

# lifelineMDD

## Sediment mobilization study

### D.T1.2.2

25.11.2021- Mid-term conference

Pomgrad VGP

Saša Sobočan

**POMGRAD**  
VODNOGOSPODARSKO PODJETJE

# What's new?

- Contract with VGB (Vodnogospodarski biro Maribor)
- Field work → done
- First input data sent



# About the study

- March 2022
- the study serves to support the planned implementation of the removal of ripraps in pilot site Hrastje Mota (WP T2)
- it will cover the whole process- before the widening of the riverbed and after



## The location in the past



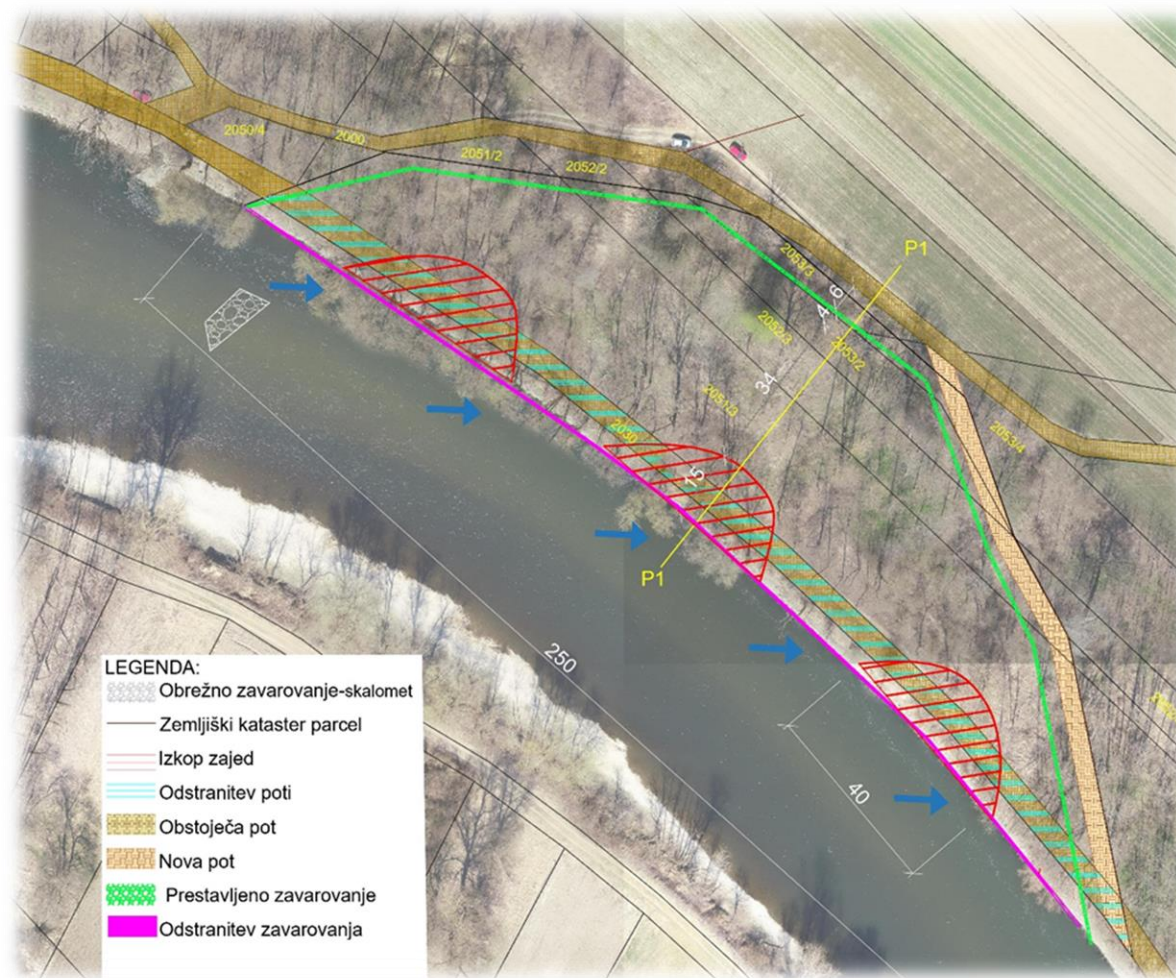
An aerial photograph of a river winding through a dense, green forest. The river is dark blue and reflects the sky. The forest is thick and covers the surrounding hills. In the distance, there are some open fields and a small building. The overall scene is a natural, scenic landscape.

## Supporting document- PROJECT WORK

- **HYDRAULIC ANALYSIS OF THE IMPACT OF THE PERFORMED WORKS ON EROSION PROCESSES WITH THE EVALUATION OF SEDIMENT TRANSPORT FROM THE REVITALIZATION AREA**

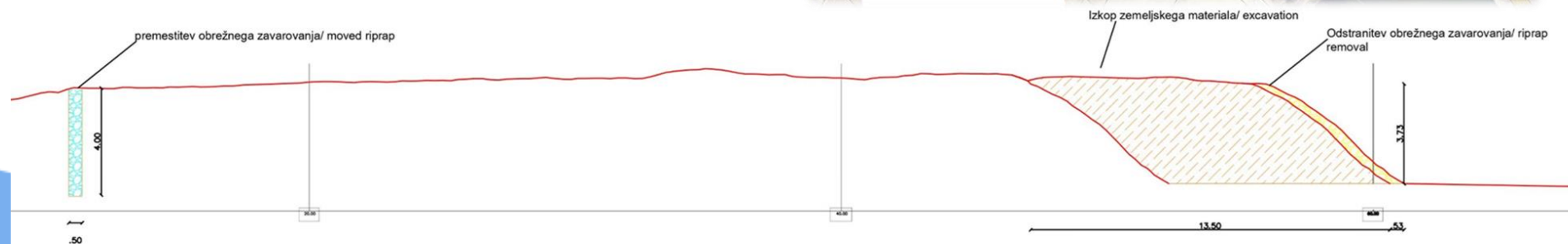
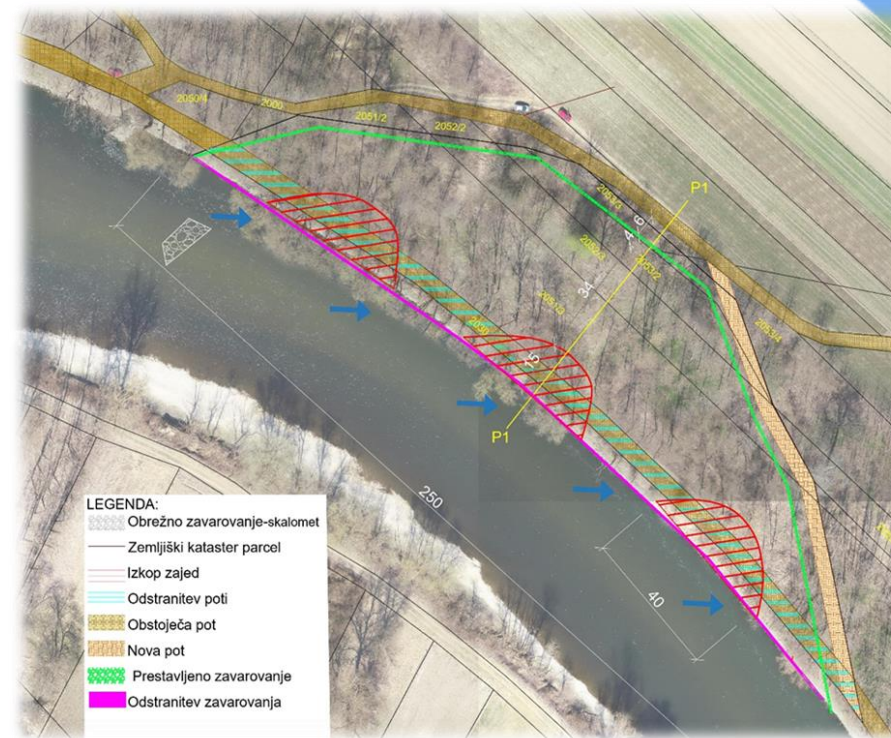
# CONTENTS

- The planned measures (widening) in Hrastje Mota will also change the hydraulic conditions in the area of the performed works.



# Short description of planned measure

- The riparian protection along the bank of the Mura on the entire section of 250 m (500 m<sup>3</sup>) removed
- 3 smaller areas of semicircular shape (as a ravine to accelerate the operation of the Mura River), 15 m wide and 40 m long, are excavated
- total area of them 1350 m<sup>2</sup>, taking into account the height of 4 m =5400 m<sup>3</sup>
- excavated material is used for field paths and for backfilling the relocated riparian protection.
- The riparian protection is moved to the hinterland- 0.5 m wide, 4 m deep and 270 m long. The total volume of excavation for riprap is about 540m<sup>3</sup>.
- a rock structure (barrier in the middle of the river, so the river won't shift to the left-to split, to accelerate the water).



- With the progression of lateral erosion, a decrease in velocity in the considered area is expected, which will have a positive effect on the stabilization of the Mura bottom in this section and downstream.
- With detailed hydraulic analysis (2D channel modeling) it is necessary to analyze the impact of the planned works on the currents in the area. Furthermore, the same model analyzes the influence of lateral erosion on the hydraulic characteristics of the Mura section (velocity in the extension area), where lateral erosion is illustrated by a change in the bathymetry.
- The estimation of the transport of deposited sediment will be made on the basis of the 1D model of sediment transport and the calculated displacement capacity of the downstream section.





