

Lot 1: Hydraulic and morphological modelling of the SRB-CRO common stretch of the Danube River

2D Modelling

Stakeholders' Forum Meeting 13 (SFHM 13)

06/02/2025

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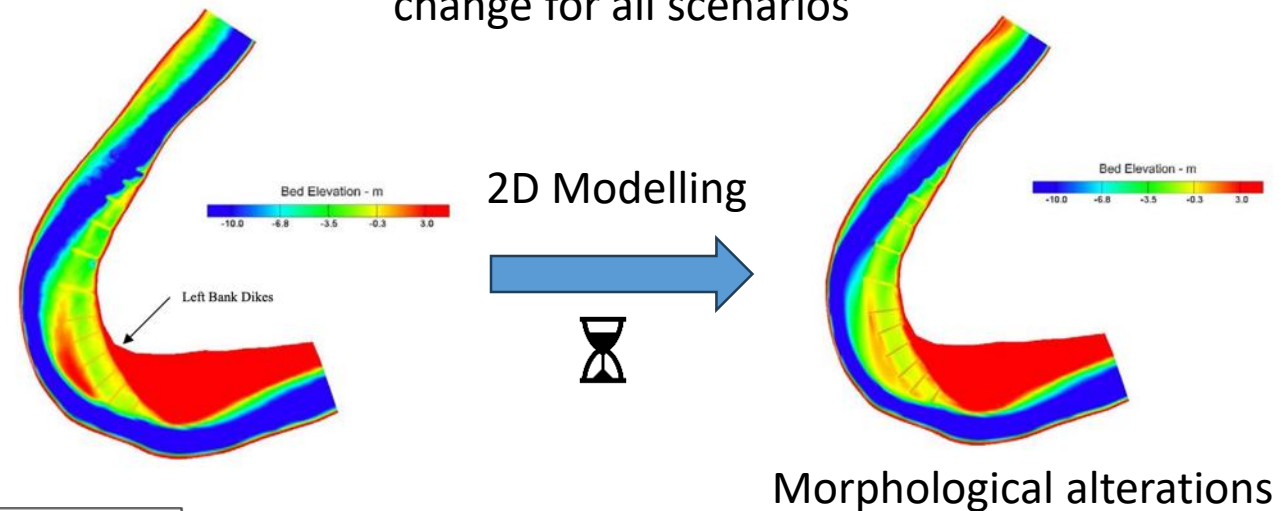
- Introduction
(Purpose of 2D Modelling)
- Data collection
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- Scenario definition
- Preparation of Model for Considered Scenarios
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Purpose of the Modelling activity

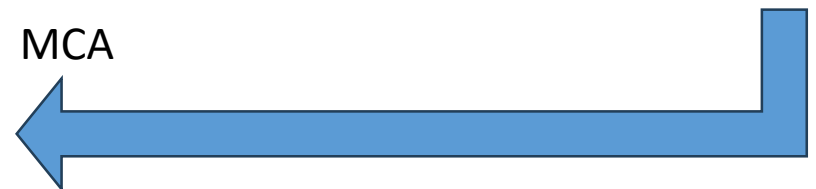
- Evaluation of solutions whose impact is considered over time (scenarios)
- „Do nothing” is base solution (zero alternative)
- 2D Sediment transport model for morphological changes prediction (effects of solutions compared)
- Expert judgment

Do nothing – scenario without measures (even operational or maintenance measures not included)

Numerical simulations of morphological change for all scenarios



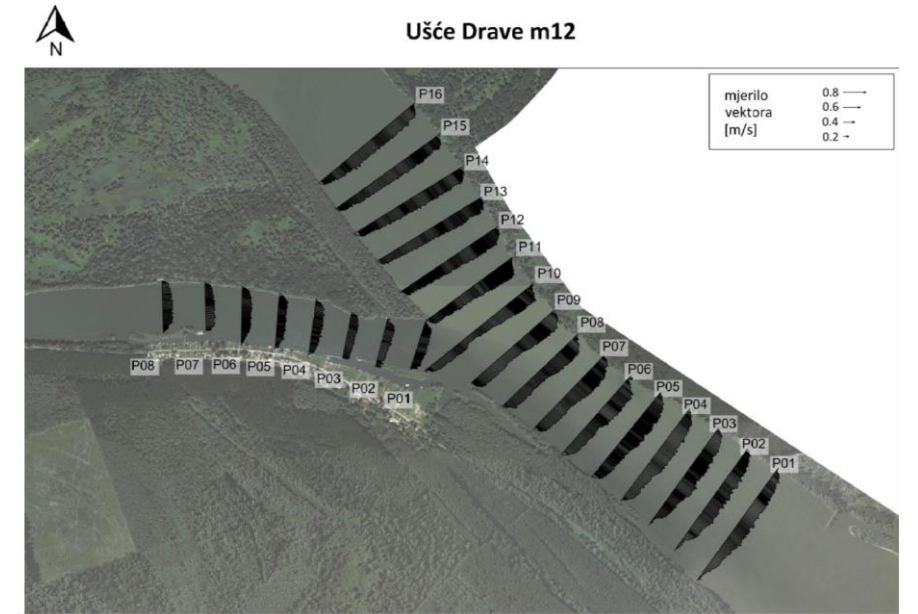
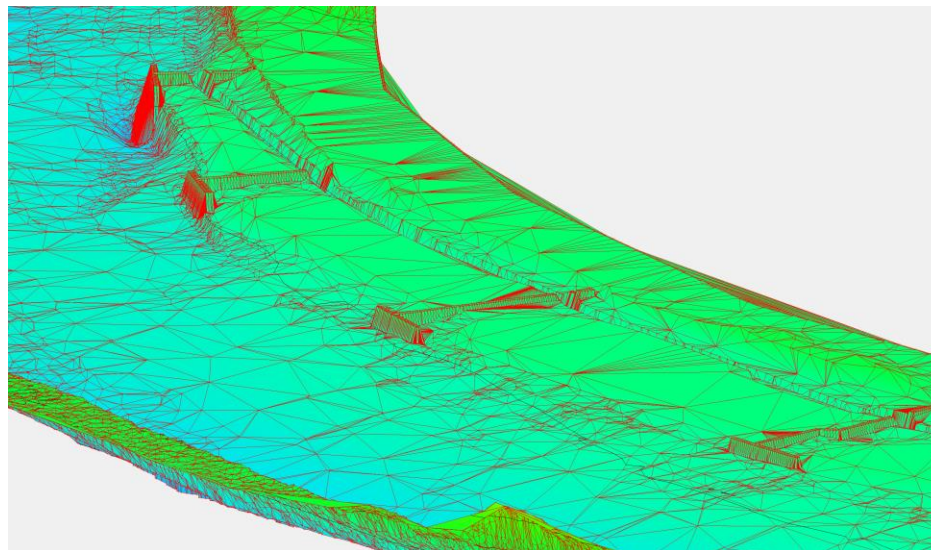
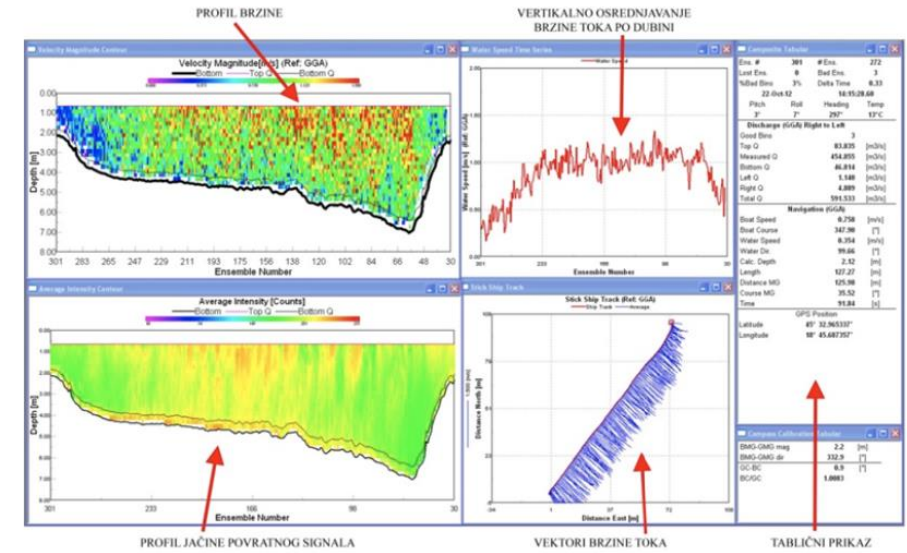
MCA



