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Monitoring of hydrological, hydraulic and morphological characteristics of the Danube and inventory of biodiversity components of the Croatian- Serbian common section of the Danube

Stakeholder's forum - June 2023

~ Analysis of the existing waterway state ~



Analysis of the existing state

Hydrological analysis (1)



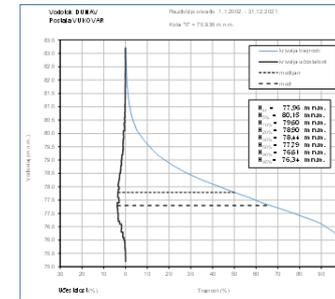
River	Station	Code	F	"0"		Distance from the confluence	Beginning of operation
			(km ²)	HDKS	HTRS		
				(m a.s.l.)	(m a.s.l.)	rkm	
DANUBE	BATINA	5170	210.250,0	80,45	80,188	1224+840	9.3.2001
	ALJMAŠ	5001	251.573,0	78,08	77,833	1381+500	1.1.1909
	DALJ	5130	--	75,204	74,953	1354+200	11.10.1985
	VUKOVAR	5070	253.147,0	76,188	75,936	1336+500	1.1.1856
	ILOK	5024	253.737,0	73,968	73,7	1301+500	1.1.1856
DRAVA	OSIJEK	5053	39.982,0	81,481	81,255	18+960	1.1.1827

River	Station	Water level	Flow	Water temperature	Ice	Suspended solids concentration	Suspended solids flow
		H	Q	Wt	I	SSc	SSf
		(cm)	(m ³ s ⁻¹)	(°C)	(%)	(gm ³)	(t)
DANUBE	BATINA	+	+	+	-	+	+
	ALJMAŠ	+	+	+	-	-	-
	DALJ	+	+	+	-	+	+
	VUKOVAR	+	+	+	-	-	-
	ILOK	+	+	+	-	+	+
DRAVA	OSIJEK	+	-	+	-	-	-

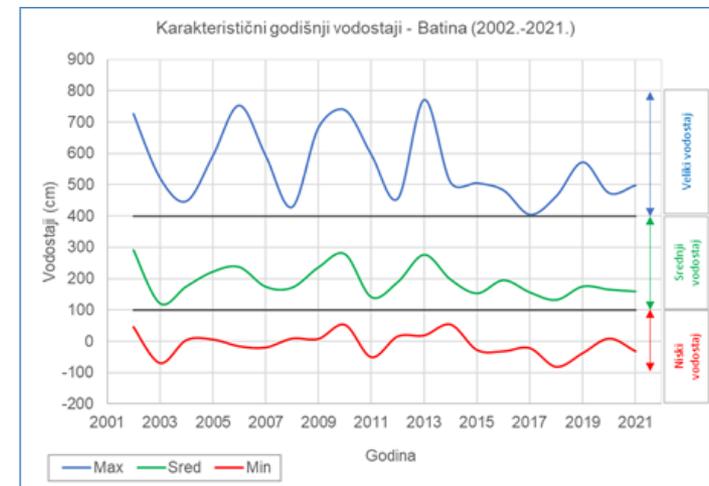
Analysis of the existing state

Hydrological analysis (2)

- ▶ Water level duration and frequency curves designed for 2002-2021 timeline
- ▶ Statistical analysis yielded 5 scenarios: min, 90%, 50%, 10% and max
- ▶ Characteristic yearly water levels for Danube (3 scenarios)



Vodomojna postaja	H _{max}	H _{10%}	H _{50%}	H _{90%}	H _{min}
Batina	772,0	385,6	192,0	36,7	-82,0
Aljmaš	815,0	417,5	224,9	68,5	-68,0
Vukovar	723,0	365,7	201,6	66,2	-48,0
Ilok	752,0	383,1	233,5	99,0	-27,0