# PREPARATION OF THE STUDY

## **Bathymetry and grain size data**

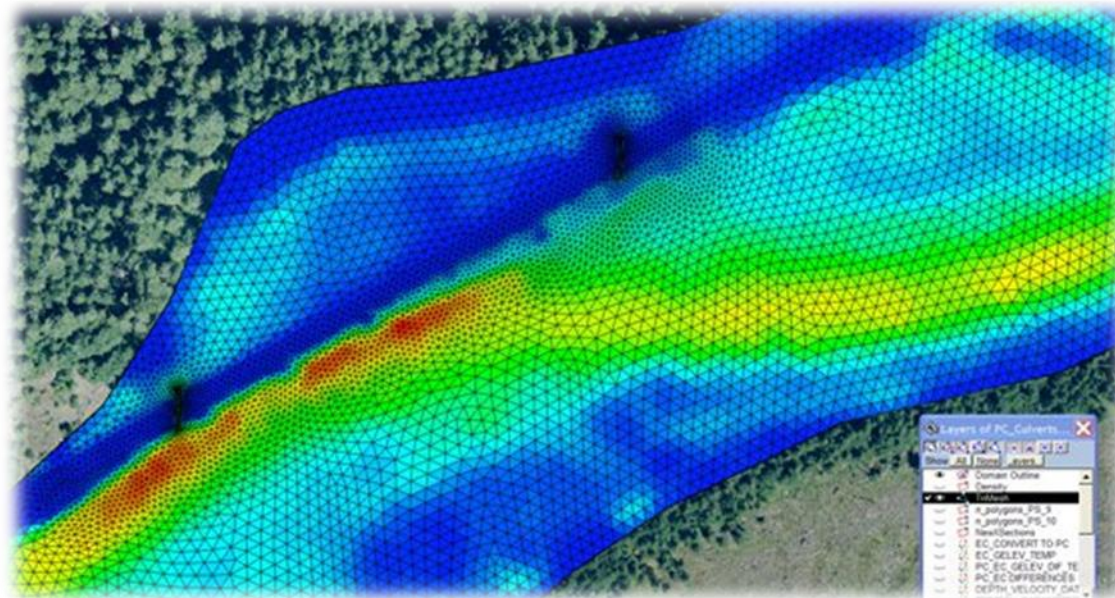
We will provide and send the contractor the following information and documents:

- Bathymetric survey (sonar, drone, lidar, GPS) of the existing state
- Project documentation of the planned measure (Project for implementation), on the basis of which the hydraulic analysis of the planned condition is going to be performed
- Sowing curves of the samples taken in the widening area, and information on the amount and composition of the excavated sediment that will be introduced into the riverbed.

# Making a hydraulic model

- The hydraulic analysis must be performed for three states, namely the state before the widening (initial state) and the state of the final widened riverbed (final state). It is necessary to make a detailed 2D hydraulic model of the existing riverbed.
- On the basis of the prepared PZI documentation on planned measure, a hydraulic calculation of the planned condition is made, including the optimization of the inflow section (max. 3 simulations (variants)). The final state of the widened riverbed is illustrated by a change in the bathymetry.

- The results of the flow analysis will be used for a detailed spatial presentation of the change of velocity currents (direction and size) and the change of shear stresses between the initial and intermediate state, from which a preliminary assessment of the most erosively exposed sections will be made. A comparison with the final situation will show the impact of the measures on the reduction of speed on the section in question.



# Assessment of sediment transport

- The widening measure envisages that the material will be deposited in whole or at least part in the bed of the riverbed, from where the Mura will gradually move it downstream at higher flows. This keeps the material in the system in order to preserve the bed-forming processes and reduce the deepening of the bed bottom downstream.
- The dynamics of transport or removal of deposited material is estimated using the 1D transport model, whereby the analysis section can also be extended using existing and available data on the transverse profiles of the Mura. Based on the annual flow curve and the calculated displacement capacity, the dynamics of sediment removal and deposition will be made.

For this reason, the assessment will be carried out using the existing available 1D transport model **or** on the basis of the calculated displacement capacity of the downstream section (up to Veržej).



# RESULTS FROM THE STUDY

- 2D hydraulic model
- impact of the measures on the reduction of speed
- 1D model of transport
- estimation of sediment drift dynamics
- visualization

# Data needed:

- **Lidar** – general terrain data (1x1m), not affected by vegetation
  - **Drone** – detailed land surveying (1x1cm)
  - **Sonar** – Underwater (Bathymetry) surveying
- Combining the data



# Data needed:

- Sample gathering
- Analysis:
  - on site
  - laboratory



## SEJALNA ANALIZA

SIST EN 933-1:1999

**NAHAJALIŠČE:**  
VUCJA VAS - LB  
MURSKI PROD

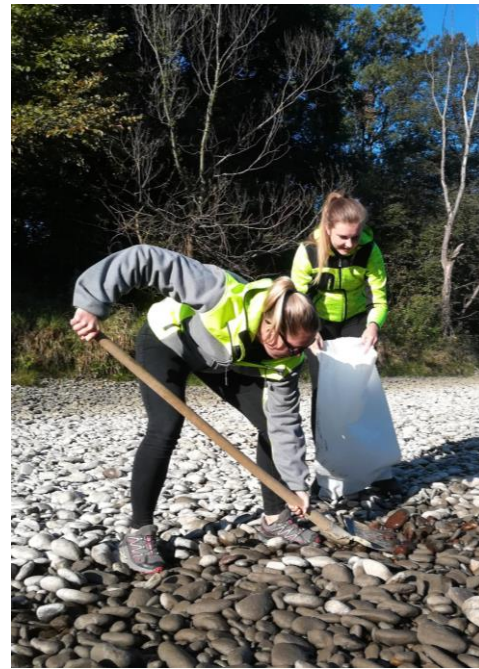
LAB. ŠT. VZORCA: 3  
NAZIV VZORCA: MURSKI PROD  
DATUM ODVZEMA: 12.6.2015  
DATUM OBDELAVE: 1.7.2015  
MESTO ODVZEMA: Vučja vas - pripeljan  
SEPARACIJA:

ZATEHTA  
MASA (SUHA) PO PRANJU  
MASA BREZ FINIH DELCEV

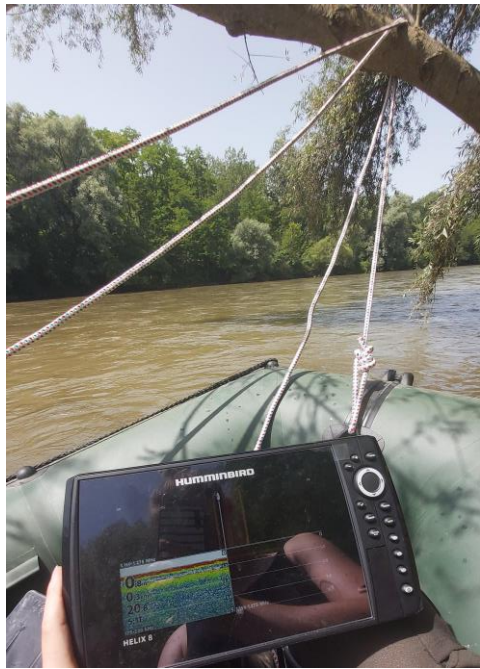
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**M2=** 45386,9  
**M1-M2=** 1200,8

Odprtina sита (mm)	OstaneK na situ (Ri) (g)	OstaneK na situ % m/m	Vsota presevkov (% m/m)
125	0,0	0,0	100,0
90	1862,3	4,0	96,0
63	3157,4	6,8	89,2
45	5567,3	12,0	77,3
31,5	8754,6	18,8	58,5
22,4	7005,2	15,0	43,4
16	5674,3	12,2	31,3
11,2	3150,8	6,8	24,5
8	2450,7	5,3	19,2
4	2516,3	5,4	13,8
2	1152,3	2,5	11,4
0,71	917,8	2,0	9,4
0,25	1352,4	2,9	6,5
0,09	1268,4	2,7	3,8
0,063	527,3	1,1	2,6
P - dno	29,4		





On field collecting samples (10.9.2021)  
-sent to Pomgrad laboratory



# On field pt.1 (june) -sonar

# Field work pt.2 (july)

- GPS measures on the gravel bar (low water level)

## Postaja Gornja Radgona I - Mura

Datum	Vodostaj [cm]	Pretok [m <sup>3</sup> /s]	Temperatura vode [°C]
28.07.2021 11:20	89	100	21.4
28.07.2021 11:10	90	102	21.4
28.07.2021 11:00	90	102	21.3
28.07.2021 10:50	90	102	21.3
28.07.2021 10:40	91	104	21.2
28.07.2021 10:30	90	102	21.2
28.07.2021 10:20	90	102	21.1
28.07.2021 10:10	89	100	21.0
28.07.2021 10:00	89	100	21.0
28.07.2021 09:50	88	98.0	20.9
28.07.2021 09:40	88	98.0	20.7
28.07.2021 09:30	88	98.0	20.7
28.07.2021 09:20	87	96.0	20.6
28.07.2021 09:10	87	96.0	20.6
28.07.2021 09:00	87	96.0	20.5
28.07.2021 08:50	86	93.9	20.5
28.07.2021 08:40	87	96.0	20.5
28.07.2021 08:30	87	96.0	20.4
28.07.2021 08:20	86	93.9	20.4
28.07.2021 08:10	85	91.9	20.4
28.07.2021 08:00	84	90.0	20.4
28.07.2021 07:50	84	90.0	20.4
28.07.2021 07:40	83	88.0	20.3
28.07.2021 07:30	82	86.0	20.3
28.07.2021 07:20	81	84.1	20.3
28.07.2021 07:10	80	82.2	20.3
28.07.2021 07:00	80	82.2	20.3