	Group score for navigation	Group score for environment	Group score for feasibility	Total Score
"Do nothing"	1.00	1.00	1.00	1.00
Groyne system	1.07	0.81	1.04	0.90
Fairway realignment	1.05	1.00	1.06	1.12

Data collection

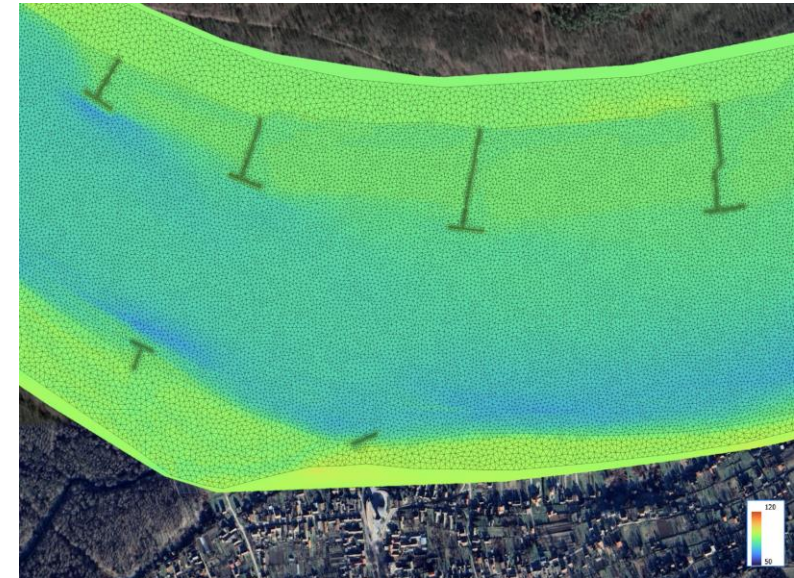
- The dataset for the model has been supplemented
 - Data related to existing river training structures (Plovput)
 - Data for calibration and verification (Hidroing&FCE Zagreb)
- Digital riverbed model has been updated



Model setup

- Basement 2D model
- Steps in model setup include the following:
 - Creation of the DTM
 - Development of the computation grid which results in the computational geometry
 - Setting “initial” values of the model parameters (Friction, turbulence, erosion/deposition rate parameters...)

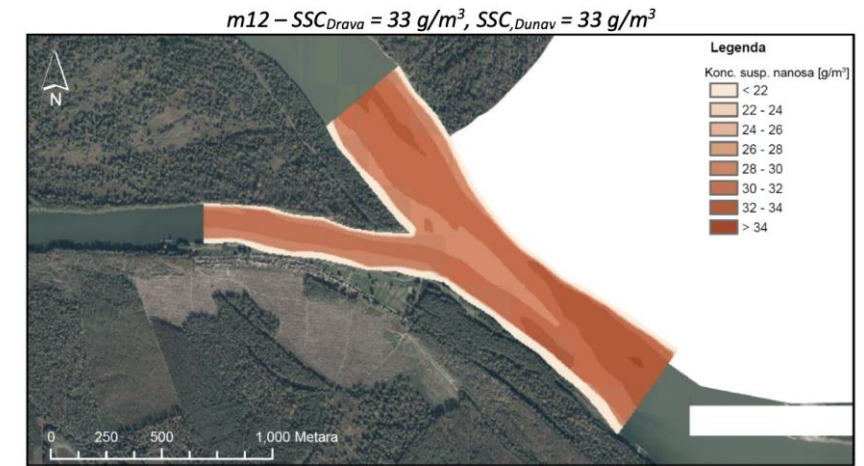
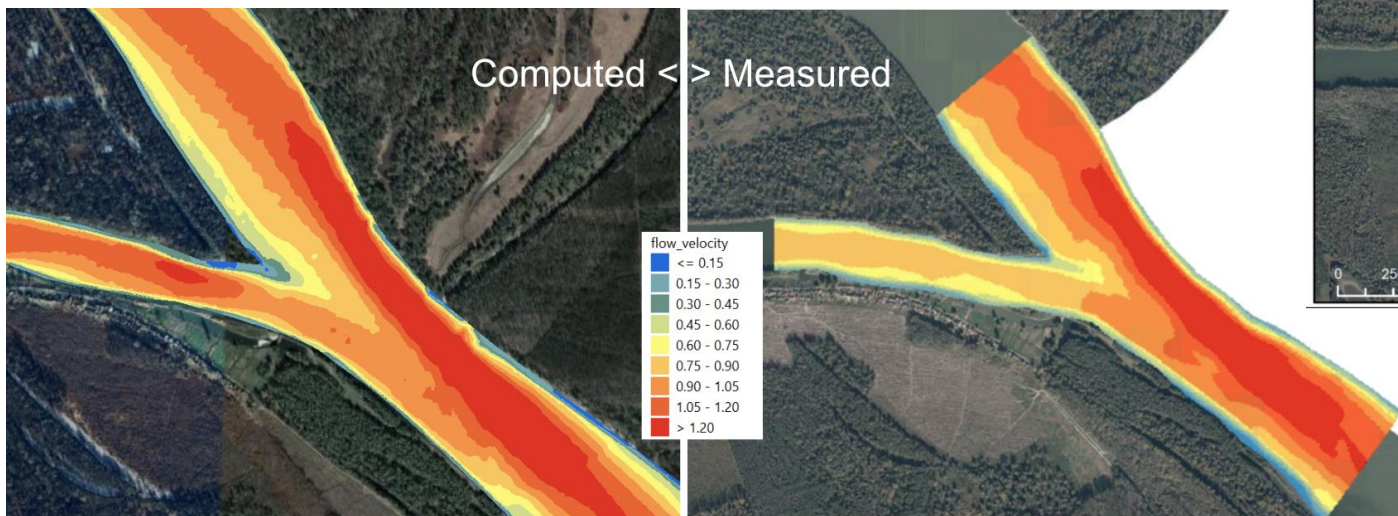
The digital model of the riverbed (computational geometry) in the Aljmas section with the computational mesh



Model Calibration

Steps in the model calibration include iterative setup of model parameters to match the results of available measurements (Hidroing&FCE Zagreb, September 2023):