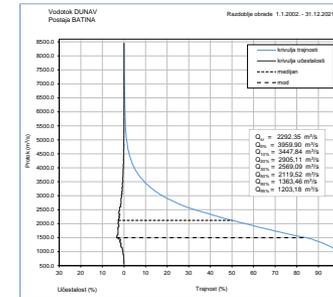
Conclusions:

- Low water levels < 100 cm
- Median water levels 100-400 cm
- High water levels > 400 cm

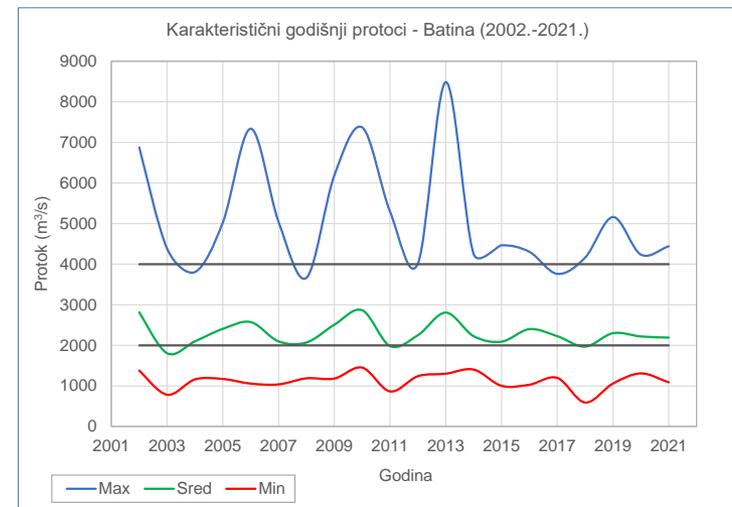
Analysis of the existing state

Hydrological analysis (3)

- ▶ Flow duration and frequency curves designed for 2002-2021 timeline
- ▶ Statistical analysis yielded 5 scenarios: min, 90%, 50%, 10% and max
- ▶ Characteristic yearly water levels for Danube (3 scenarios)



Vodometna postaja	Q _{max}	Q _{10%}	Q _{50%}	Q _{90%}	Q _{min}
Batina	8.486,00	3.447,84	2.119,52	1.363,46	590,00
Aljmaš	8.597,00	4.084,64	2.616,78	1.785,60	1.149,00
Vukovar	7.789,00	4.153,26	2.709,80	1.831,23	1.015,00
Ilok	8.027,00	4.197,34	2.729,65	1.888,61	1.192,00

