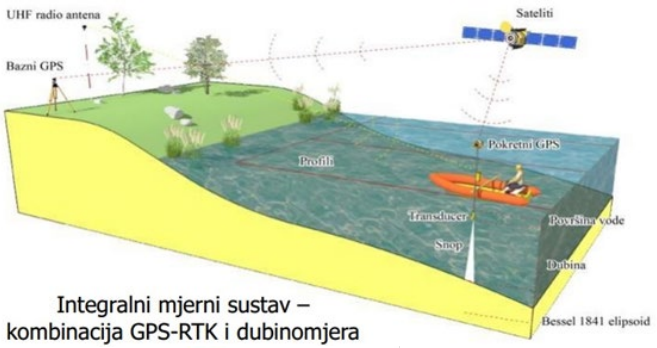
2
Croatia

Monitoring of the Croatian/ Serbian Danube common section (river-km 1433,1 - 1295,5)

Focus on the navigational parameters and bottlenecks

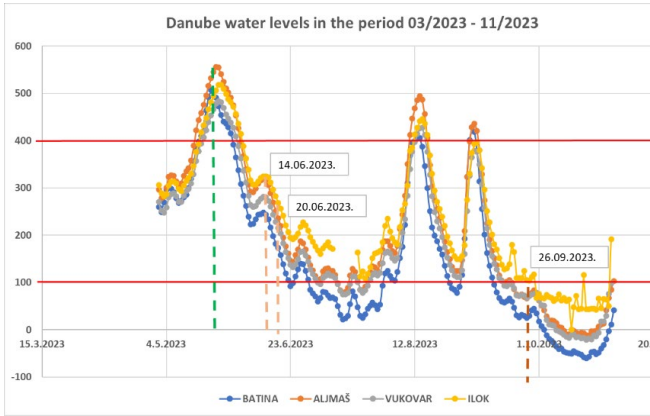
1. Riverbed surveys of cross-sections of Danube river
2. Inventory of existing river regulation structures (geodetically surveyed, photographed & documented)
3. Monitoring and analysis of flow, velocity and sediment transport
4. Piezometer installation

▶ **Input to *"Modelling & Multi-criteria Analysis"*** to identify possible variants for infrastructure related measures



Integralni mjerni sustav – kombinacija GPS-RTK i dubinomjera

vodoprivredno projektni biro



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2
Croatia

Monitoring of the Croatian/ Serbian Danube common section (river-km 1433,1 - 1295,5)

Focus on the environmental characteristics

1. Inventory of ichthyofauna along common Danube section
2. Inventory of ornithofauna along common Danube section *(sand bar nesting species, steep river banks nesting species, passage birds fauna, wintering bird fauna)*
3. Mapping of river bottom types (benthos) along critical locations
4. Mapping floodplain habitats along common Danube section

2

Monitoring of the Croatian/ Serbian Danube common section (river-km 1433,1 - 1295,5)

Final results of the implemented monitoring

https://www.vodniputovi.hr/en/

Thank you for your attention!

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Activities Breakdown

- Act. 00 **Inception phase**
- Act. 01 **1D Hydraulic Modelling**
- Act. 02 **Redefinition and Prioritization of Navigational bottlenecks**
- Act. 03 **Definition of Criteria for Multi-criteria Analysis**
- Act. 04 **2D Hydrodynamic and Morphological Modelling**
- Act. 05 **Elaboration of an Integrated study on alternative solution**
- Act.06 **Project Management**

3 Serbia

modelling activities

Stakeholders Forum (Integrated Planning)

Stakeholder Engagement

- A total of 17 Stakeholder Forum Meetings (SHFM) have been organized to date
- SHFM #6 was held in Kopački rit, SHFM #8 in Belgrade while SHFM #9 took place in Bačka Palanka.
- SHFMs #10 through #17 were conducted online, ensuring broad participation and project continuity.

Documentation and Communication

- For each forum, a detailed meeting minutes was prepared.
- Regular communication was maintained with stakeholders - both during the forums and between meetings -through continuous feedback exchange and consultations.