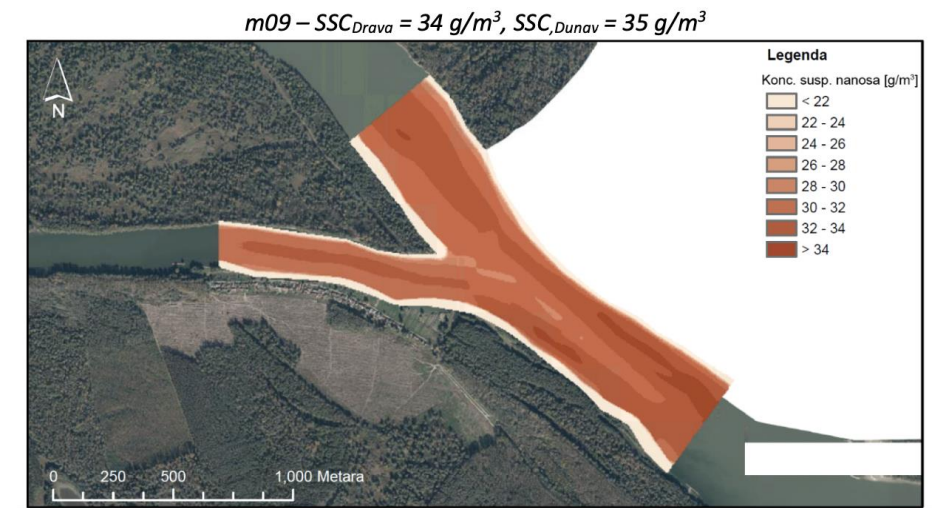
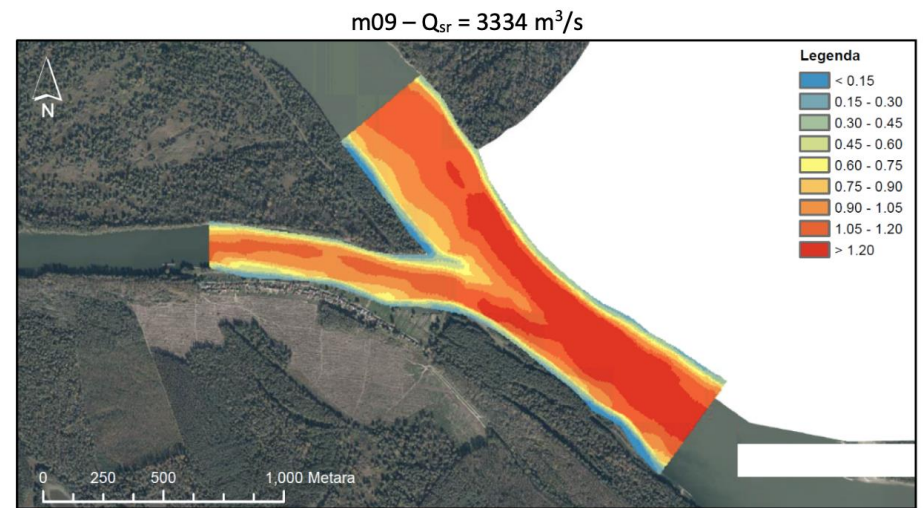
- Measured flow velocities (*Manning coef., Turbulent viscosity*)
- Suspended sediment distribution (Erosion/Deposition rate parameters)
- Bathymetric measurements



Model Verification

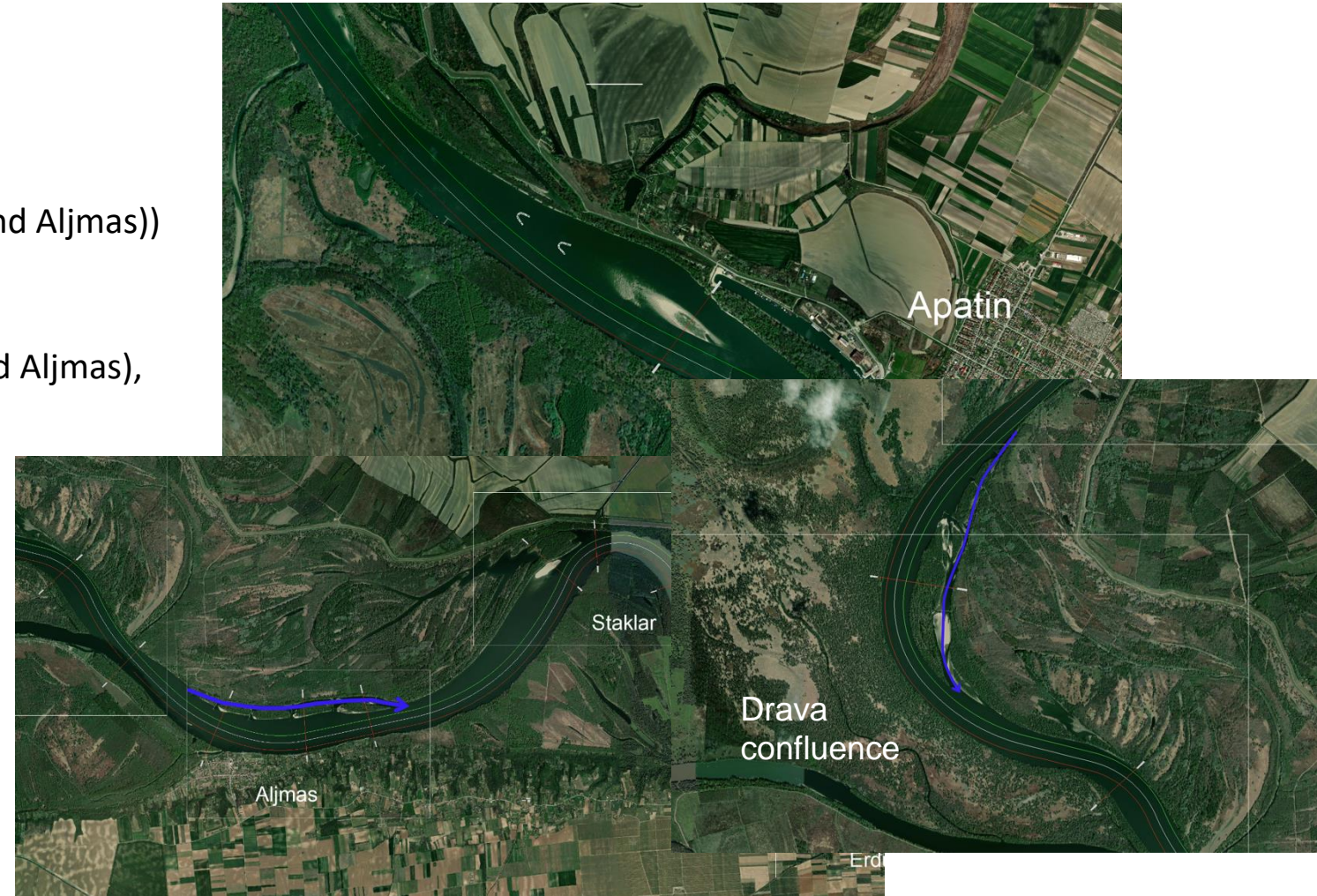
Steps in the model verification include control confirmation of model parameters to match the results of data set available for the verification:

- Measured flow velocities (May, 2023)
- Suspended sediment distribution (May, 2023)
- Bathymetric measurements (September, 2023)



Definition of Scenarios

- Four scenarios are defined:
 - Scenario 1: Do nothing
 - Scenario 2: Structural measures (2 chevrons, 5 sills (Apatin), 2 sidearm openings (Civutski Rukavac and Aljmas))
 - Scenario 3: Fairway realignment
 - Scenario 4: Re-naturalization (sidearm openings- Civutski Rukavac and Aljmas), removal of other existing structures)
- Task 04-05 is still on-going (Scenario 4)



