Data Collection, hydraulic and morphological modelling of the Danube River and the Sava River in the Republic of Serbia
Lot 1: Hydraulic and morphological modelling of the SRB-HRV common stretch of the Danube River

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REPORT ON PRIORITIZATION OF NAVIGATION BOTTLENECKS

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Abbreviations

Abbr.	Meaning
1D	One dimensional (model, modeling)
2D	Two dimensional (model, modeling)
AD	*Akcionarsko društvo* (Joint-Stock Company)
AGN	European Agreement on Main Inland Waterways of International Importance
CA	Contracting Authority
CEF	Connecting Europe Facility
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ENR	Etiage navigable et de régularisation
EU	European Union
EUSDR	European Union Strategy for the Danube Region
GNS	Guidelines Towards Achieving a Good Navigation Status
HRV	Croatia
JS	Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin
km	Kilometer
LNWL	Low Navigation Water Levels
m	Meter
MoCTI	Ministry of Construction, Transport and Infrastructure
NAIADES	Action plan for boosting future-proof European inland waterway transport
PIANC	World Association for Waterborne Transport Infrastructure
PLATINA	PLATform for Implementation of NAiades
SEA	Strategic Environmental Assessment
SRB	Serbia
TBR MDD	The Transboundary Biosphere Reserve Mura-Drava-Danube
TEN-T	Trans European Transport Network
UN	United Nations
UNFCCC	UN Framework Convention on Climate Change
WFD	Water Framework Directive

Introduction

The Contract "Data Collection, hydraulic and morphological modelling of the Danube River and the Sava River in the Republic of Serbia, Lot 1: Hydraulic and morphological modelling of the SRB-CRO common stretch of the Danube River" is financed by the European Union under the Connecting Europe Facility (CEF) Programme and the European Investment Bank, under the Finance Contract Serbian Inland Waterway Infrastructure between the European Investment Bank and the Republic of Serbia. The Contracting Authority (CA) is the Ministry of Construction, Transport and Infrastructure (MoCTI) of the Republic of Serbia. The service contract was concluded between the MoCTI and the Hidrozavod DTD AD Novi Sad (hereinafter referred to as the Consultant).

The overall objective of the project is to contribute to the creation of competitive transport system by the improvement of infrastructure alongside the Danube River, in accordance with the national policy and strategy provisions and with the respect of EU transport system development plans in order to ensure fast, safe, reliable and environmentally friendly transportation, smooth flow of freight and mobility of people. Integrated planning approach and inter-sectoral cooperation through the Stakeholders' Forum platform is planned throughout the process.

The Activity 2 of the Contract deals with the update of the bottlenecks catalogue and prioritization of bottlenecks in order to select sections of the SRB-HRV common stretch of the Danube River to be the subject of 2D modeling under the Activity 4 of the Contract, in order to analyze alternative solutions for improvement of navigations conditions during low water periods.

Chapter 1 of this report provides basic international strategic and legal framework of the project. Chapter 2 contains the list of identified navigation bottlenecks. Methodology for the prioritization of navigation is presented in the Chapter 3, and application of that methodology and the list of prioritized navigation bottlenecks is given in the Chapter 4.

1. List of identified navigation bottlenecks

Based on the results of the 1D modeling report, including the Hydrological Study, the Consultant calculated new reference water levels (Etiage navigable et de régularisation – ENR, or Low Navigation Water Levels - LNWL) for the entire project area (SRB-HRV common stretch of the Danube River). After application of the official designed fairway axis (provided by the CA), the Consultant applied designed 2.5m depth and different widths of the fairway (100m, 120m, 150m, and 200m, in line with the Level of Service approach) to calculate the volume of sediment within the fairway in the critical sectors. The Level of Service approach is related to different quality levels of services which waterway administrations are providing to waterways users, in this case in the terns of available fairway parameters (the higher values of fairways parameters provided corresponds to the higher level of services, and vice versa). The Consultant applied those different fairway parameters throughout the project area (the common SRB-HRV stretch of the Danube River). Additionally, the Consultant used historical hydrographic data provided by the Contracting Authority, to add additional perspective on the characteristics of historical morphological development of those sectors. List of analyzed navigation bottlenecks, as stretches of the Danube River with potentially limited fairway parameters during low water periods, is presented in the Table 1.