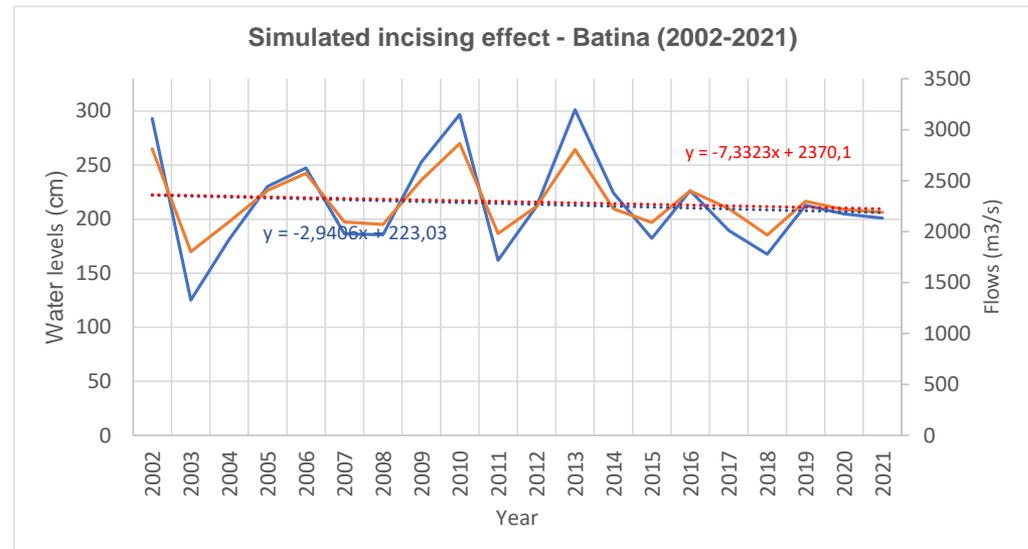
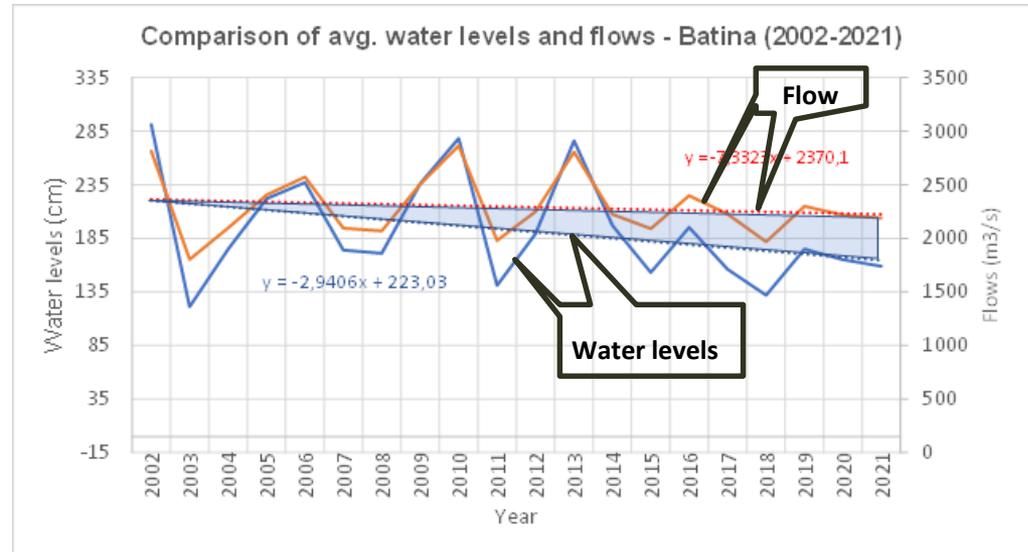


Analysis of the existing state

Hydrological analysis (4)