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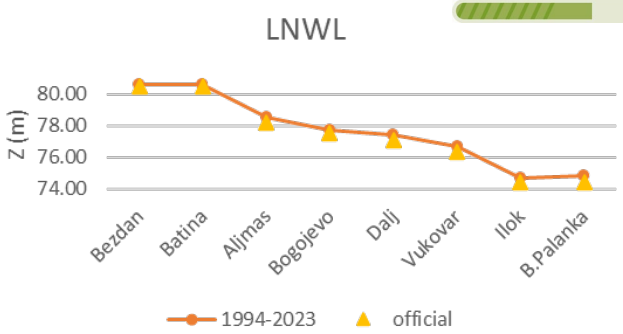
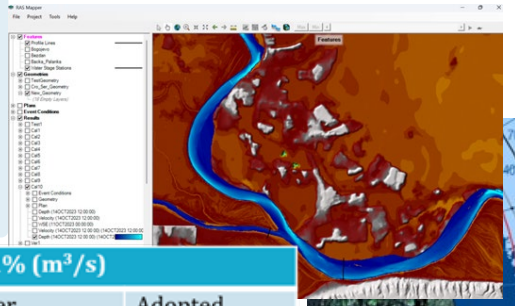
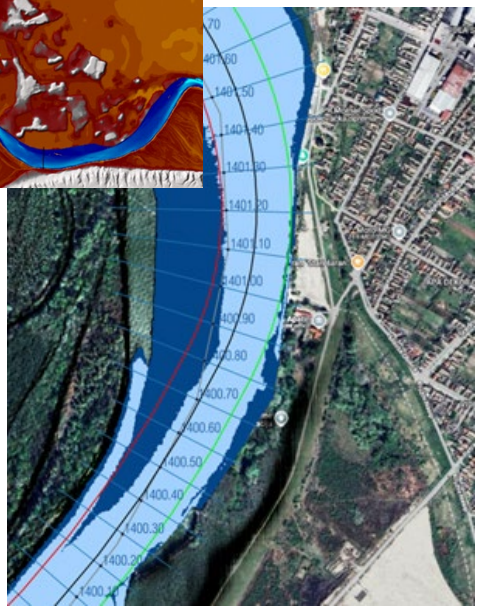
Act. 01 1D Hydraulic Modeling – Outcomes

- Hydrological Study
- Calibrated and Verified 2D model of the common Serbian-Croatian stretch between km 1433.1 to km 1295.5
- Updated Low Navigation Water Levels (LNWLs)
- Visual presentation of the bottlenecks and shallow zones along the observed stretch







Station	Q94% (m³/s)			Q1% (m³/s)		
	Before adjustment	After adjustment	Adopted	Before adjustment	After adjustment	Adopted
Bezdan	1344	–	1344	4920	–	4920
Batina	1316	1349	1349	4817	4940	4940
Aljmas	1735	1719	1707	5290	5430	5395
Bogojevo	1707	–	1707	5395	–	5395
Dalj	1791	1768	1768	5252	5392	5395
Vukovar	1774	1769	1769	5266	5391	5395
Ilok	1821	1813	1778	5292	5449	5449
Backa Palanka	1897	1778	1778	4835	5173	5449

Act. 02 Redefinition and Prioritization of Navigational Bottlenecks – Outcomes

- Updated catalogue of bottlenecks

No.	Sector	Chainage (from km to km)	Quantity of sediment within the fairway of 2.5m depth &			
			Width 100m	Width 120m	Width 150m	Width 200m
1	Bezdan	1,429.0 – 1,425.0	0	0	0	4,745
2	Siga Kazuk	1,424.2 – 1,414.4	0	0	0	1,106
3	Apatin	1,408.2 – 1,400.0	7,035	14,635	26,821	54,311
4	Civutski Rukavac	1,397.2 – 1,389.0	343	1,494	8,164	52,977
5	Drava Confluence	1,388.8 – 1,382.0	0	441	4,221	22,013
6	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781
7	Bogojevo	1,366.2 – 1,361.4	0	0	0	330
8	Dalj	1,357.0 – 1,351.0	0	0	0	344
9	Borovo 1	1,348.6 – 1,343.6	0	415	5,431	26,555
10	Borovo 2	1,340.6 – 1,338.0	0	346	6,863	40,353
11	Sotin	1,324.0 – 1,320.0	0	0	0	85
12	Opatovac	1,315.4 – 1,314.6	0	0	0	37
13	Mohovo	1,311.4 – 1,307.6	93	177	368	748

- The List of prioritized navigation bottlenecks

No.	Sector	Chainage (from km to km)	Quantity of sediment within the fairway of 2.5m depth &			
			Width 100m	Width 120m	Width 150m	Width 200m
3	Apatin	1,408.2 – 1,400.0	7,035	14,635	26,821	54,311
4	Civutski Rukavac	1,397.2 – 1,389.0	343	1,494	8,164	52,977
5	Drava Confluence	1,388.8 – 1,382.0	0	441	4,221	22,013
6	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781

Act. 03 Definition of Criteria for Multi-criteria Analysis - Outcomes

- MCA Criteria
- Technical report on the definition of the MCA

The quantitative indicators have continual scoring from 0.0 to 2.0. Qualitative indicators have discrete scoring 0 (unacceptable), 0.5 (slightly worse compared to the do-nothing scenario), 1 (approximately the same compared to the do-nothing scenario), 1.5 (moderately better) and 2 (significantly better).