15 9 17  
188.5543 19

20 22 25 28 30  
188.418

188.327 29 31 32 34

188.255 33 36 37 39

188.227 41 42 43 44

38.189 45 46 47 48  
188.241

• 48 points on gravel bar

IME	GKY	GKX	VIŠINA	DATUM	ČAS	DOLŽINA
3	164.595.076	583.719.574	189.407	28.07.2021	09:21:51	4.060
4	164.597.492	583.720.490	188.525	28.07.2021	09:22:06	4.723
5	164.598.296	583.719.530	188.525	28.07.2021	09:22:22	5.041
6	164.598.315	583.719.539	188.525	28.07.2021	09:22:28	5.044
7	164.598.735	583.718.702	188.525	28.07.2021	09:22:40	5.345
8	164.598.163	583.718.068	188.525	28.07.2021	09:22:48	5.464
9	164.598.210	583.717.381	188.525	28.07.2021	09:23:06	5.795
10	164.598.247	583.716.024	188.525	28.07.2021	09:23:27	6.614
11	164.598.623	583.714.462	188.525	28.07.2021	09:23:39	7.846
12	164.599.119	583.713.283	188.525	28.07.2021	09:24:02	8.912
13	164.599.166	583.713.315	188.525	28.07.2021	09:24:10	8.960
14	164.599.234	583.711.684	188.525	28.07.2021	09:24:24	10.260
15	164.599.567	583.710.975	188.525	28.07.2021	09:24:57	10.972
16	164.599.184	583.709.106	188.525	28.07.2021	09:25:18	12.534
17	164.593.374	583.725.928	188.525	28.07.2021	09:27:34	7.762
18	164.593.191	583.728.572	188.525	28.07.2021	09:27:52	9.865
19	164.592.249	583.729.634	188.525	28.07.2021	09:28:06	11.071
20	164.579.682	583.770.215	188.525	28.07.2021	09:33:30	52.710
21	164.579.178	583.772.742	188.525	28.07.2021	09:33:40	55.260
22	164.578.820	583.775.575	188.525	28.07.2021	09:33:52	58.052
23	164.577.687	583.779.664	188.525	28.07.2021	09:34:03	62.283
24	164.576.616	583.784.419	188.525	28.07.2021	09:34:16	67.128
25	164.574.474	583.789.982	188.525	28.07.2021	09:34:29	73.065
26	164.574.741	583.790.486	188.525	28.07.2021	09:34:33	73.464
27	164.572.624	583.795.513	188.525	28.07.2021	09:34:57	78.886
28	164.570.147	583.802.376	188.525	28.07.2021	09:35:12	86.166
29	164.568.107	583.808.824	188.525	28.07.2021	09:35:31	92.917
30	164.566.407	583.817.082	188.525	28.07.2021	09:35:52	101.295
31	164.563.090	583.823.931	188.525	28.07.2021	09:36:16	108.821
32	164.559.657	583.831.937	188.525	28.07.2021	09:36:44	117.491
33	164.555.959	583.837.911	188.525	28.07.2021	09:37:04	124.330
34	164.554.101	583.844.937	188.525	28.07.2021	09:37:24	131.572
35	164.550.410	583.848.998	188.525	28.07.2021	09:37:39	136.620
36	164.544.544	583.856.251	188.525	28.07.2021	09:38:03	145.454
37	164.540.840	583.866.301	188.525	28.07.2021	09:38:42	156.158
38	164.537.351	583.869.184	188.525	28.07.2021	09:38:57	160.110
39	164.532.773	583.873.957	188.525	28.07.2021	09:39:18	166.253
40	164.528.148	583.878.921	188.525	28.07.2021	09:39:31	172.623
41	164.522.348	583.885.371	188.525	28.07.2021	09:39:48	180.861
42	164.516.179	583.892.532	188.525	28.07.2021	09:40:10	189.938
43	164.509.630	583.897.854	188.525	28.07.2021	09:40:31	197.560
44	164.503.855	583.903.838	188.525	28.07.2021	09:40:47	205.488
45	164.497.480	583.910.109	188.525	28.07.2021	09:41:05	213.976
46	164.489.671	583.917.210	188.525	28.07.2021	09:41:34	223.913
47	164.477.727	583.929.385	188.525	28.07.2021	09:42:10	240.354
48	164.461.420	583.942.745	188.525	28.07.2021	09:43:35	260.132

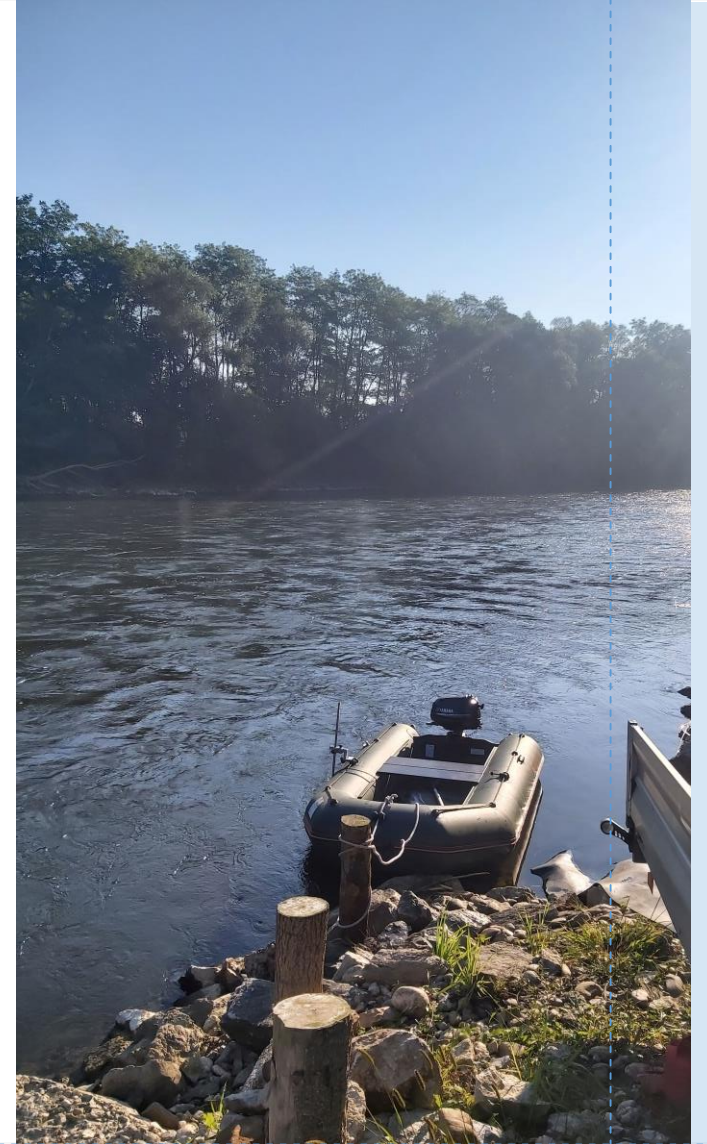
## Field work pt.3 (August)

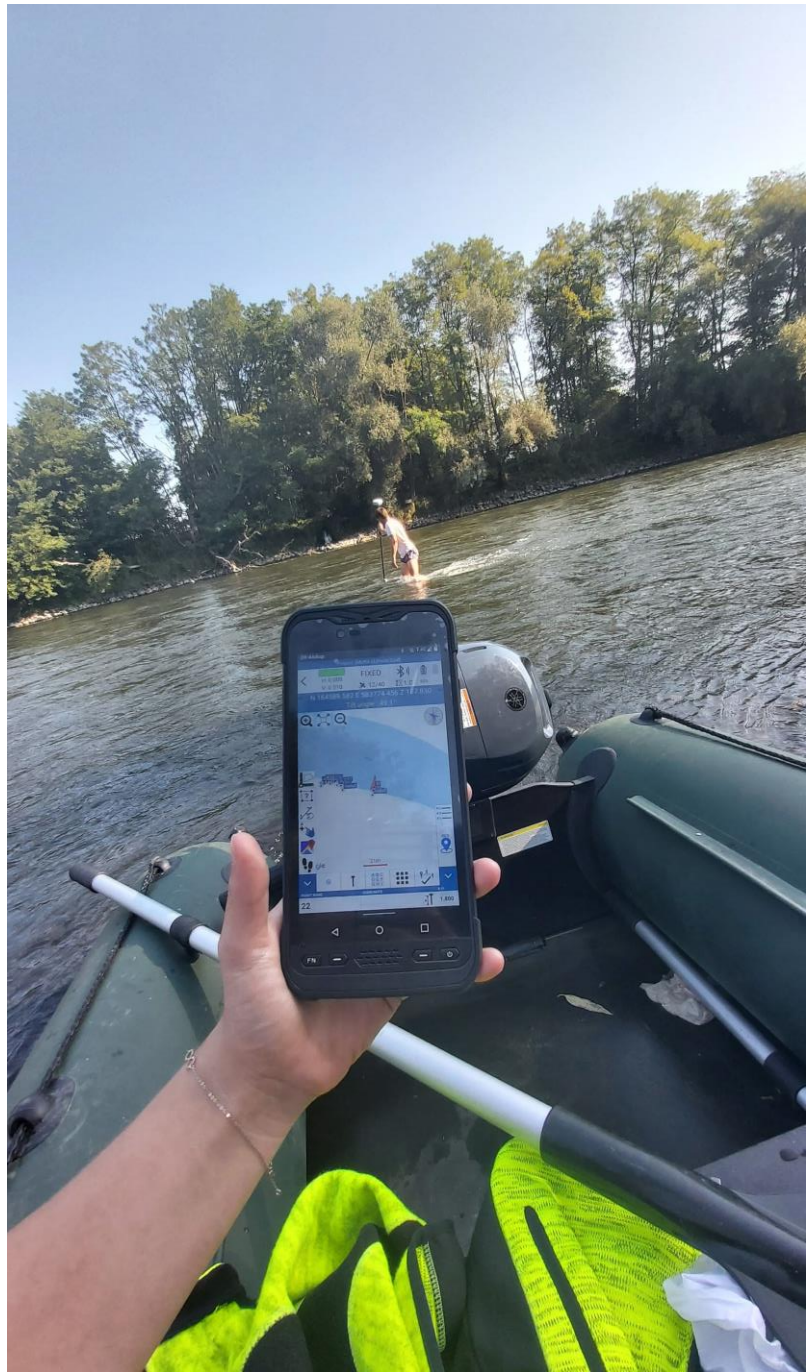
We tried to install a rope - we used two trees, we tied a rope to one and transferred it to the other side of the river by boat and tied it to another tree. We then placed a pulley on this rope, which was connected to another rope, and there to the boat. We tried to measure the previous profile with GPS - some starting points succeeded, but further due to the strong current of the river Mura the measurement was not possible. We found that we would need to measure differently.