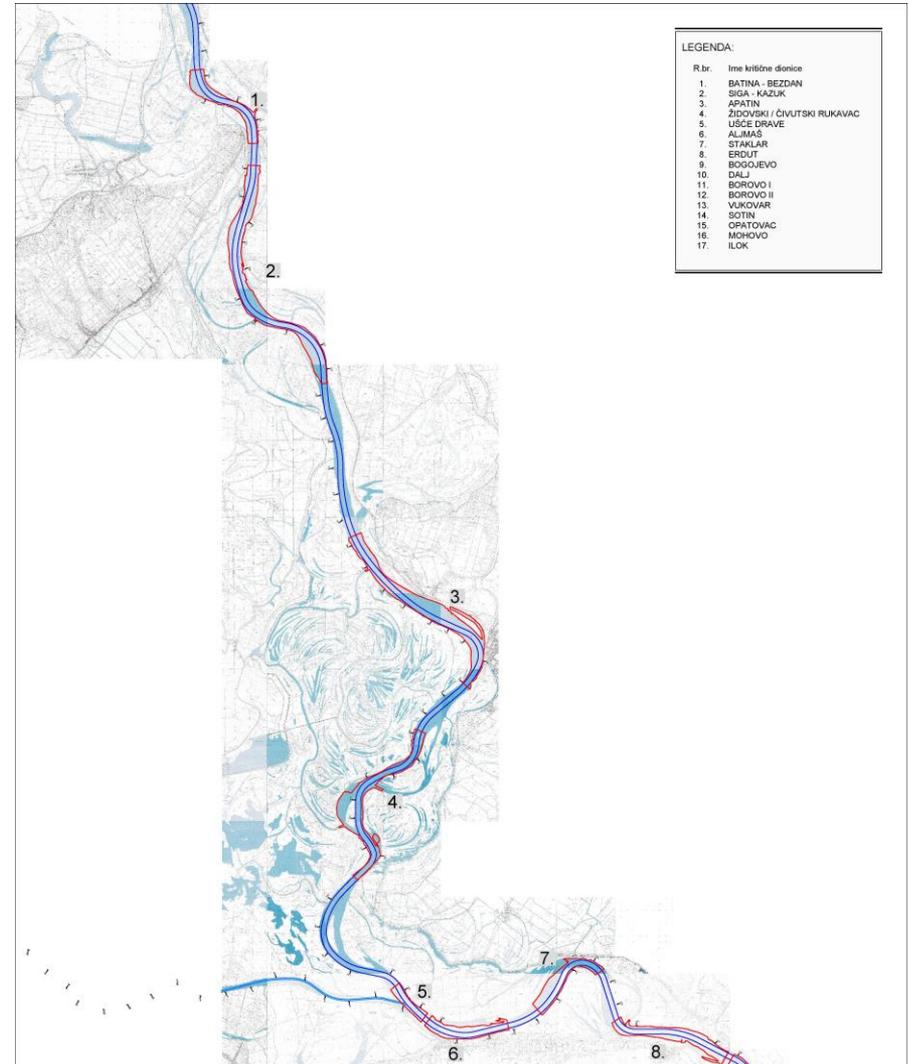
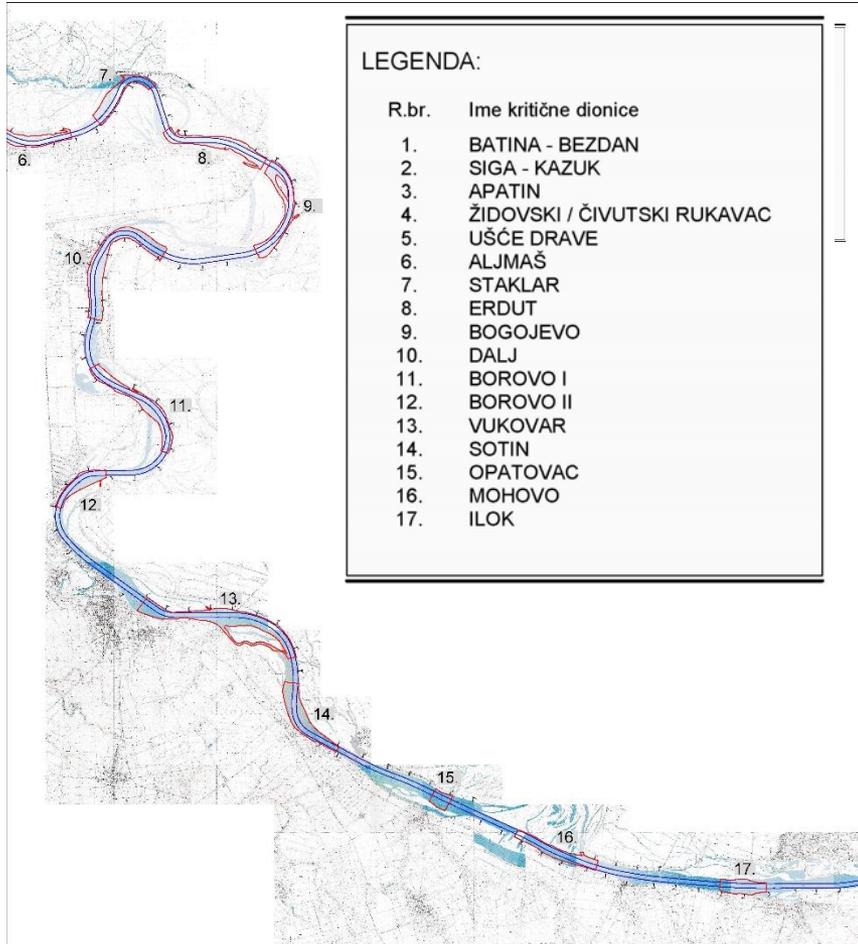
- ▶ Comparison of water levels and flow data in analyzed timeline
 - Batina WM example
- ▶ General decline in values, sharper decline for water levels – incising effect
- ▶ Simulation of incising effect – **2,1 cm/ann** for Batina WM station