Table 1: List of Analyzed navigation bottlenecks

No.	Sector	Chainage (from km to km)	Quantity of sediment (m^3) within the fairway of 2.5m depth &			
			Width 100m	Width 120m	Width 150m	Width 200m
1	Bezdan / Batina	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 / Zidovski 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	Aljmas	1,381.4 – 1,378.2	0	0	0	0
7	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781
8	Erdut	1,371.4 – 1,366.4	0	0	0	0
9	Bogojevo	1,366.2 – 1,361.4	0	0	0	330
10	Dalj	1,357.0 – 1,351.0	0	0	0	344
11	Borovo 1	1,348.6 – 1,343.6	0	415	5,431	26,555
12	Borovo 2	1,340.6 – 1,338.0	0	346	6,863	40,353
13	Vukovar	1,332.0 – 1,325.0	0	0	0	2
14	Sotin	1,324.0 – 1,320.0	0	0	0	85
15	Opatovac	1,315.4 – 1,314.6	0	0	0	37
16	Mohovo	1,311.4 – 1,307.6	93	177	368	748
17	Backa Palanka / Iok	1,302.0 – 1,300.0	0	0	0	0

Compared to the existing list of bottlenecks identified by the SRB and HRV authorities a decade ago, the updated list of bottlenecks contains 13 sectors. This means that 4 sectors from the previous list —**Aljmaš**, **Erdut**, **Vukovar**, and **Ilok**— are no longer considered critical for navigation, as the full fairway parameters are now available. The updated list of navigation bottlenecks is presented in the Table 2.

Table 2: Updated list of navigation bottlenecks

No.	Sector	Chainage (from km to km)	Quantity of sediment (m^3) within the fairway of 2.5m depth &			
			Width 100m	Width 120m	Width 150m	Width 200m
1	Bezdan / Batina	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 / Zidovski 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
7	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781
9	Bogojevo	1,366.2 – 1,361.4	0	0	0	330
10	Dalj	1,357.0 – 1,351.0	0	0	0	344
11	Borovo 1	1,348.6 – 1,343.6	0	415	5,431	26,555
12	Borovo 2	1,340.6 – 1,338.0	0	346	6,863	40,353
14	Sotin	1,324.0 – 1,320.0	0	0	0	85

No.	Sector	Chainage (from km to km)	Quantity of sediment (m^3) within the fairway of 2.5m depth &			
			Width 100m	Width 120m	Width 150m	Width 200m
15	Opatovac	1,315.4 – 1,314.6	0	0	0	37
16	Mohovo	1,311.4 – 1,307.6	93	177	368	748

For the sake of traceability, the Consultant preserved the numbering established by the SBR and HRV authorities in all tables throughout this report.

Details on all 13 bottlenecks are presented in the Updated Bottlenecks Catalogue.

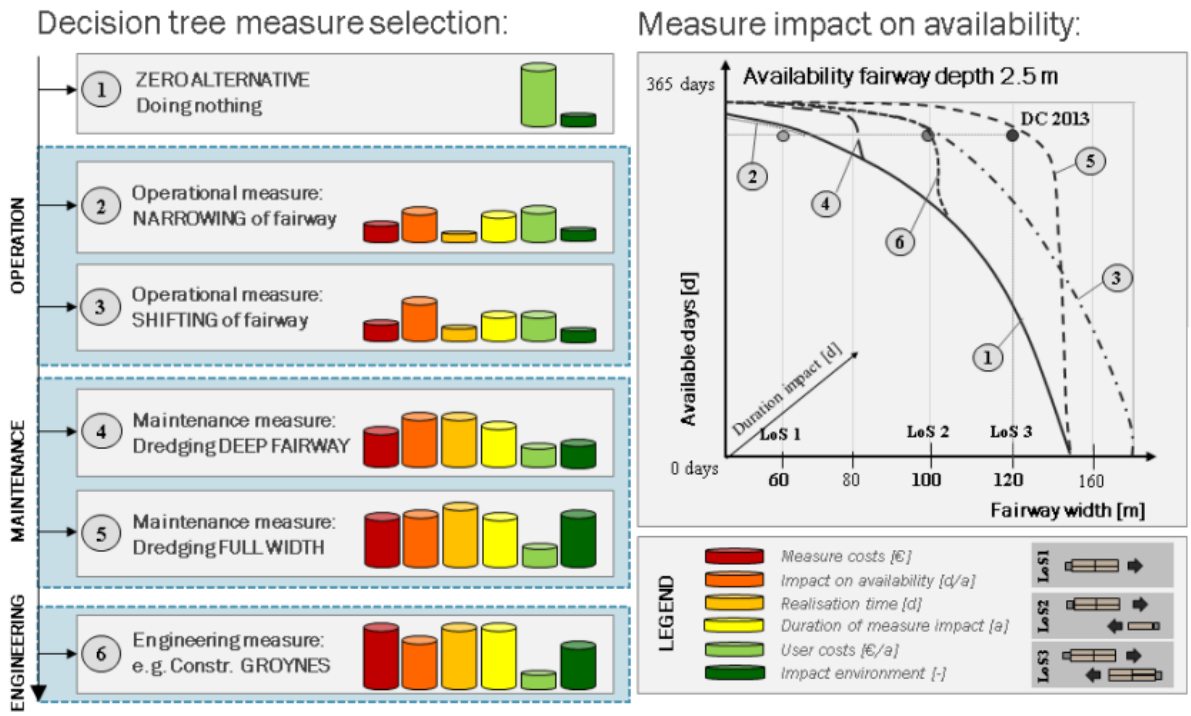
General observation is that the total number of navigation bottlenecks is decreased.