# Final field work pt.4 (September)

- Final model with Drone
- Sonar
- GPS













**Interreg**



EUROPEAN UNION

Danube Transnational Programme

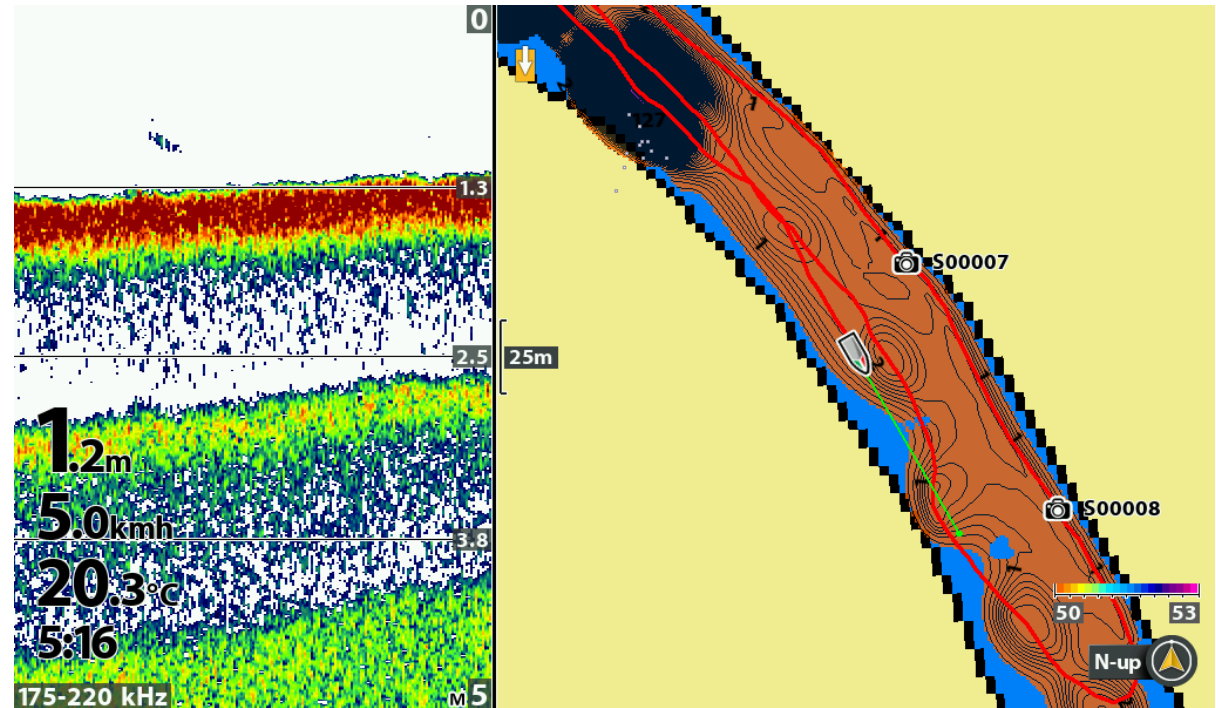
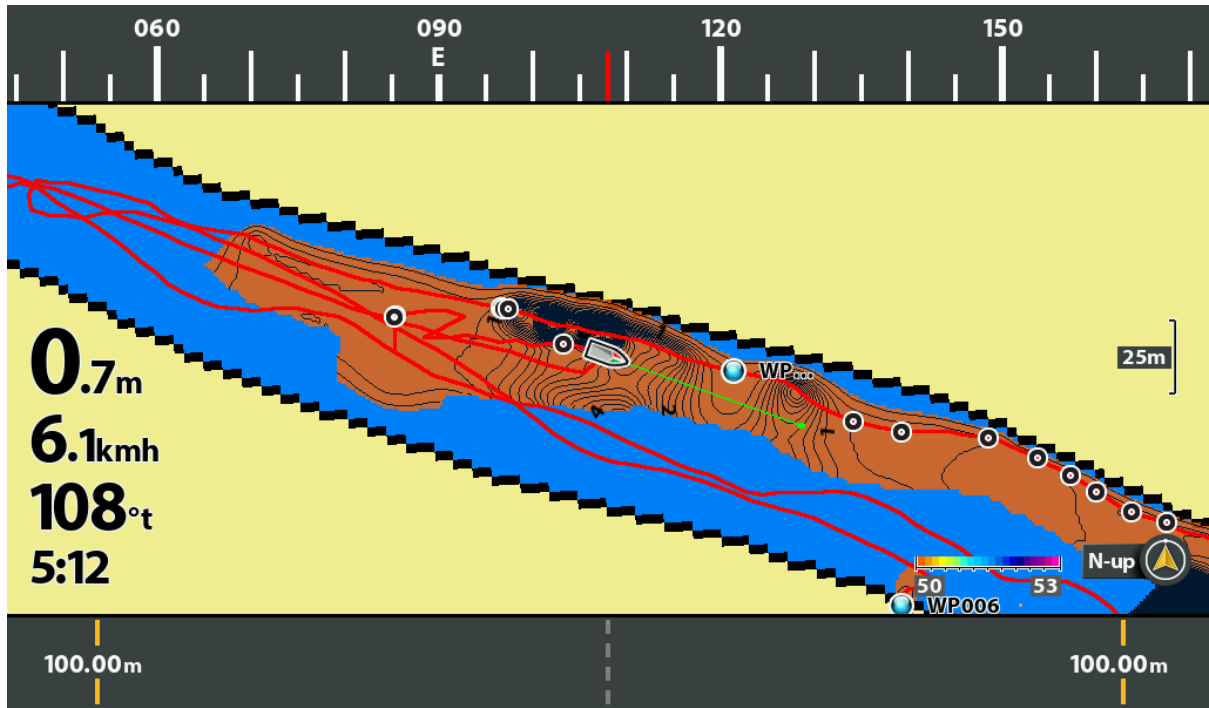
lifelineMDD



## Postaja Gornja Radgona I - Mura

Datum	Vodostaj [cm]	Pretok [m³/s]	Temperatura vode [°C]
13.09.2021 13:50	78	78.4	17.7
13.09.2021 13:40	78	78.4	17.7
13.09.2021 13:30	78	78.4	17.6
13.09.2021 13:20	78	78.4	17.6
13.09.2021 13:10	79	80.3	17.5
13.09.2021 13:00	80	82.2	17.5
13.09.2021 12:50	80	82.2	17.5
13.09.2021 12:40	81	84.1	17.4
13.09.2021 12:30	81	84.1	17.4
13.09.2021 12:20	81	84.1	17.3
13.09.2021 12:10	82	86.0	17.3
13.09.2021 12:00	82	86.0	17.3
13.09.2021 11:50	82	86.0	17.2
13.09.2021 11:40	82	86.0	17.2
13.09.2021 11:30	81	84.1	17.1
13.09.2021 11:20	81	84.1	17.1
13.09.2021 11:10	81	84.1	17.1
13.09.2021 11:00	81	84.1	17.0
13.09.2021 10:50	80	82.2	17.0
13.09.2021 10:40	80	82.2	16.9
13.09.2021 10:30	80	82.2	16.9
13.09.2021 10:20	80	82.2	16.8
13.09.2021 10:10	80	82.2	16.8
13.09.2021 10:00	80	82.2	16.7
13.09.2021 09:50	79	80.3	16.7
13.09.2021 09:40	79	80.3	16.7
13.09.2021 09:30	79	80.3	16.7
13.09.2021 09:20	79	80.3	16.6
13.09.2021 09:10	79	80.3	16.6
13.09.2021 09:00	78	78.4	16.6
13.09.2021 08:50	79	80.3	16.6
13.09.2021 08:40	79	80.3	16.6