Code	Criteria	Indicators	Acceptable Score	Weighting coefficient
N_1	Maximal DC recommendations	Quantitative - Water depth ratio (width of 200 m used as reference value), Width ratio (water depth of 2.5 m used as reference value), Curve radius ratio	1.5 - 2	0.30
N_2	Maneuverability	Quantitative - Velocity ratio Qualitative - Hindrance	0.25 - 2	0.05
N_3	Safety	Qualitative - Visibility of the structures	0.25 - 1	0.05

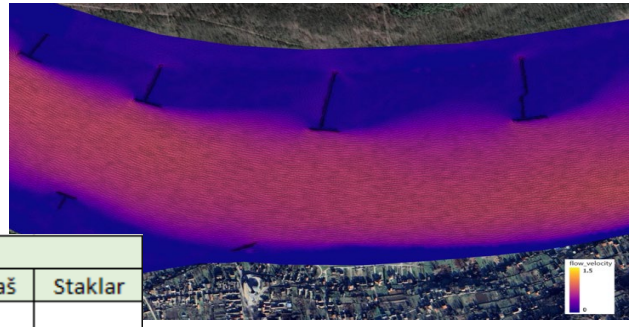
Code	Criteria	Indicators	Acceptable Score	Weighting coefficient
E_1	Hydro-morphology	Quantitative - Riverbed volume ratio, SHDi ratio, Length of low flow channels ratio, Bankfull discharge water level difference, Near bank velocity ratio, bank erosion length ratio	0.25 - 2	0.15
E_2	Physical naturalness of solution	Quantitative - Number of structures difference and level of nature protection	0.25 - 2	0.05
E_3	Sediment and water quality	Quantitative - Dredging volume Qualitative - Effects on physical, chemical and biological parameters of water quality	0.25 - 2	0.05
E_4	Bird population	Qualitative - Aspects of nesting, wintering and foraging	1 - 2	0.05
E_5	Fish population	Qualitative - Aspects of spawning, migration, wintering habitats, growing and living	1 - 2	0.05
E_6	Flora	Qualitative - Creation of new areas for distribution	1 - 2	0.05

Code	Criteria	Indicators	Acceptable Score	Weighting coefficient
F_1	Technical aspects	Quantitative - Execution of works and Response time	0.25 - 1	0.05
F_2	Financial aspects	Quantitative - Investment and maintenance costs/avoided users costs as benefit	0.25 - 2	0.10

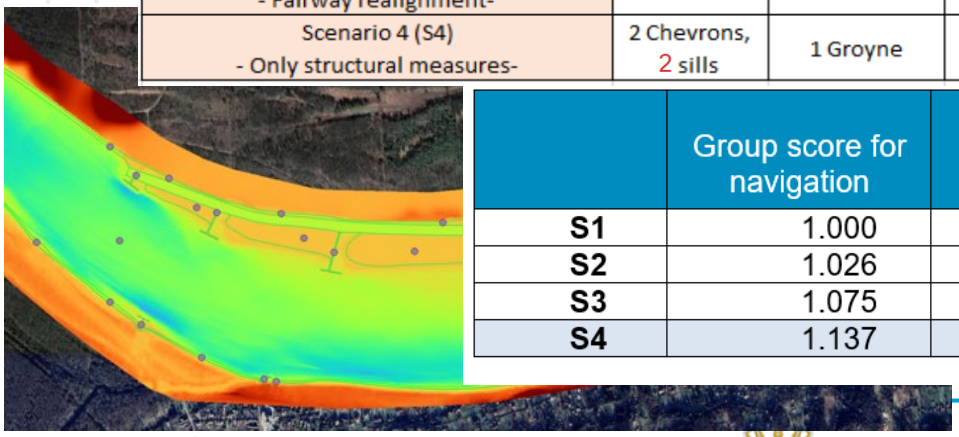
Code	Criteria	Indicators	Acceptable Score	Weighting coefficient
C	Climate change vulnerability	Qualitative - Aspects of exposure, sensitivity and resilience	0.25 - 2	0.05

Act. 04 2D Hydrodynamic and Morphological Modelling - Outcomes

- 2D Hydraulic model including suspended and bedload transport model – calibrated and validated
- Bottlenecks variants defined
- Technical report on 2D modelling and application of MCA



Scenario	Sector				
	Apatin	Čivutski rukavac	Drava Confluence	Aljmaš	Staklar
Scenario 1 (S1) - Do nothing-	-	-	-	-	-
Scenario 2 (S2) - Structural and revitalization measures -	2 Chevrons, 2 sills		Sidearm channel	Sidearm channel	
Scenario 3 (S3) - Fairway realignment-	-	-	-	-	-
Scenario 4 (S4) - Only structural measures-	2 Chevrons, 2 sills	1 Groyne	2 sills		2 sills