Analysis of the existing state

Transport analysis (1)

▶ Critical sectors (17)



Analysis of the existing state

Transport analysis (2)

- ▶ IWT levels (Danube commission):
 - ▶ Low-level: 94% occurrence (343 days/a) of a 25RP
 - ▶ High-level: 1% occurrence (4 days/a) of a 25RP
- ▶ **Vic** class of waterways – 2,5m of min. depth
- ▶ *Methodology for prioritization of critical sectors* (Plovput&MSTI, 2014) – waterway widths of 100, 120, 150 and 200m
- ▶ Additional analysis: analysis of 2,8/3m depths and 80m widths (Danube commission; MSTI)
- ▶ Criteria for critical sectors:
 - ▶ Dredging quantities *exceed/do not exceed* 10.000 m³ for required depths and widths

Analysis of the existing state

Transport analysis (3)

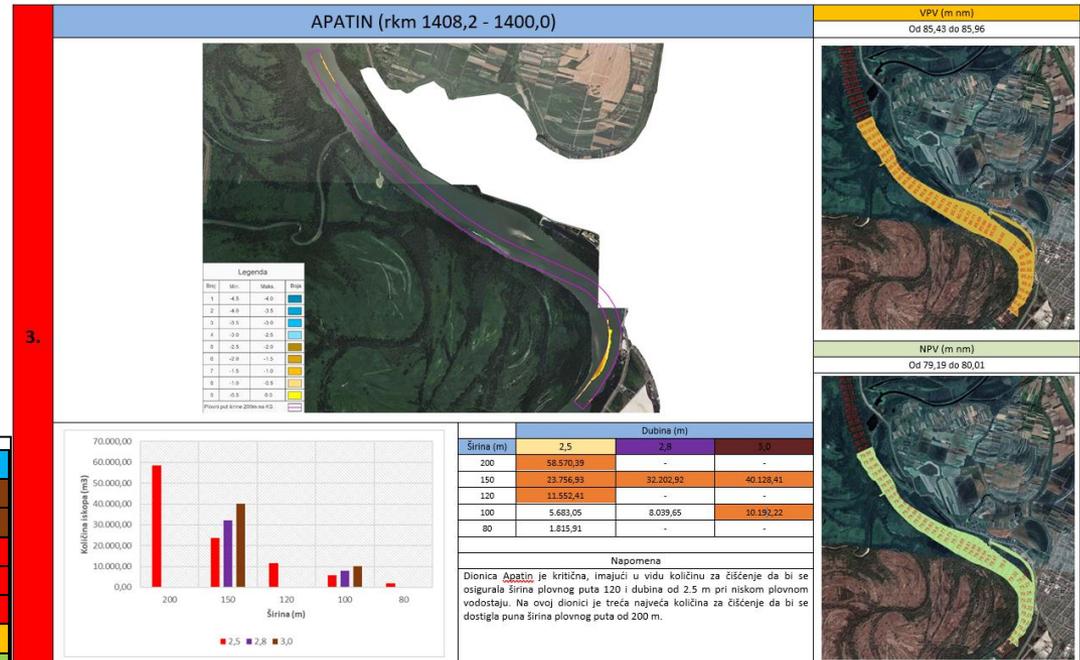


▶ Example of analysis (Apatin)

▶ Results:

No dredging quantity (0 m3)	
Dredging quantity 0-10.000 m3	
Dredging quantity 10.001-25.000 m3	
Dredging quantity 25.001 – 75.001 m3	
Dredging quantity >75.001 m3	