Definition of Scenarios

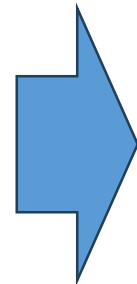


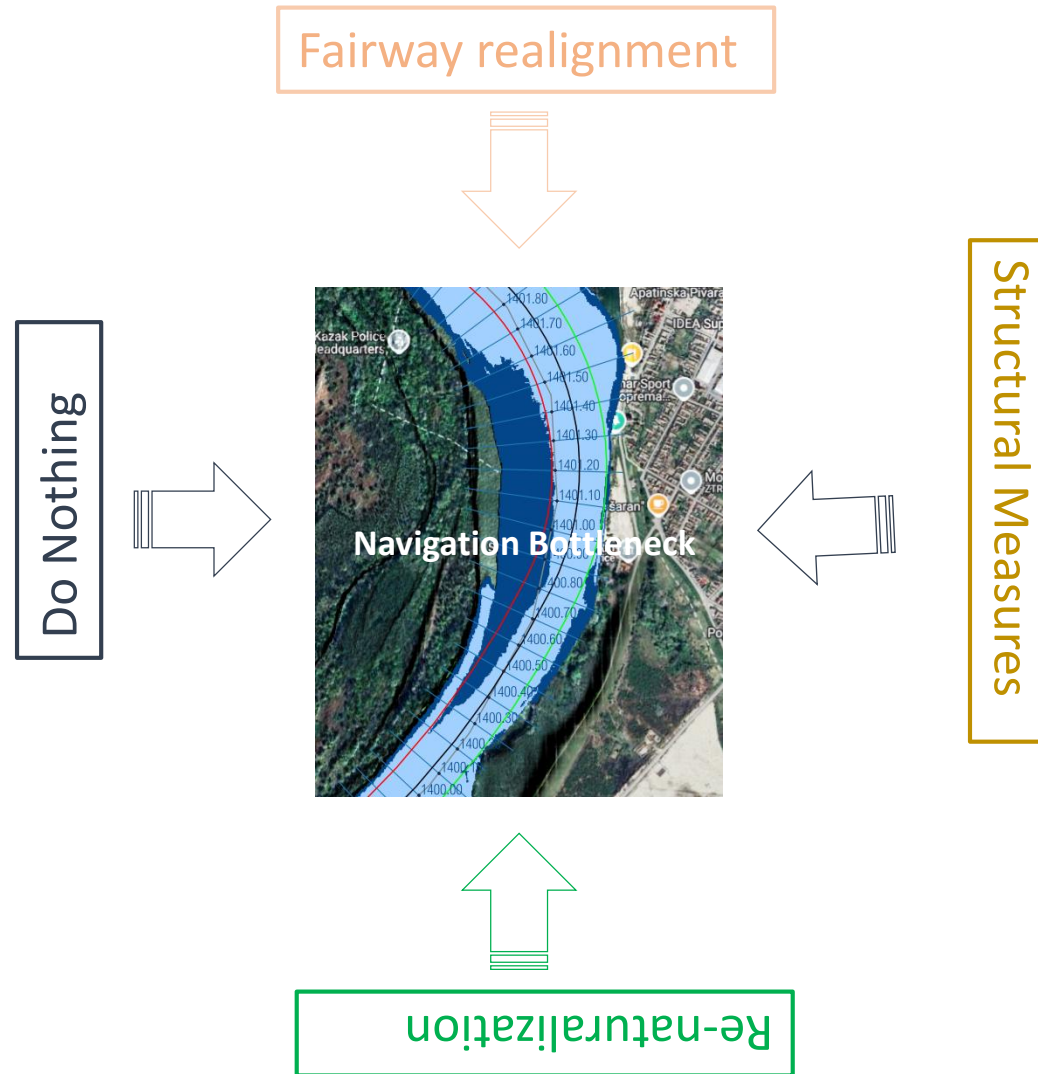
Table. Dredging volume in cubic meters for different level of service

Sector	Chainage [rkm]	B[m] 100	B[m] 120	B[m] 150	B[m] 200
1 Bezdan	1429.0 - 1425.0	0	0	0	4745
2 Siga Kazuk	1424.2 - 1414.4	0	0	0	1016
3 Apatin	1408.2-1400.0	7035	14635	26821	54311
4 Židovski rukavac	1397.2-1389.0	343	1494	8164	52977
5 Drava Confluence	1388.8-1382.0	0	441	4221	22013
6 Aljmaš	1381.4-1378.2	0	0	0	0
7 Staklar	1376.8-1373.4	733	1571	3823	14781
8 Erdut	1371.4-1366.4	0	0	0	0
9 Bogojevo	1366.2-1361.4	0	0	0	330
10 Dalj	1357.0-1351.0	0	0	0	244
11 Borovo 1	1348.6-1343.6	0	415	5431	26555
12 Borovo 2	1340.6-1338.0	0	346	6863	40353
13 Vukovar	1332.0-1325.0	0	0	0	2
14 Sotin	1324.0-1320.0	0	0	0	85
15 Opatovac	1315.4-1314.6	0	0	0	37
16 Mohovo	1311.4-1307.6	93	177	368	748
17 Ilok	1302.0-1300.0	0	0	0	0

Bottlenecks breakdown

1D Model RESULTS

How to manage navigation bottleneck?

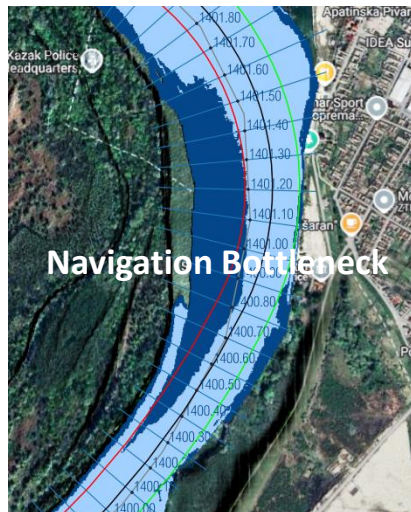


Fairway realignment

Do Nothing

Re-naturalization

Structural Measures



Do nothing

The fundamental concept of “Do Nothing” scenario involves numerical simulations of river flow and sediment transport using a calibrated and validated model within the riverbed without any interventions.

The results of modeling in “Do Nothing” scenario will be validated and appraised in comparison with results obtained in modeling of other scenarios.

“Structural Measures”

The fundamental concept of “Structural Measures” scenario involves numerical simulations of river flow and sediment transport using a calibrated and validated model within the riverbed that incorporates structural measures.