2. Methodology for prioritization of navigation bottlenecks

Navigation bottlenecks, or critical sectors for navigation, are stretches of the river characterized by the reduced fairway parameters during low water periods and jeopardized safety of navigation. Not all identified bottlenecks have the same level of impact to the reduction of fairway parameters and, consequently, not all of them have the same level of impact to the navigation safety.

In this sense, link can be made to the Good Practice Manual on Inland Waterway Maintenance (MOVE/FP7/321498/PLATINA II, 2016) and example of different measures applicable to identified navigation bottlenecks (Figure 1). Similar approach can be found under the Guidelines Towards Achieving a Good Navigation Status – the GNS study (2018) as well.

Figure 1: Example of visualization of results of evaluation of different measures (from do nothing through O&M to engineering measure)



Source: Good Practice Manual on Inland Waterway Maintenance, MOVE/FP7/321498/PLATINA II, 2016, p. 86; based on NEWADA duo (2014): Feasibility Study for a Waterway Maintenance Management System (WMMS) for the Danube, Network of Danube Waterway Administrations – data and user orientation, Final Report, NEWADA duo project deliverable O.6.4.9

According to this approach, firstly, it should be investigated if soft measures like narrowing of the fairway or realignment (shifting) of the fairway or similar can be applied. In the next step, it should be investigated if maintenance dredging activities can improve navigation conditions. Finally, if none of previous options seems reasonable, alternatives with application of river training structures should be designed and eventually constructed.

3. Application of the methodology for prioritization of navigation bottlenecks

As the first step in the application of the previously elaborated methodology for the prioritization of navigation bottlenecks, narrowing of the fairway is applied. This means reduction of the fairway width from 200m to 150m, by which the following sectors are removed for the list: **Bezdan**, **Siga Kazuk**, **Bogojevo**, **Dalj**, **Sotin**, and **Opatovac**. The Consultant notes that volume of sediment within fairway of defined dimensions identified at sectors Bogojevo, Dalj, Sotin and Opatovac is rather small and can be attributed to the method of hydrographic survey as well. After this step, the reduced list of navigation bottlenecks after application of the narrowing of the fairway is presented at the Table 3.

Table 3: List of navigation bottlenecks after application of operation measures

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
7	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781
11	Borovo 1	1,348.6 – 1,343.6	0	415	5,431	26,555
12	Borovo 2	1,340.6 – 1,338.0	0	346	6,863	40,353
16	Mohovo	1,311.4 – 1,307.6	93	177	368	748

The Consultant notes that it cannot make predictions on long term sustainability of these measures. All these sectors should be monitored regularly by relevant SRB and HRV administration, and adequate measures should be applied based on the prevailing circumstances and observed trends.

In the next step, a combination of further reduction of the fairway width in combination with potential maintenance dredging (if needed) could be applied to sectors **Borovo 1** and **Borovo 2**, being two sectors with relatively positive morphological dynamics.

Finally, the Consultant notes the fact that some sectors show specific characteristics (such as the **Mohovo** Sector), where the river bottom is characterized by the existence of rocky spikes. This brings a whole different perspective to the navigation safety issue, and such sectors are not treatable with any regular maintenance dredging activities nor application of river training structures. On this sector, the quantity of identified sediment which the fairway doesn't correspond to the level of limitations that it creates to the navigation process. Simply, on this sector, no hydraulic and morphological modeling can be useful, identified rocky spikes are fixed and must be removed in order to establish fairway parameters needed for the safe navigation.

After this step, the list of navigation bottlenecks after application of possible fairway operation and maintenance measures is presented at the at the Table 4.

Table 4: 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
7	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781

In close coordination with the CA, as well as with the interest of both SRB and HRV administrations expressed during the SHFM09 meeting, the Consultant is proposing the revision of this list by inclusion of the sector **Aljmas**, the sector which currently is not considered as critical for navigation (Table 5). The reason behind such recommendation is that this sector is positioned between and is sharing hydro-morphological characteristic with two prioritized sector (sector Drava Confluence upstream of Aljmas and sector Staklar downstream of Aljmas). The Consultant considers that joint modeling of these sectors might provide better insight into potential future hydro-morphological development of the area.

Table 5: List of prioritized navigation bottlenecks to be the subject of 2D modeling

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	Aljmas	1,381.4 – 1,378.2	0	0	0	0
7	Staklar	1,376.8 – 1,373.4	733	1,571	3,823	14,781

At the same time, this is the list of prioritized navigation bottlenecks to be the subject of the 2D modeling.

Sources

1. Good Practice Manual on Inland Waterway Maintenance (MOVE/FP7/321498/PLATINA II, 2016).
2. Guidelines Towards Achieving a Good Navigation Status – the GNS study (2018).
3. Feasibility Study for a Waterway Maintenance Management System (WMMS) for the Danube, Network of Danube Waterway Administrations – data and user orientation, Final Report, NEWADA duo project deliverable O.6.4.9
4. Navigation Bottlenecks Catalogue.
5. 1D modeling report.