24°

14°

SIDE VIEW

1.3

2.5

3.8

2.2m

7.5kmh

19.4°C

3:28

1.100-1.200 MHz

m5

DOWN VIEW

**1.4m**

**8.6kmh**

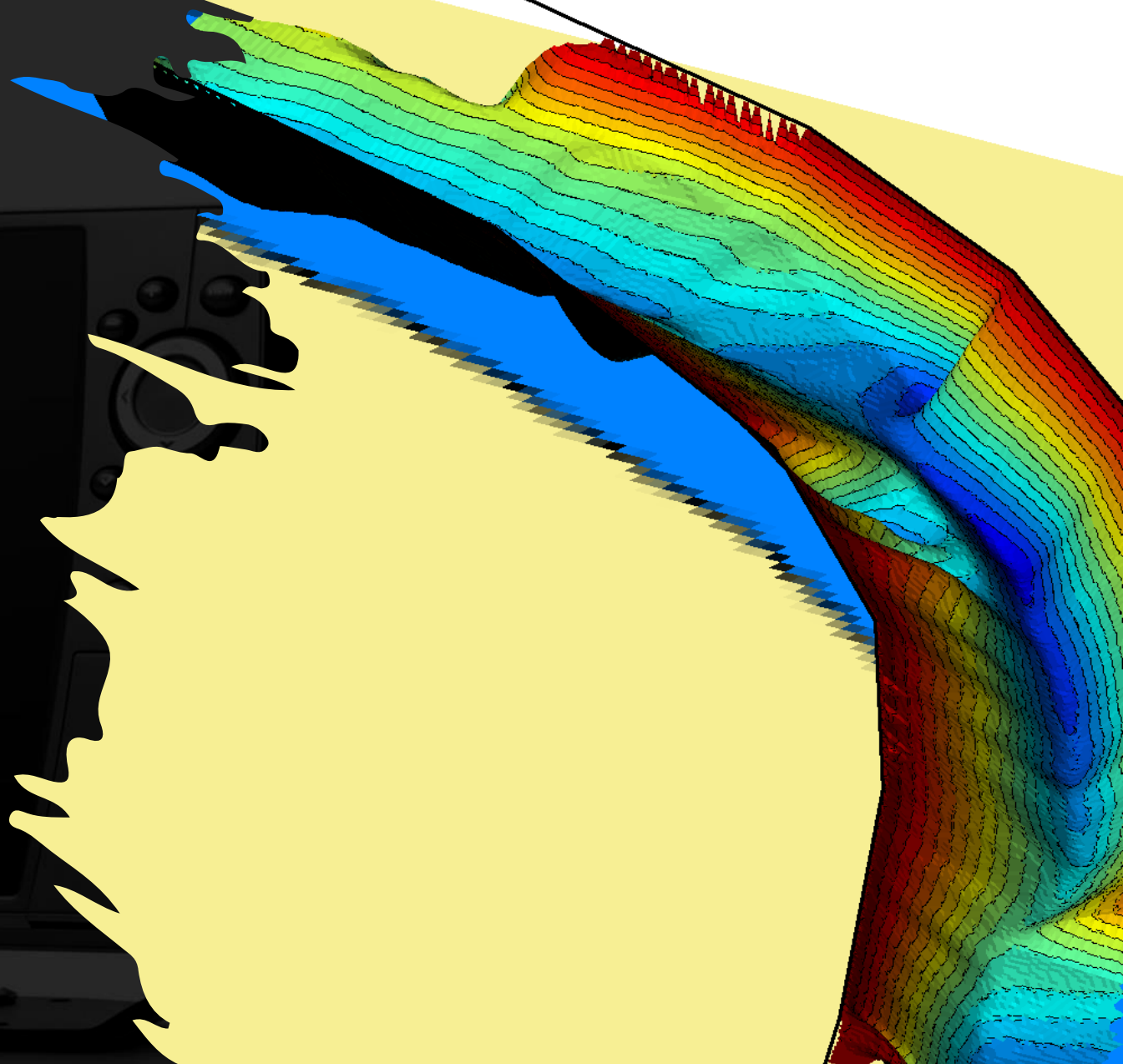
**21.7°C**

**4:54**

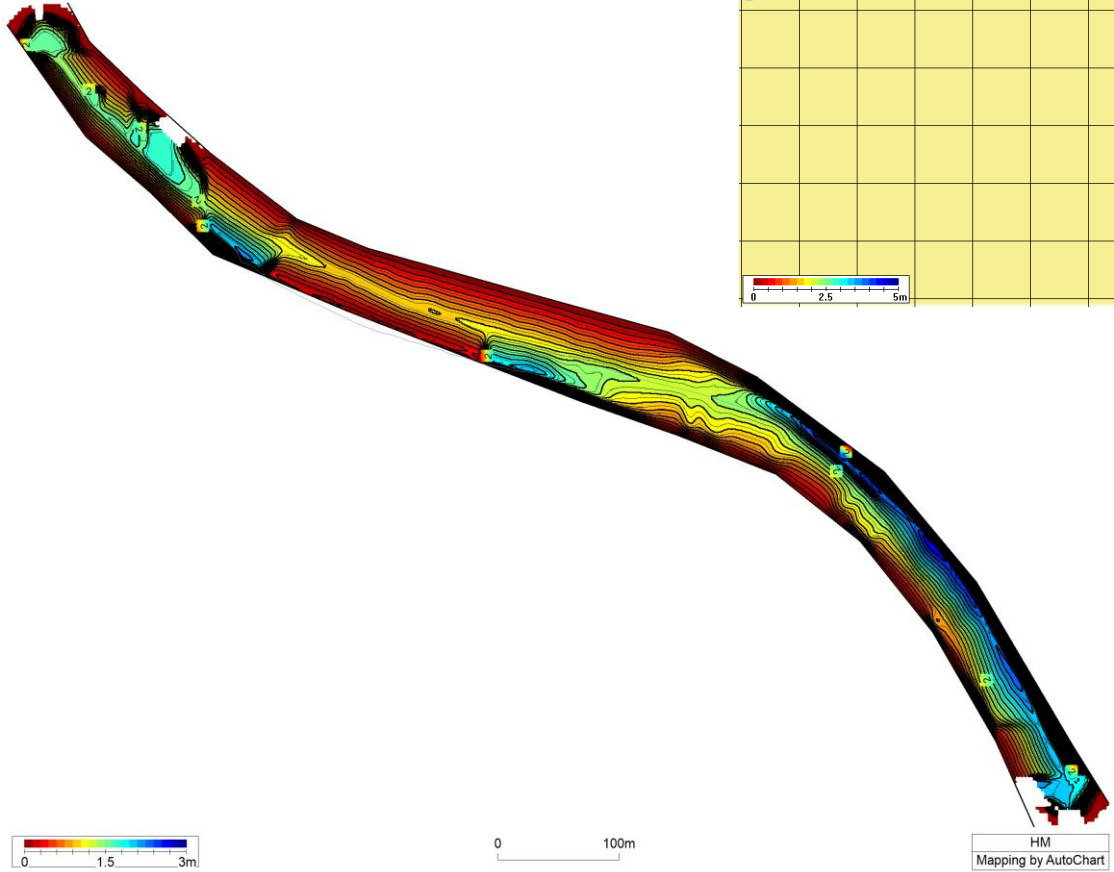
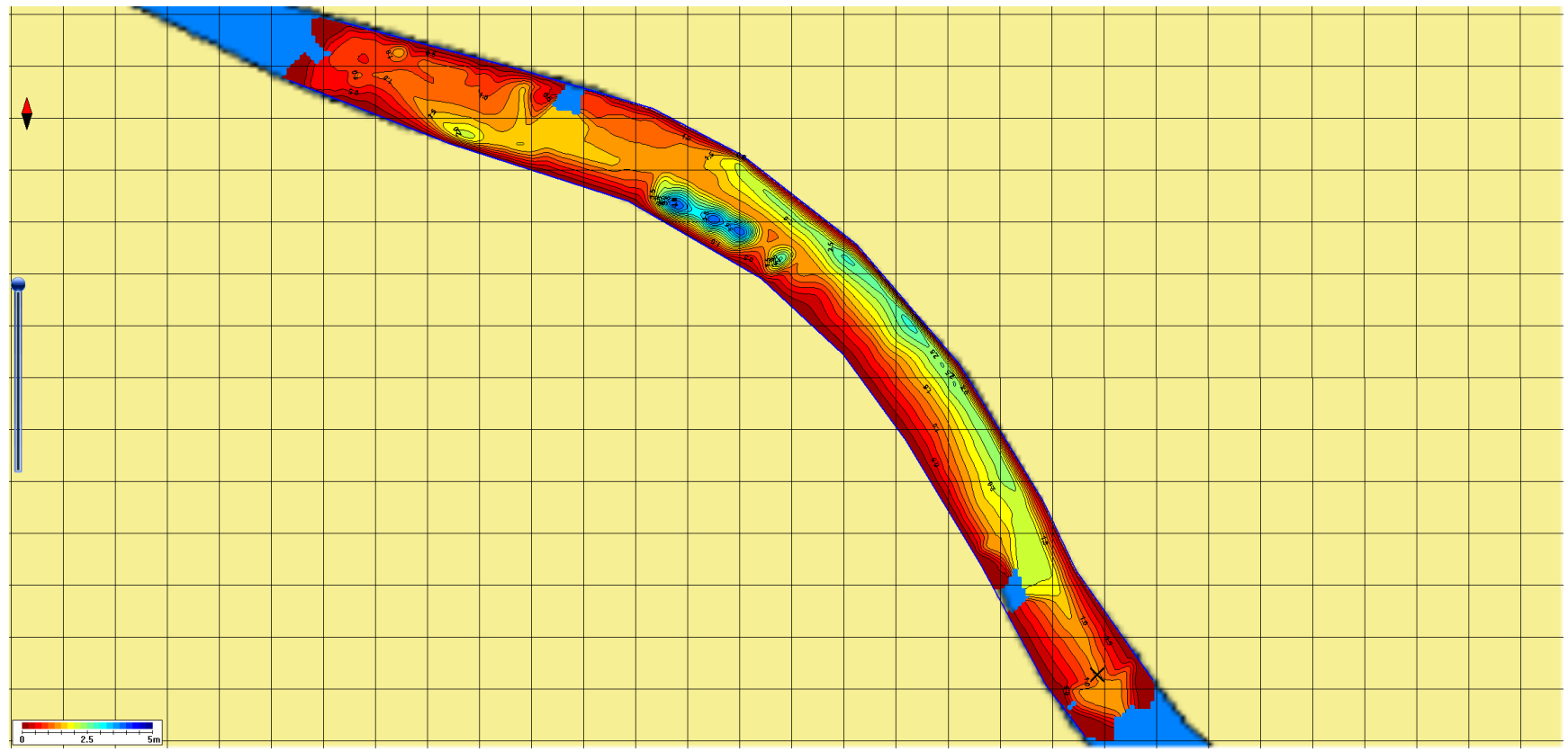
1.150-1.275 MHz