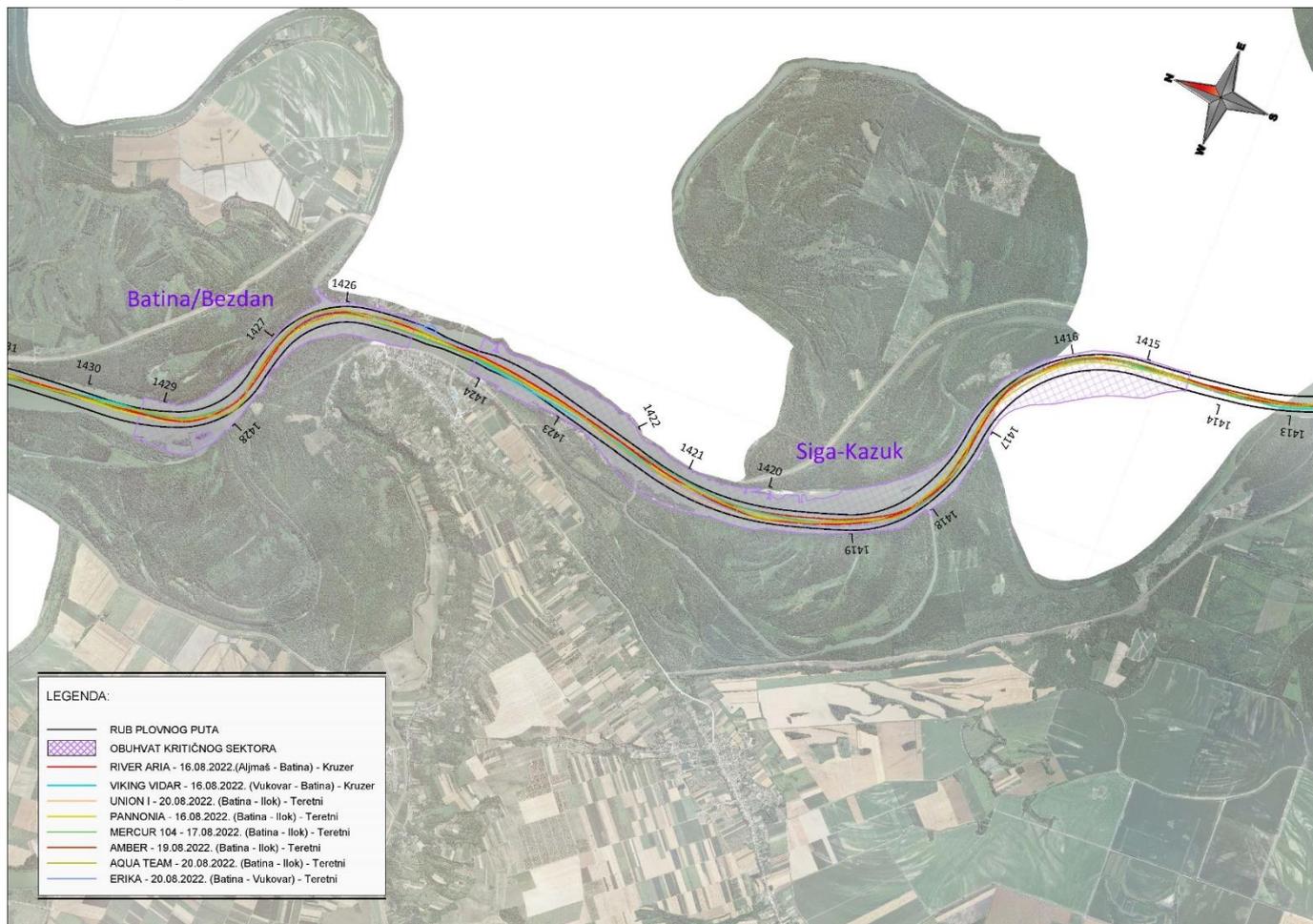
Rangiranje	Naziv	od rkm	do rkm	h	200
1	Borovo I	1348,40	1343,60	2,5	85.065,32
2	Židovski/Čivutski rukavac	1397,20	1389,00	2,5	83.865,61
3	Apatin	1408,20	1400,00	2,5	58.570,39
4	Borovo II	1340,60	1338,00	2,5	51.804,63
5	Ušće Drave	1383,40	1381,60	2,5	42.927,77
6	Staklar	1376,80	1373,40	2,5	10.166,37
7	Mohovo	1311,40	1307,60	2,5	3.914,10
8	Dalj	1357,00	1351,00	2,5	9.202,99
9	Sotin	1324,00	1320,00	2,5	8.013,52
10	Batina / Bezdan	1429,00	1425,00	2,5	1.664,97
11	Bogojevo	1366,20	1361,40	2,5	1.283,23
12	Vukovar	1332,00	1325,00	2,5	843,86
13	Erdut	1371,40	1366,40	2,5	436,33
14	Opatovac	1315,40	1314,60	2,5	9,72
15	Siga-Kazuk	1424,20	1414,40	2,5	9,27
16	Ilok	1302,00	1300,00	2,5	0,00
17	Aljmaš	1381,40	1378,20	2,5	0,00
UKUPNO:					357.778,08