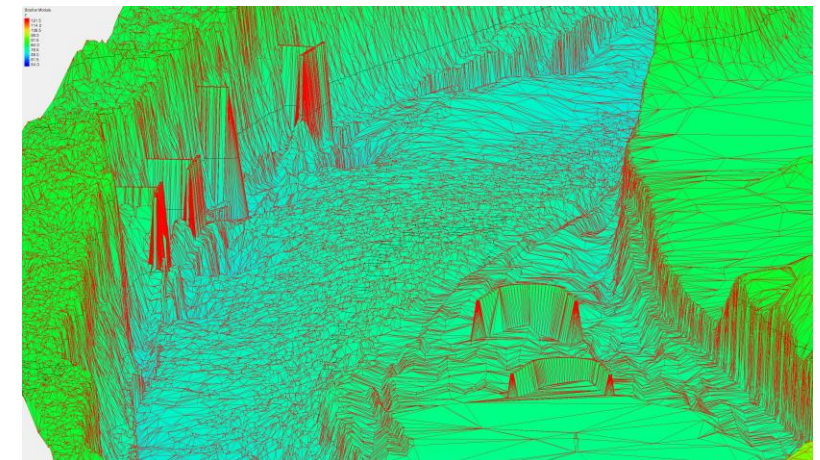
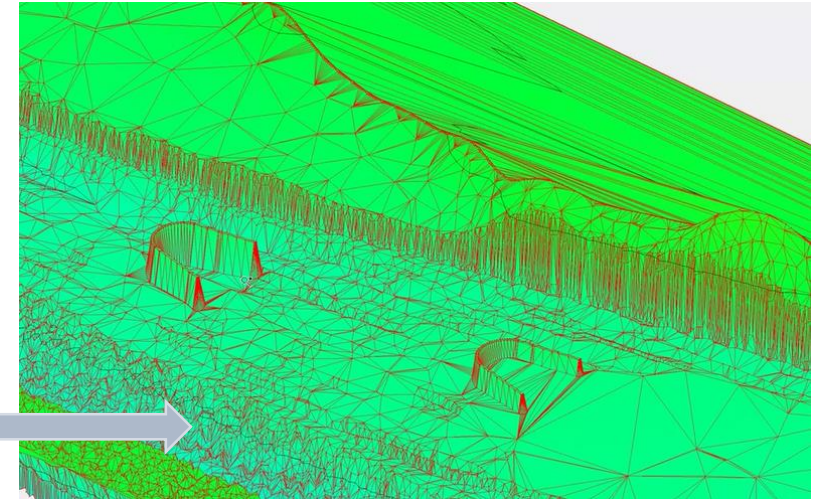
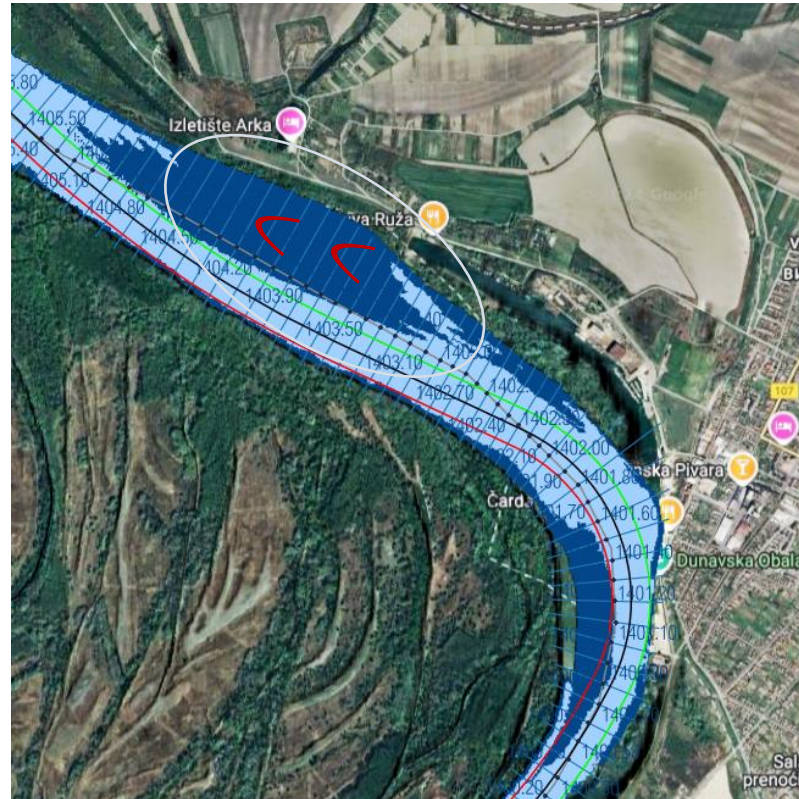
The structural measures are implemented across the entire observed section to enhance and stabilize the riverbed with regard to navigation. The second objective is to ensure that ecological indicators are improved or not deteriorated.

No.	Sector	Chainage (from km to km)	Structural Measures
1	Apatin	1,408.2 – 1,400.0	2 Chevrons and 5 sills
2	Židovski/Čivutski Rukavac	1,397.2 – 1,389.0	Sidearm opening
3	Drava Confluence	1,388.8 – 1,382.0	Sidearm opening

“Structural Measures”

Apatin 1408.2 - 1400

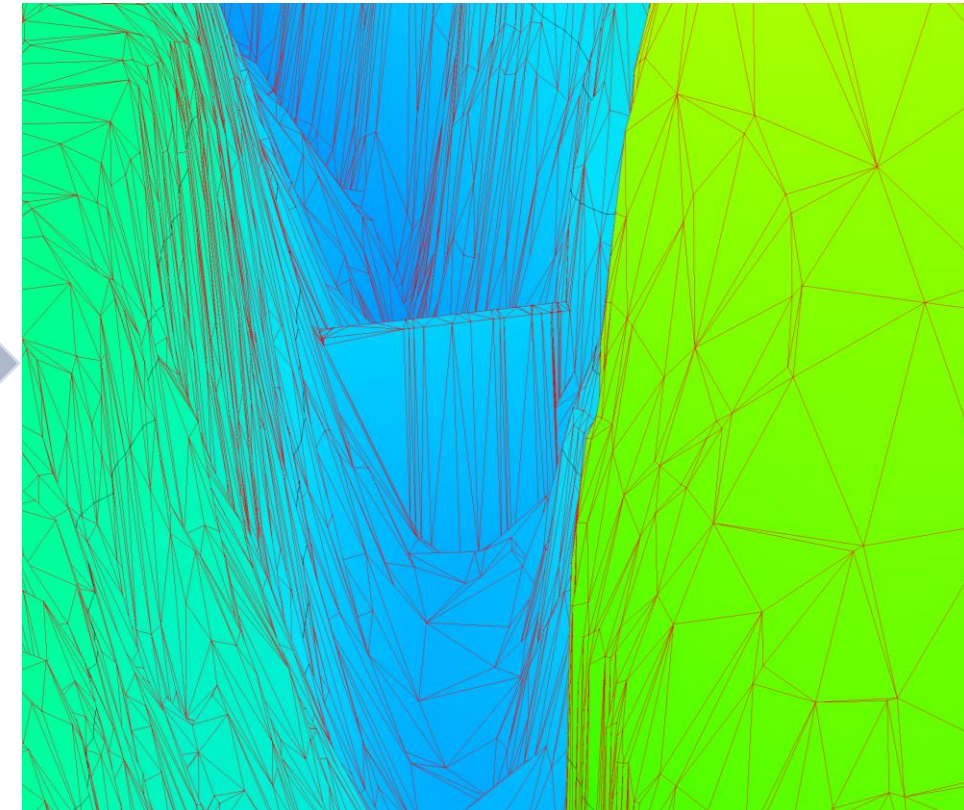
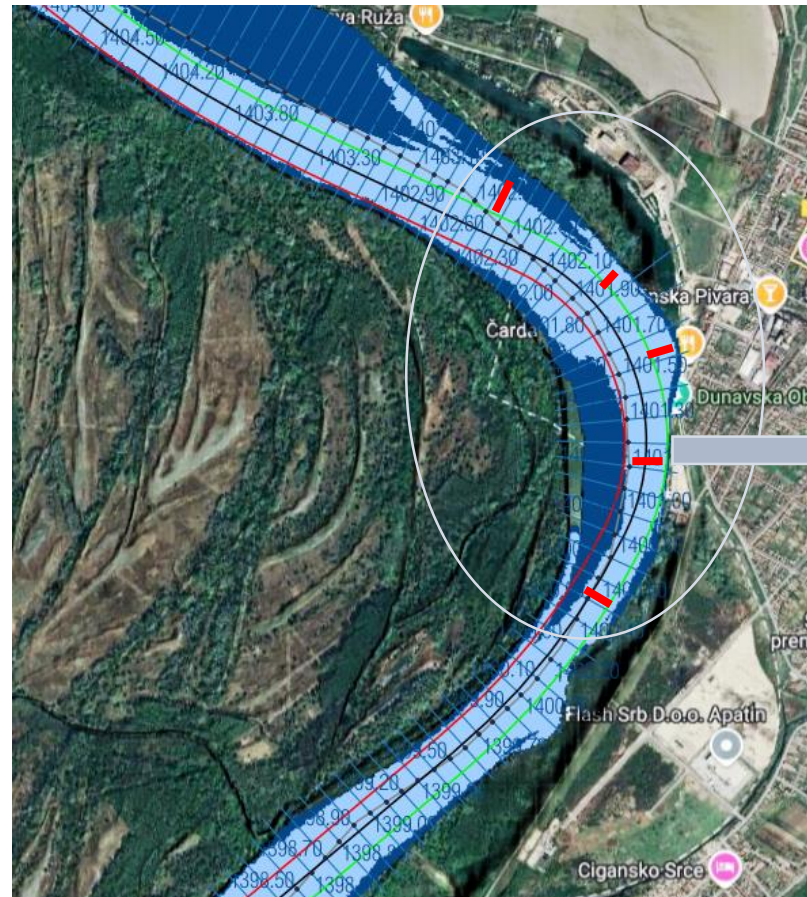
Chevrons ---> Flow redistribution
(Both side channel deepening and
creation of middle bar)