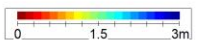
- SONAR  
-cross sections







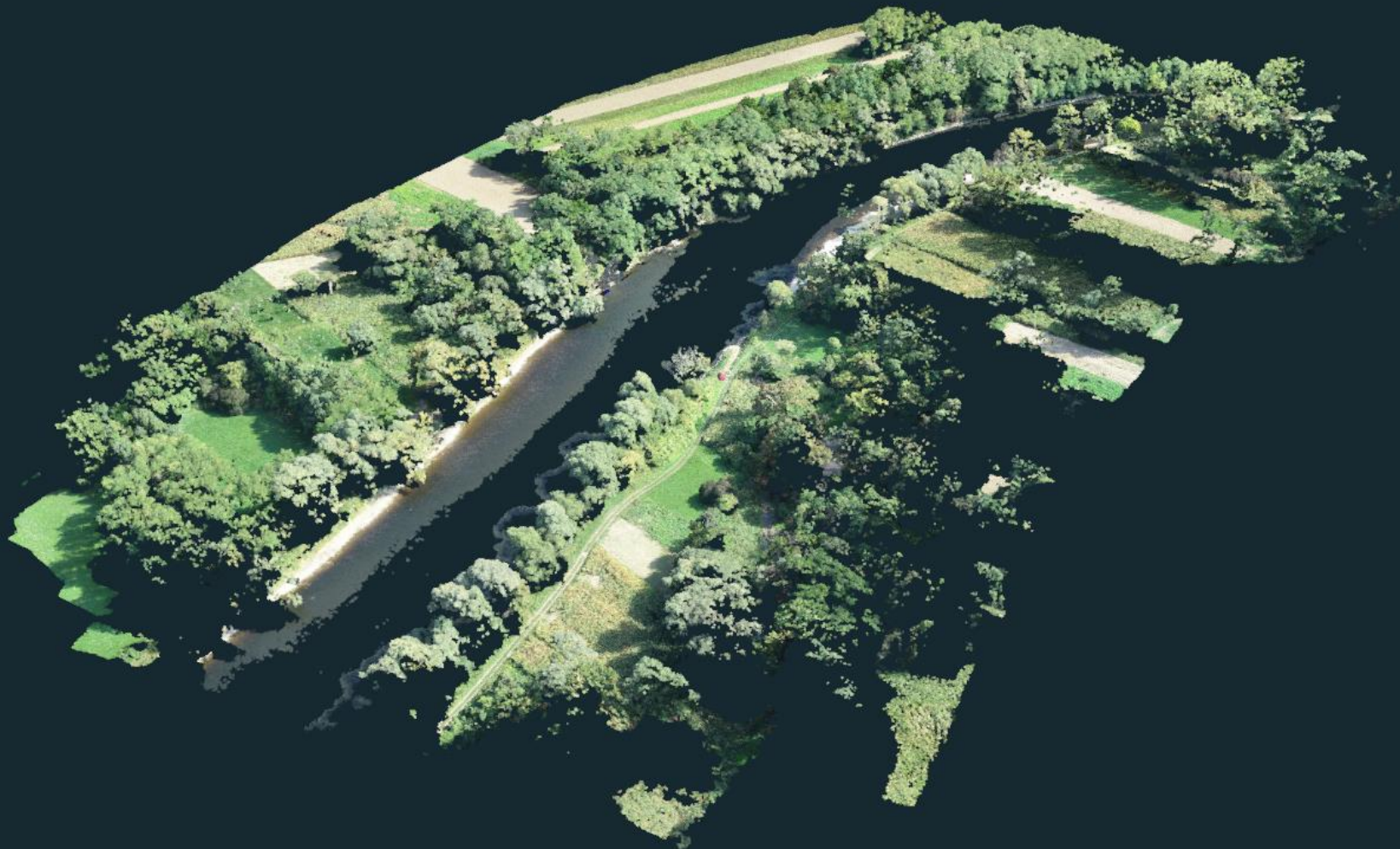
EDIT AND EXPORT CONTOUR  
LINES  
-extract points from lines



HM  
Mapping by AutoChart



ORTOPHOTO



List of point clouds:

- Ground control points
- PointCloud\_2021\_09\_15-16\_40\_29

Total: 25,228,676 points

Delete Duplicate

View options:

Heightmap Shading Point snapping

Point render size: [slider]

Polygon selection:

Select Deselect Clear

Delete selected Delete other Manipulate point cloud

Undo Redo

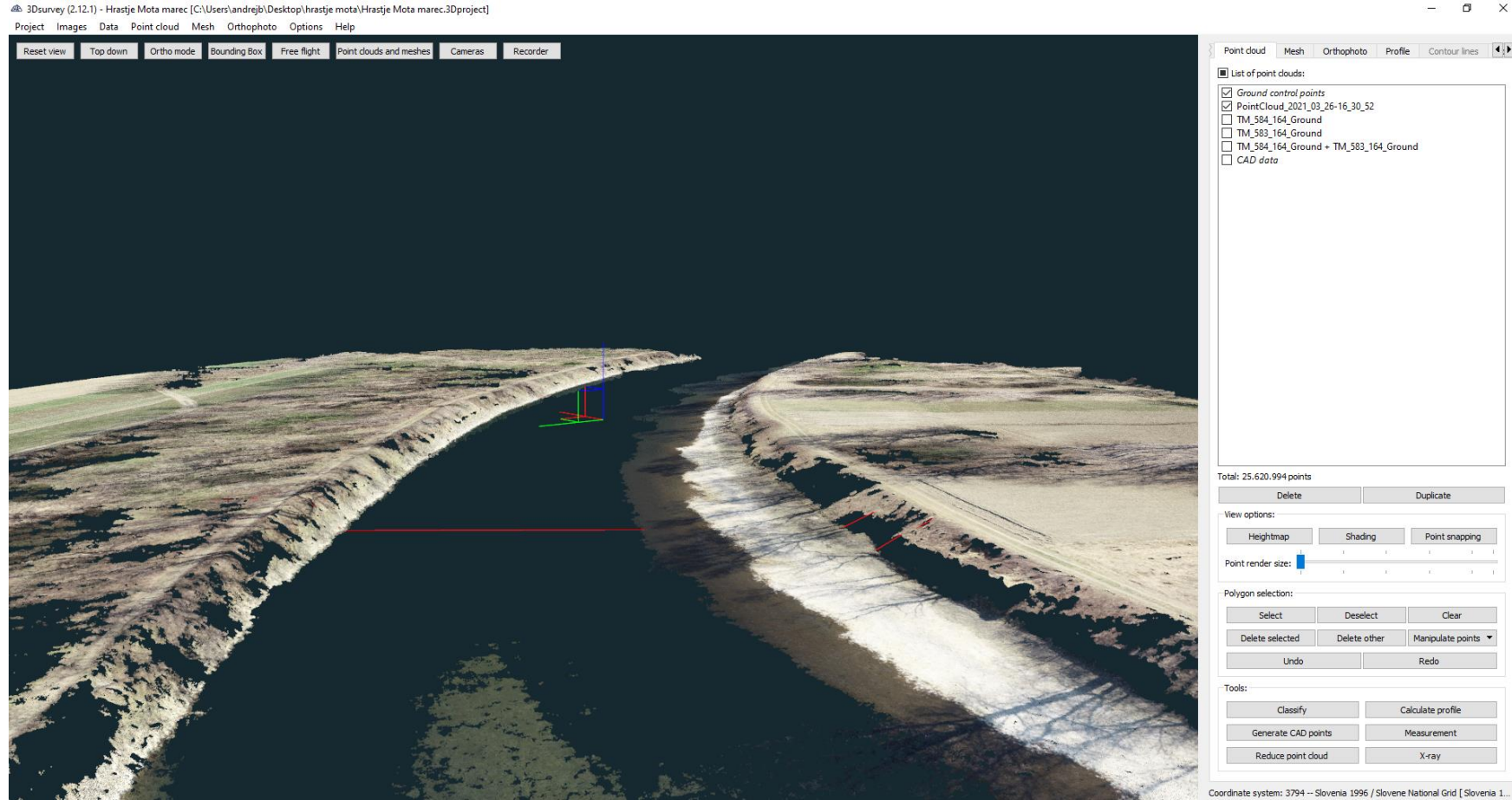
Tools:

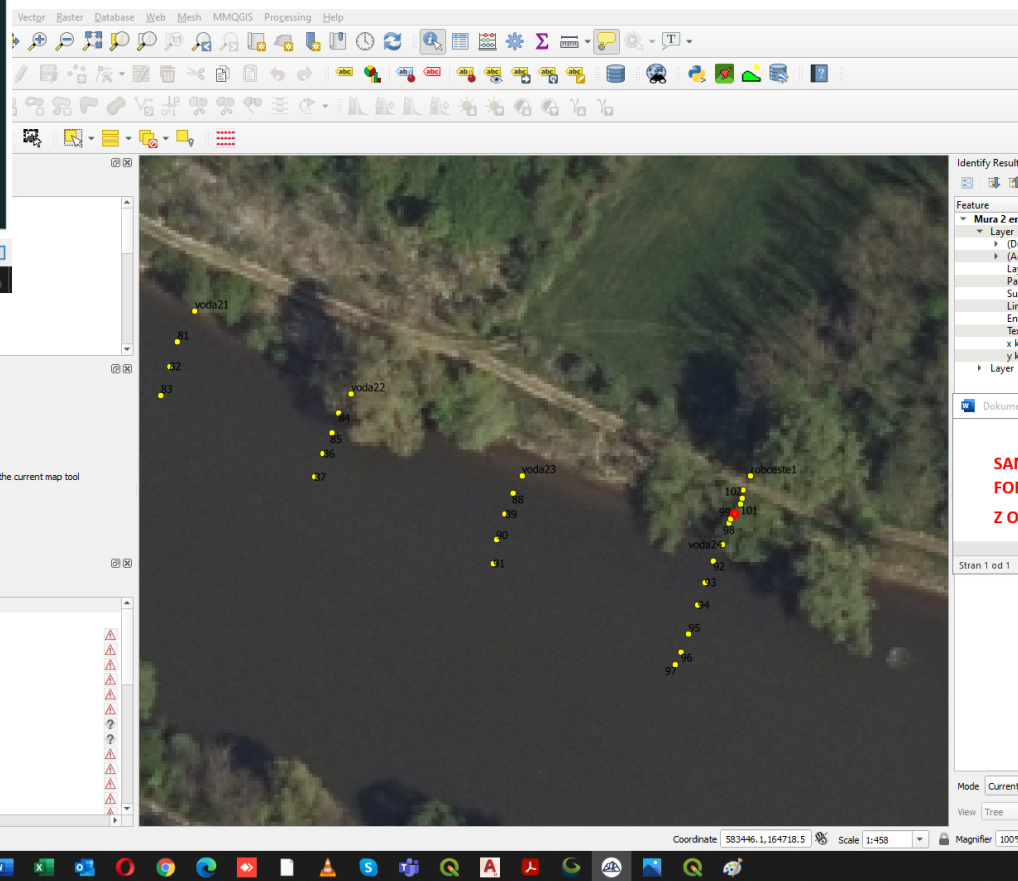
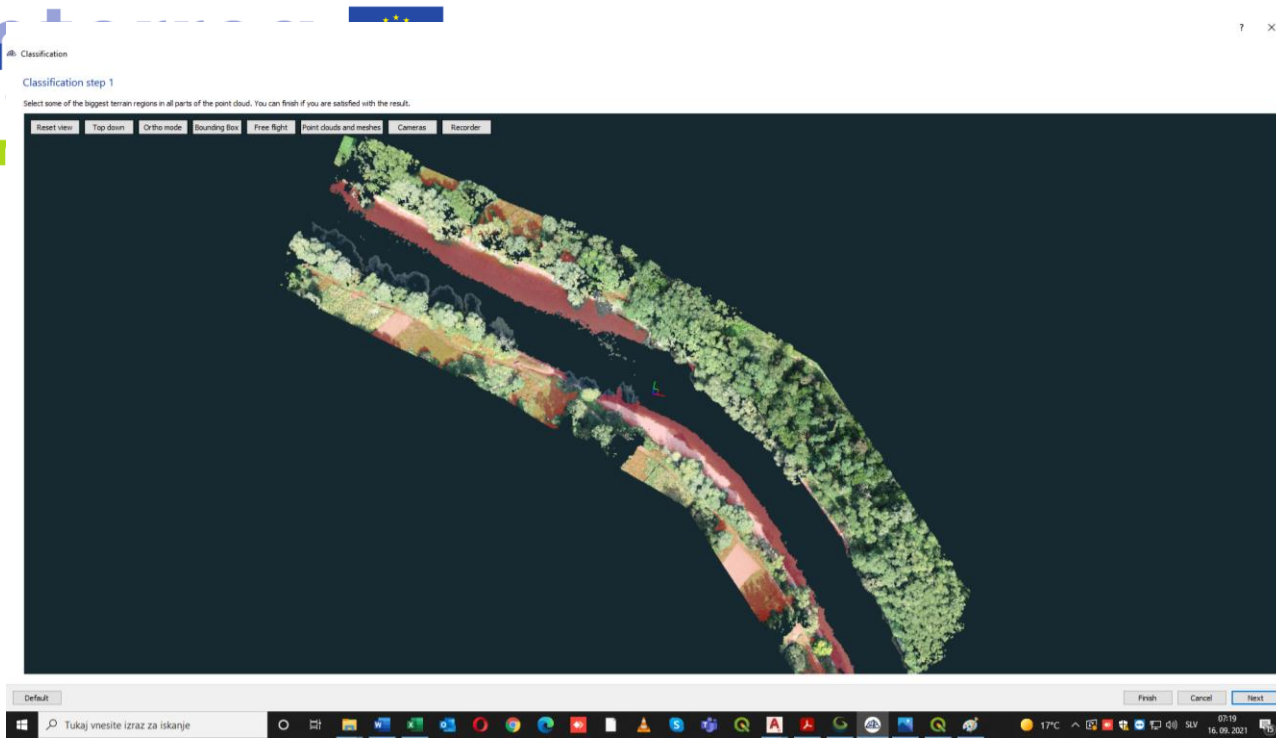
Classify Calculate profile