Analysis of the existing state

Transport analysis (4)

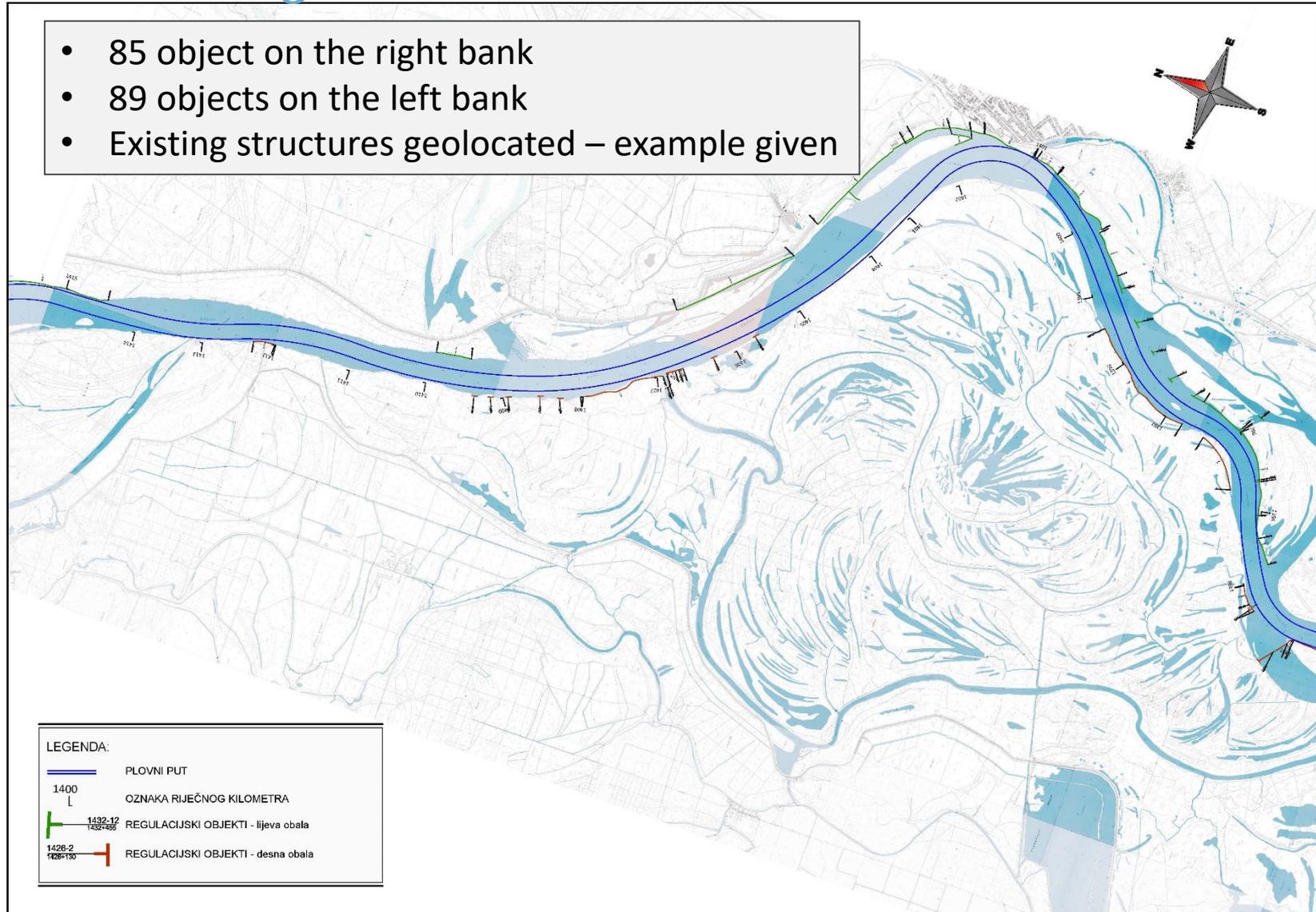
- Fairway analysis: for low levels, 200m fairway width contains all registered ship routes