“Structural Measures”

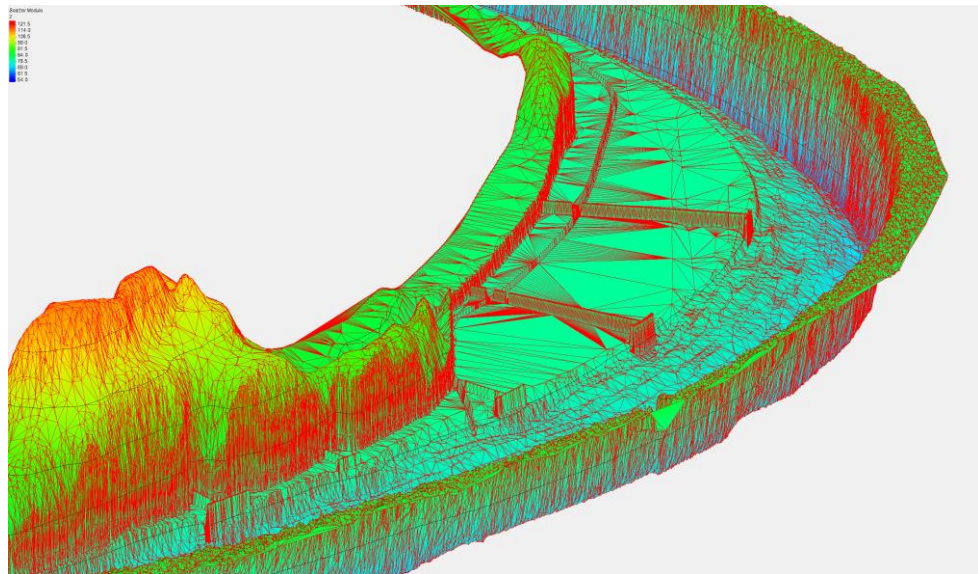
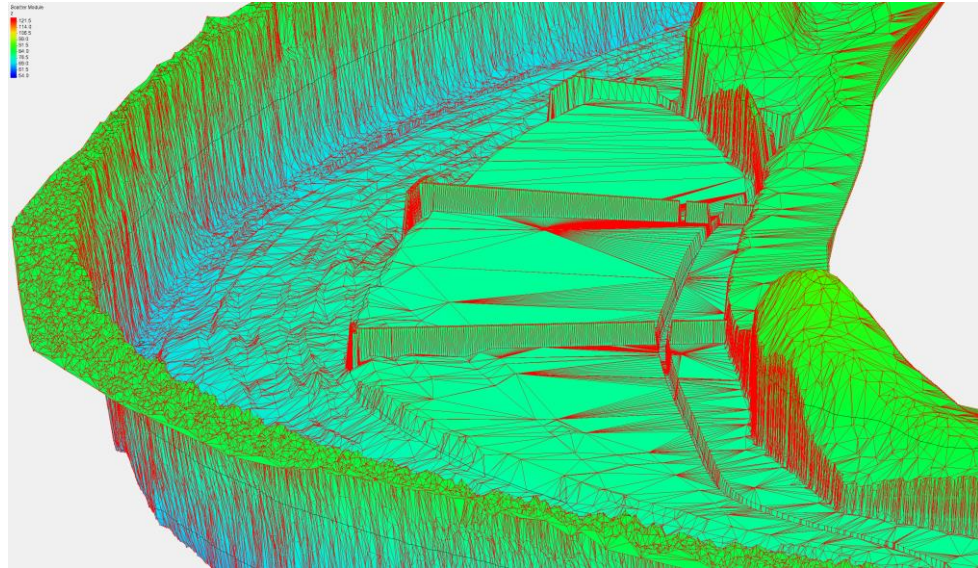
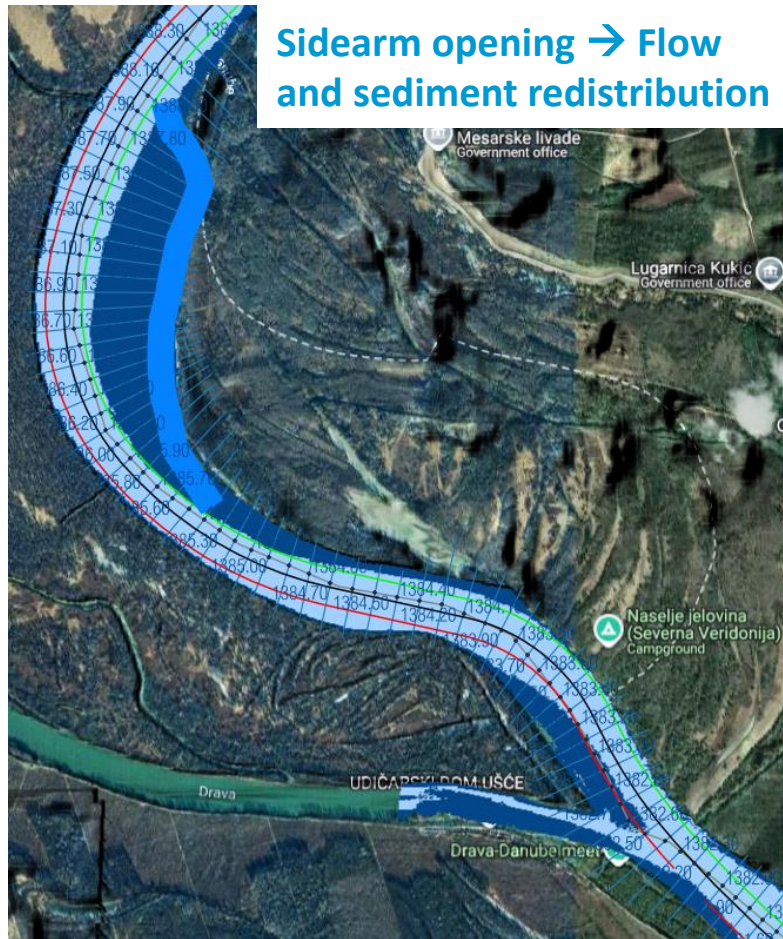
Apatin 1408.2 - 1400

Sills → Increasing discharge along right bank



“Structural Measures”

