

Insights to the Modelling Activities & Multi-Criteria Analysis

Modelling and Multi-Criteria Analysis of the Danube common section (river km 1433.1 to river km 1295.5)" under the "Preparing Fairway 2 works" project

Stakeholders' Forum Meeting Number 08

03.07.2024. Nikola Rosić/Awarded Consortium Key Expert

Modelling components & methodology

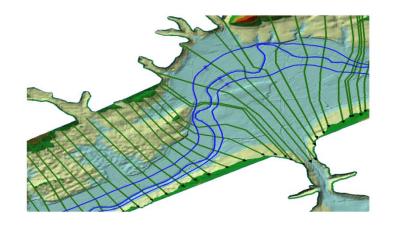


- 1D hydraulic model for the entire SRB-CRO Danube stretch
- Redefinition and prioritization of navigational bottlenecks
- Definition of parameters for the multi-criteria analysis
- Definition of alternative solutions for prioritized sectors and 2D hydrodynamic and morphological modelling
- Development of the integrated study on alternative solutions and definition of next steps for future investments.

1D Hydraulic model



- Data collection
- Model setup
- Model calibration and validation
- Simulations for relevant discharges
- Interactions with stakeholders





📕 Technical Report on 1D Hydraulic Modelling and Update of ENRs 🚗

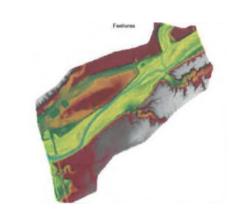


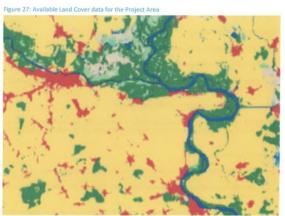
Data collection



- Hydrological data
- Bridges and hydro-technical structures (Geometry)
- ► Floodplain data
- Observed water surface elevations



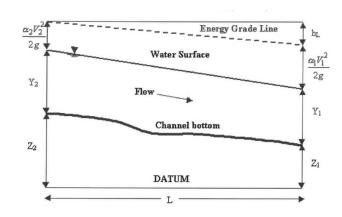


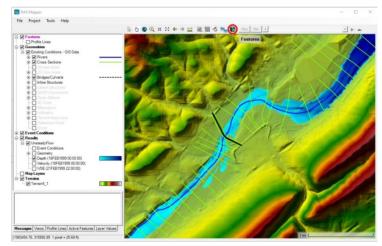


1D Modelling software



- HECRAS 1D model
- Cross sectional averaged data
- ► (1D) Water depths and Velocities
- ▶ Ras Mapper ← → GIS

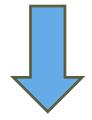


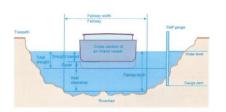


Redefinition and prioritization of navigational bottlenecks



- Current bottlenecks catalogue
- ▶ 1D Modelling outputs
- List of updated bottlenecks
- Prioritization of bottlenecks
- Feedback from the Stakeholders' Forum





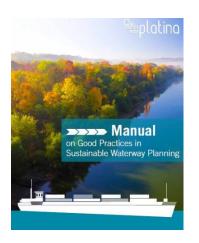


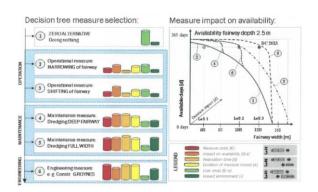
- Technical Report on Redefined Bottlenecks
- **Technical Report on Prioritization of Bottlenecks**

Redefinition and prioritization of navigational bottlenecks (2)



- Definition of bottlenecks types
- Application of relevant guidelines
- Exclusion of sectors that can be treated by operational or maintenance activities







Multi-criteria analysis



Ponder (weight)

- Method selection
- Overall criteria
- Sub-criteria
- Interactions with stakeholders

 C01
 Navigation
 30%

 C02
 Environment
 50%

 C03
 Feasibility (Costs)
 20%

 TOTAL
 100%

Table 9: MCA Example - Possible Criteria and Weights

Criteria

Code



Technical Report on the Definition of the MCA

WPM or WSM method



- Weighted product or sum model
- Dimensionless analysis or normalization problem
- Simple implementation
- Comparison of alternatives

	<i>C</i> ₁	C_2	<i>C</i> ₃	<i>C</i> ₄
Alts.	0.20	0.15	0.40	0.25
A ₁	25	20	15	30
A ₂	10	30	20	30
<i>A</i> ₃	30	10	30	10

$$P(A_K) = \prod_{j=1}^n (a_{Kj})^{w_j}, ext{ for } K = 1, 2, 3, \ldots, m_j$$

$$P(A_1/A_2) = (25/10)^{0.20} imes (20/30)^{0.15} imes (15/20)^{0.40} imes (30/30)^{0.25} = 1.007 > 1.007$$

$$P(A_1/A_3) = 1.067 > 1$$
, and $P(A_2/A_3) = 1.059 > 1$.

$$A_1 > A_2 > A_3$$

Criteria selection



- Legislation
- Section dependent
- Improvement of navigation conditions
- Multidisciplinary experts
- Multidisciplinary stakeholder forum