Analysis of the existing state

Existing structures

- 85 object on the right bank
- 89 objects on the left bank
- Existing structures geolocated – example given



Analysis of the existing state

Critical sections (1)

- ▶ Following criteria analyzed:
 - ▶ **Waterway depth and width:**
 - 2,5 m of depth for a range of widths
 - ▶ **Waterway radiuses (curvature):**
 - 1000m radius (750 exceptionally)
 - ▶ **Width and height of bridge passes:**
 - 50m of minimal width
 - 9,10m of minimal height, measured from high-water level (1% occurrence (4 days/a) of a 25RP) to lowest bridge construction
 - ▶ **Critical sections due to bank erosion:**
 - Qualitative factor taking into account the vicinity of the bank
 - ▶ **Total/overall**

Analysis of the existing state

Critical sections (2)



Criteria fulfilled	
Criteria not fulfilled	

No	Name of critical section	from rkm	to rkm	Depth of waterway	Width of waterway					Radius of waterway	Width and height of bridge passes	Critical sections due to erosion	TOTAL
					200 m	150 m	120 m	100 m	80 m				
1	Batina / Bezdán	1429,00	1425,00										
2	Siga-Kazuk	1424,20	1414,40										
3	Apatin	1408,20	1400,00										
4	Židovski/Čivutski rukavac	1397,20	1389,00										
5	Ušće Drave	1383,40	1381,60										
6	Aljmaš	1381,40	1378,20										
7	Staklar	1376,80	1373,40										
8	Erdut	1371,40	1366,40										
9	Bogojevo	1366,20	1361,40										
10	Dalj	1357,00	1351,00										
11	Borovo I	1348,40	1343,60										
12	Borovo II	1340,60	1338,00										
13	Vukovar	1332,00	1325,00										
14	Sotin	1324,00	1320,00										
15	Opatovac	1315,40	1314,60										
16	Mohovo	1311,40	1307,60										
17	Ilok	1302,00	1300,00										

- 10 critical sectors determined (out of 17), predominantly due to insufficient waterway depth/width and erosion potential
- Currently, no ongoing/long-term traffic disturbances in critical sections – short distances with small occurrence of two-way traffic
- Critical sections – to be further analyzed, potentially to implement mitigation measures



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Thank you for your attention !



Preparing FAIRway2 works in the Rhine Danube Corridor (2019-EU-TM-0262-S and 2019-HR-TMC-0263-S)

Preview of ongoing activities...



Piezometer installation



Flow, velocity and sediment monitoring (high-water scenario)