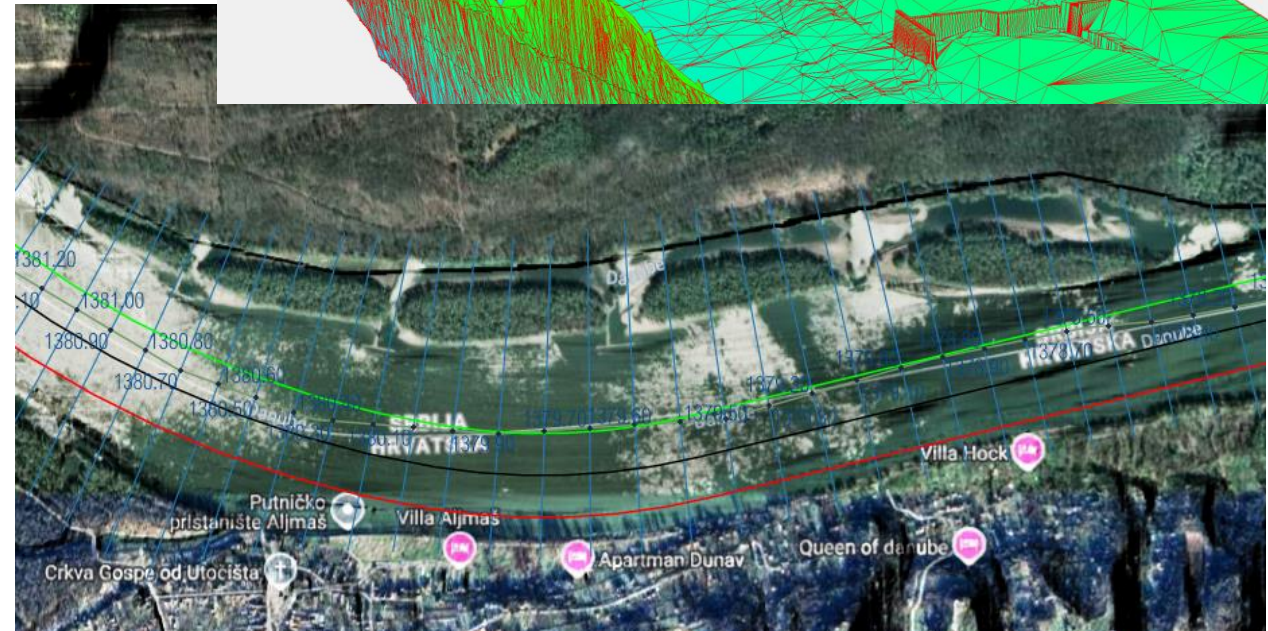
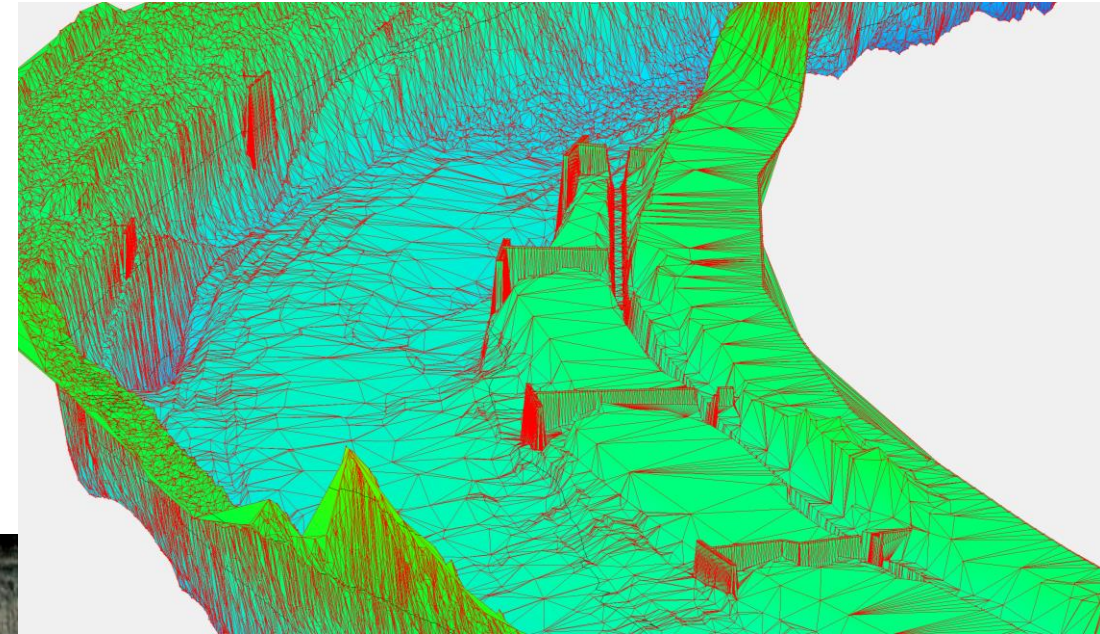
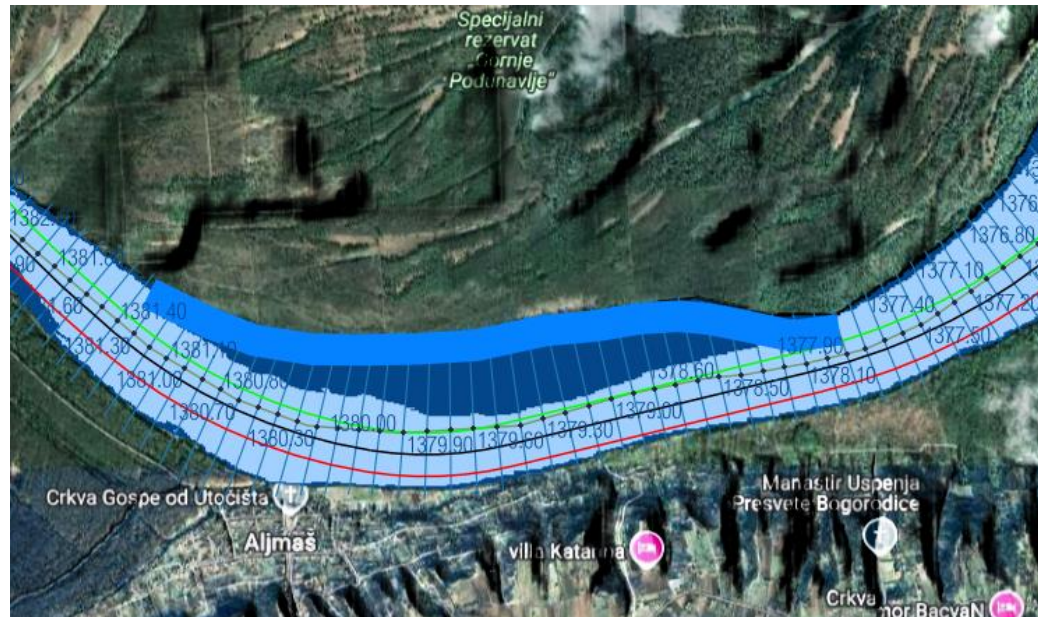
Židovski/Čivutski Rukavac 1397.2 – 1389.0



“Structural Measures”

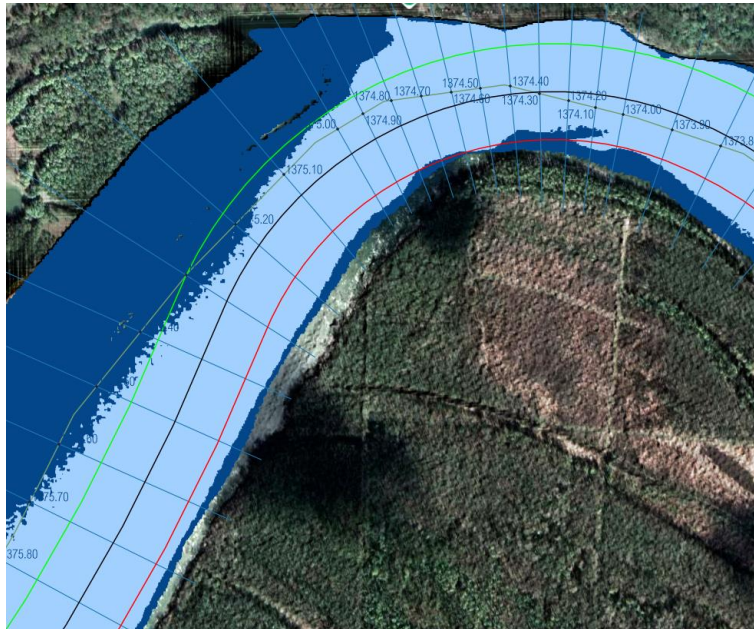
Aljmaš – Drava Confluence 1388.8 – 1382.0

Sidearm opening



“Fairway Realignment”

The fundamental concept of “Fairway Realignment” scenario involves numerical simulations of river flow and sediment transport using a calibrated and validated model within the riverbed without any interventions.