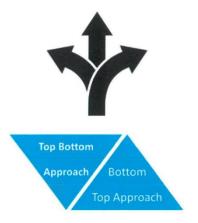


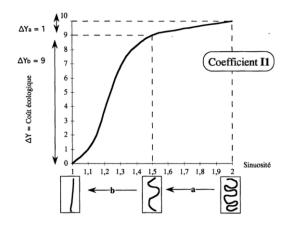
Table 11: MCA Example - Possible Criteria, Weights, Sub-criteria and Sub-weights

Code	Criteria / Sub-criteria	Ponder (weight)
C01	Navigation	30%
SC01-01	Fairway depth	10%
SC01-02	Fairway width	4%
SC01-03	Fairway curve radius	3%
SC01-04	Flow velocity	3%
SC01-05	Sustainability of measure	10%
C02	Environment	50%
SC02-01	Fish population	5%
SC02-02	Bird population	5%
SC02-03	Microzoobenthos	5%
SC02-04	Noise	5%
SC02-05	Sediment and water quality	5%
SC02-06	Hydro-morphology	20%
SC02-07	Climate change vulnerability	5%
C03	Feasibility (Costs)	20%
C03-01	Technical feasibility	5%
C03-02	Financial feasibility	10%
C03-03	Duration of construction	5%
	TOTAL	100%

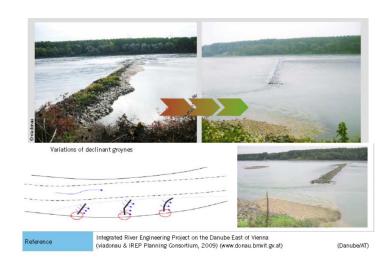
MCA Scores



- ► Hydraulic data → Enviromental impact
- Other types of "disturbances"



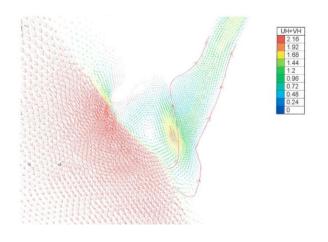
		Net reduction in water covered areas (%)			
		Large effect > 25	Moderate effect 11- 25	Little effect < 10	No effect
Reduced production (%)	Large > 25				
	Moderate 11- 25				
ed pro	Little < 10				
Reduc	None				

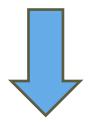


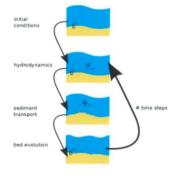
Coupled 2D Hydrodynamic & Sediment transport model



- Data collection
- 2D Model(s) setup
- Model calibration and validation
- Simulations for defined "bottlenecks" variants
- Interactions with stakeholders







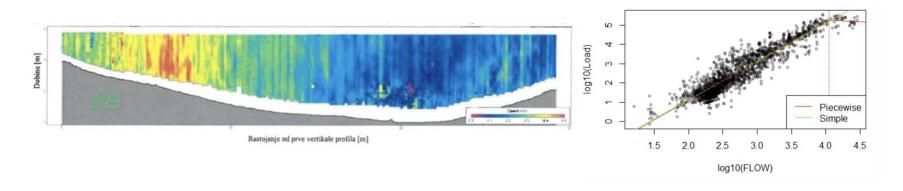


Technical Report on 2D Modelling and Application of MCA

Data collection



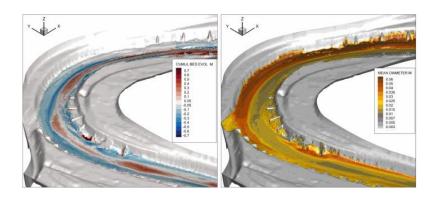
- Geometry (Maps, Land surveys, Structures)
- Hydrodynamics (Water levels, Velocities)
- Sediment Transport (Bed and Suspended samples, Sediment rating curves)
- Morphology
- Model setup and numerical simulations
- Definition of Alternative variants for each bottleneck (in parallel with model development)

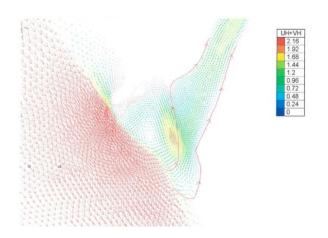


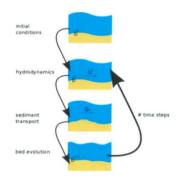
2D Modelling software



- Telemac 2D/3D
- ► Telemac Sisyphe/Gaia
- Results presented in GIS



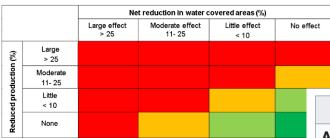


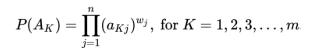


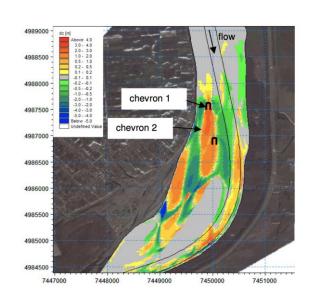


MCA Application

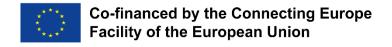
- ▶ 2D Simulations outputs
- Optimal mitigation measures







	C ₁	C_2	<i>C</i> ₃	<i>C</i> ₄
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Thank you for your kind attention

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