	Group score for navigation	Group score for environment	Group score for feasibility	Group score for climate change	Total Score
S1	1.000	1.000	1.000	1.000	**1.000**
S2	1.026	1.144	0.901	0.966	**1.022**
S3	1.075	1.020	1.072	1.000	**1.176**
S4	1.137	1.036	1.035	0.966	**1.177**

Technical characteristics of the finally proposed variants

- **Scenario 1 (Baseline)** serves as a benchmark "do nothing" approach;
- **Scenario 2 (Structural and Revitalization)** introduces non-traditional structural measures;
- **Scenario 3 (Minimal Intervention)** represents a business-as-usual approach;
- **Scenario 4 (Comprehensive Measures)** combines traditional structural measures with nature-inclusive solutions.

- The final design variants for river training structures along the Danube River comprise five types of solutions:
  - Chevron Structures;
  - Sill Structures;
  - Detached T-Groyne Structure;
  - Sidearm Channel Systems;
  - Fairway Realignment Specifications.

Act. 05 Integrated study on alternative solutions - Outcomes

- Update of Low Navigaton Water Levels (LNWLs)
- Bottlenecks catalogue
- Prioritization of navigational bottlenecks
- Definition of MCA (Multi Criteria Analysis)
- Definition of bottlenecks variants
- Application of MCA
- Summary

- Developed a comprehensive hybrid 2D hydraulic model;
- Revised Low Navigation Water Levels (LNWLs) and High Navigation Water Levels (HNWLs);
- The hybrid model demonstrated satisfactory agreement between simulated and observed water surface levels within the low-flow domain;
- The need to enhance the quality of hydrological data;
- To improve data harmonization between Serbian and Croatian gauging stations;
- All newly observed LNWLs for the period 1994–2023 are higher and all newly observed HNWLs for the period 1994–2023 are lower compared to those previously reported to the Danube Commission.

Key findings 1/2

Topic	Key Points
Hydraulic Modelling	Developed a hybrid 2D hydraulic model showing good agreement between simulated and observed water levels (low-flow domain).
Navigation Water Levels (NWLs)	Revised LNWLs and HNWLs (1994–2023): LNWLs are higher and HNWLs are lower than previously reported to the Danube Commission.
Data Quality & Harmonization	Identified the need to improve hydrological data quality and harmonize datasets between Serbian and Croatian gauging stations.
Critical Bottlenecks	Four most critical sections: Apatin, Čivutski/Židovski Rukavac, Drava Confluence, Staklar.
Morphological Findings	Sediment accumulation and unstable morphology identified as key issues affecting navigation.
Multi-Criteria Analysis (MCA)	Applied Weighted Product Model and discrete scoring thresholds for scenario evaluation.
Proposed Measures	Nature-inclusive solutions: chevrons, detached groynes, sills, and sidearm openings.
Optimal Scenario	Scenario 4 selected as optimal: includes 2 chevrons, 1 detached groyne, and 6 sills.

Key findings 2/2

Limitations		
Technical	Organizational	Data-Related
• Incomplete floodplain data • Modeling constraints • Infrastructure data gaps	• Fragmented stakeholder coordination • The lack of a holistic approach	• Missing historical datasets • Missing geospatial and bathymetric data • Inconsistent metadata standards

Recommendations out of modelling activities

- **Updated ENRs (LWNLs):** The Serbian river administration shall inform the Hydrometeorological Institute of the Republic of Serbia and the Danube Commission about the updated ENRs. Both administrations shall incorporate updated ENRs into everyday operations;
- **Bottleneck Catalogue at the shared stretch of the Danube**: Both administrations shall regularly update the Bottleneck Catalogue to ensure effective management and navigation improvements;
- **Sustainable solutions:** Both administrations shall explore opportunities to develop potential sustainable solutions for addressing navigational challenges in prioritized bottlenecks, in alignment with these General and Specific recommendations;
- **MCA:** Both administrations shall adopt the MCA approach in the planning process to ensure structured and effective decision-making;
- **Application of the 2D model:** shall serve as a capacity-building exercise and be integrated into regular planning operations for both administrations.

Next steps

- Dedication of both sides (SRB-CRO) to the results that have been achieved
- Official harmonisation (interstate commission) and the delivery of the results to the Danube commission
- Use of existing provisions within „Agreement between the Government of the Republic of Serbia and the Government of the Republic of Croatia on Navigation and Waterways on Inland Waters and their Technical Maintenance“
- Potential use of mobile infrastructure

СПОРАЗУМ

између

Владе Републике Србије

и

Владе Републике Хрватске

о пловидби пловним путевима на унутрашњим водама
и њиховом техничком одржавању

Thank you for your attention!

Ljubiša Mihajlović

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