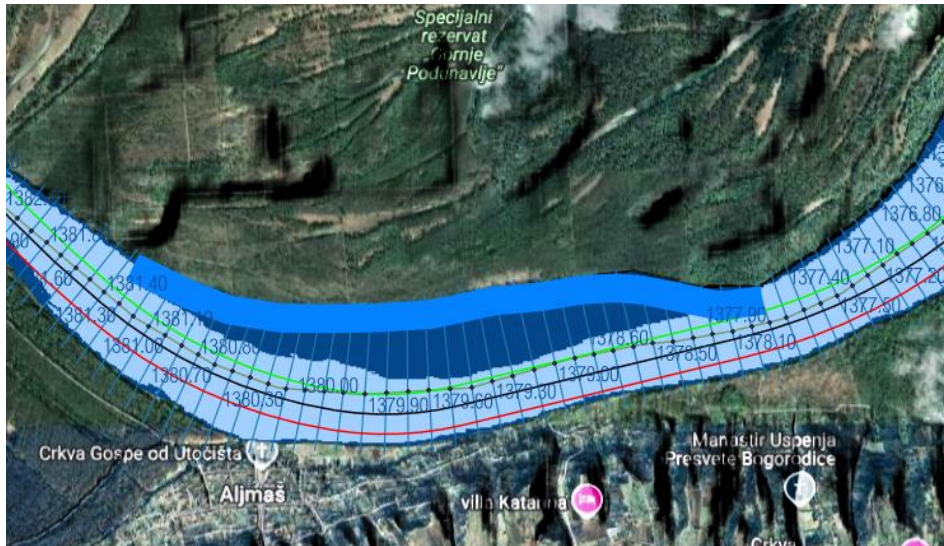
The model remains consistent with the „Do Nothing“ approach, yet the navigation parameters are managed through continuous monitoring and adjustments to the fairway signaling system based on field conditions.

“Re-naturalization”

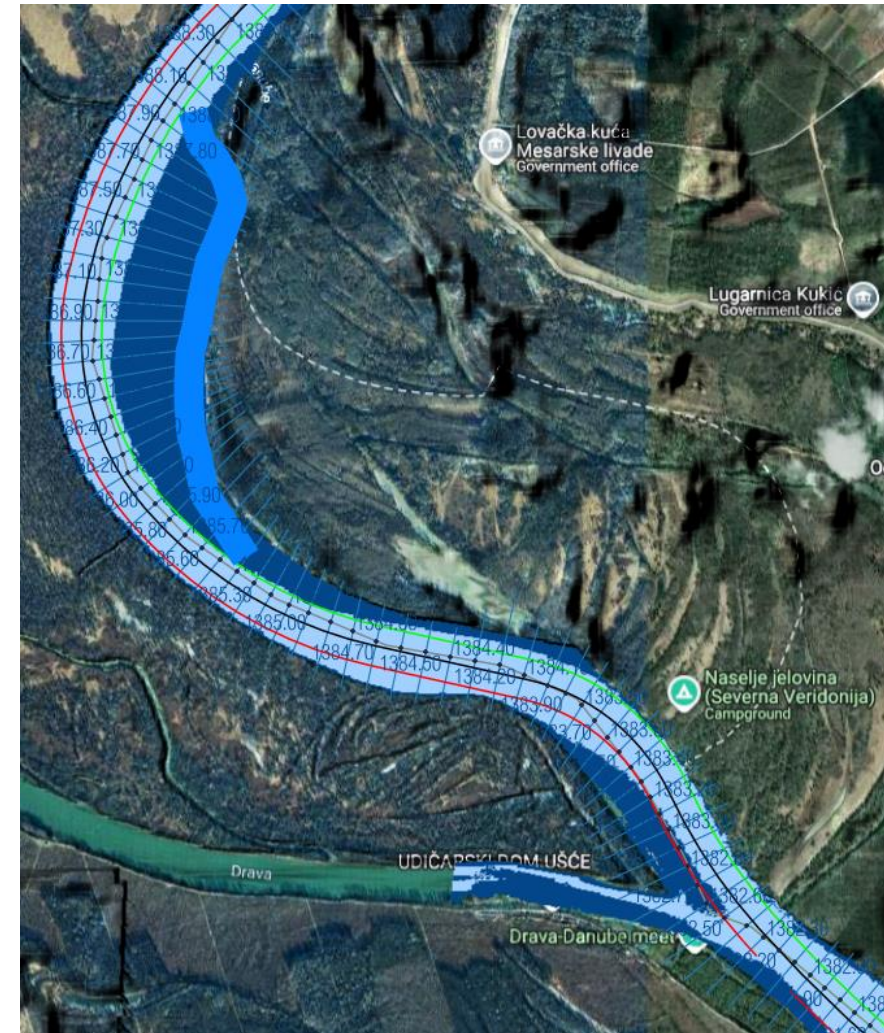
Aljmaš – Drava Confluence 1388.8 – 1382.0

Židovski/Čivutski Rukavac 1397.2 – 1389.0

Sidearm opening



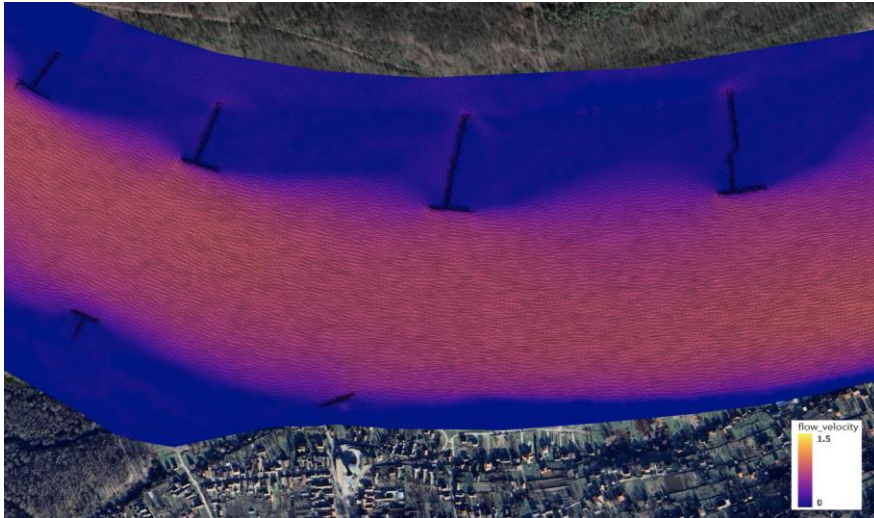
The model exploring sidearm opening approach without proposed structural measures aiming to reduce water speed in the zone of intervention, increase bedload deposition and free the water energy for the downstream erosion.



Preparation of Model for Considered Scenarios

- DTM prepared for “do nothing” (S1&S3) and Scenario 2
- Simulation results for the “do nothing” scenario
- Task 04-06 is still on-going

Hydrodynamic simulation – $Q_{Danube} = 2200 \text{ m}^3/\text{s}$



2D Sediment transport simulation – $Q_{Danube} = 3300 \text{ m}^3/\text{s}$



Following steps

- Finalization of Task 04-05 – regarding Scenario 4
- Finalization of Task 04-06 - Preparation of Model for all 4 considered scenarios
- Start of the Task 04-07 - Analysis of Results
- ...
- MCA Application (Task 04-08)

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SRB-CRO common stretch of the Danube River

Thank you for your kind attention

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