Generate CAD points Measurement

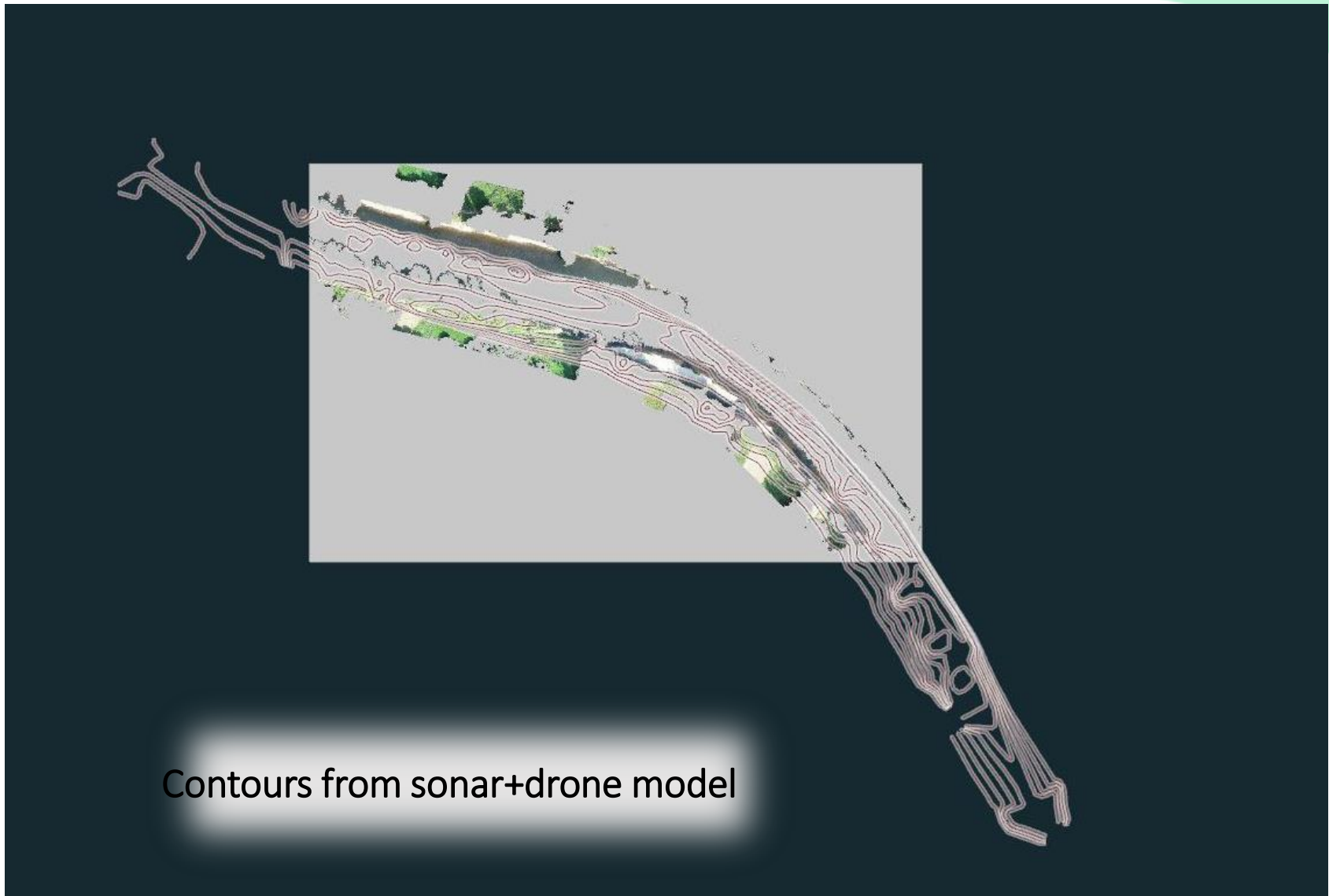
Reduce point cloud X-ray

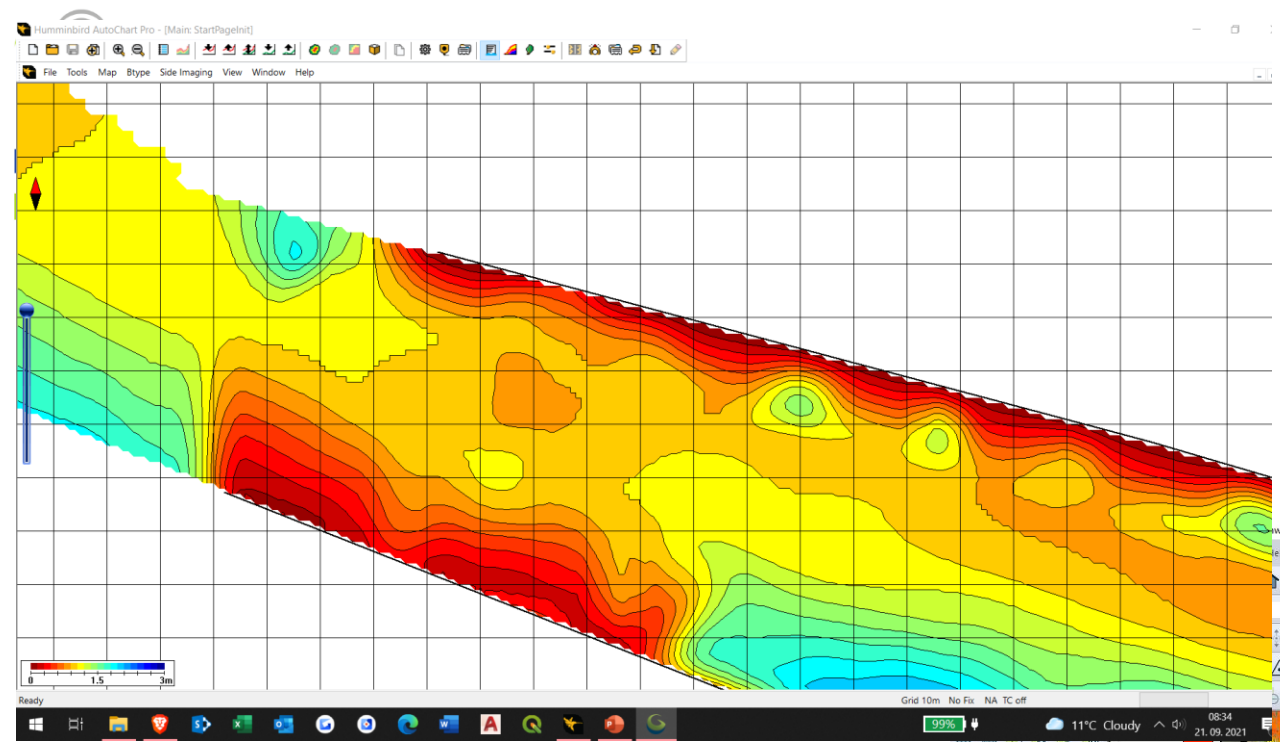
# Point cloud from March



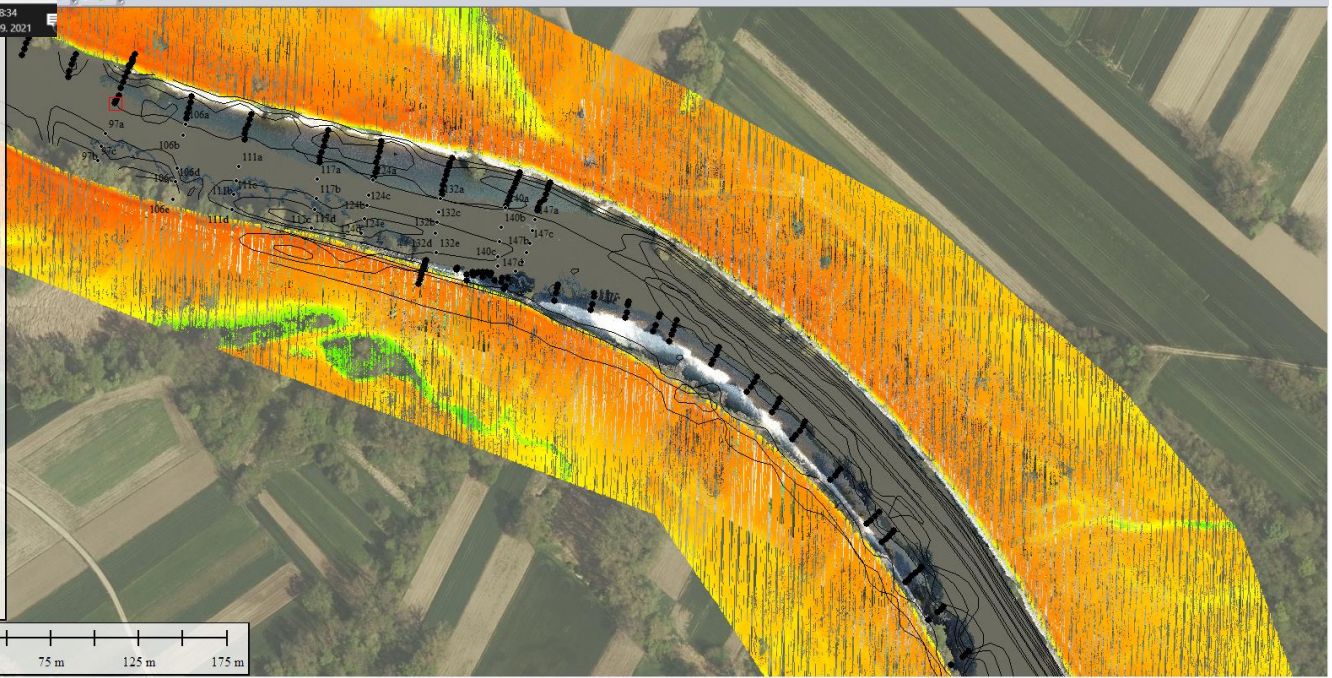


Combining data  
 -point cloud from March (less trees)  
 and from September  
 -classification  
 -MESH



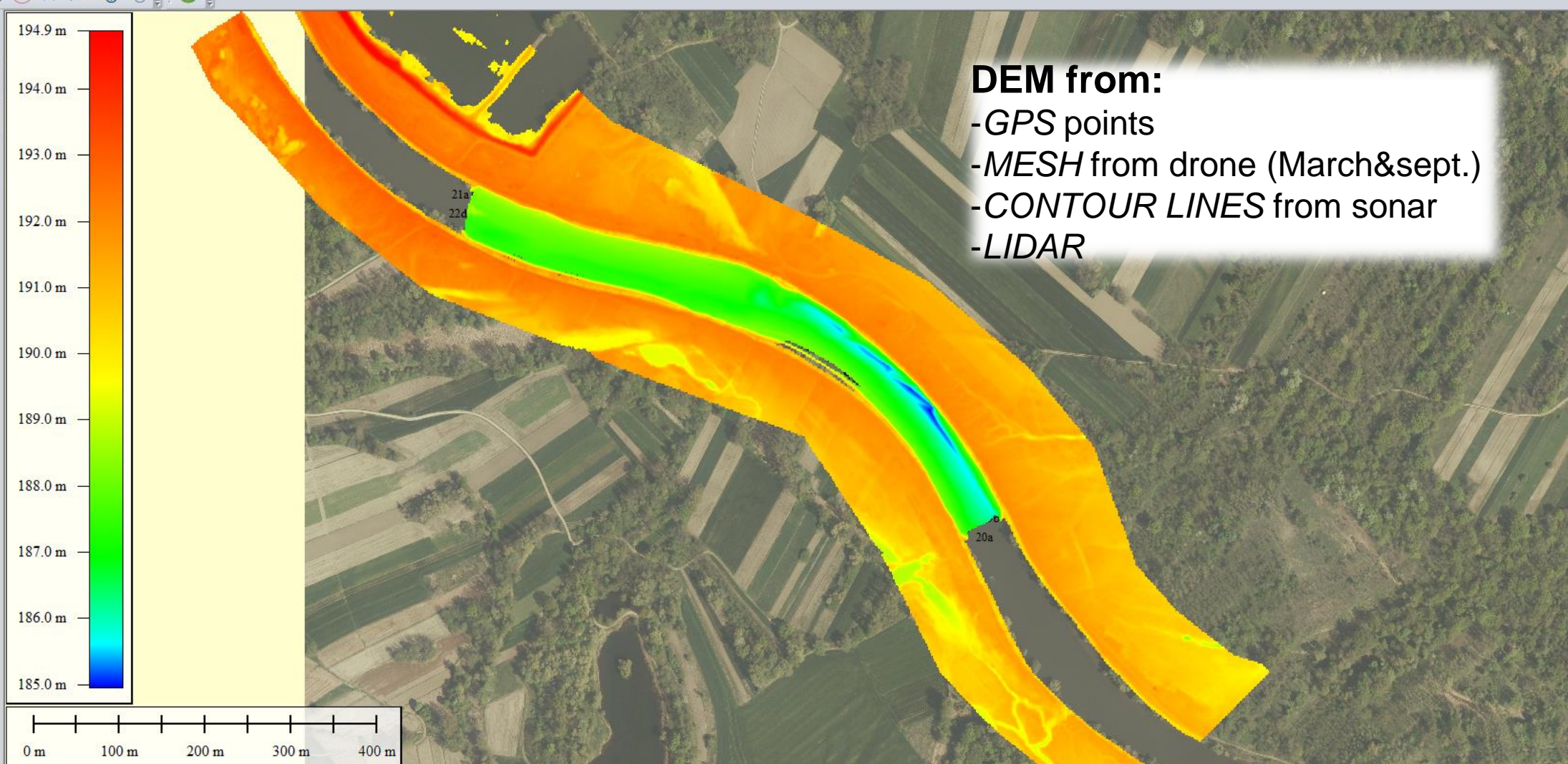


- Current Workspace <Hrastje I
- TM\_584\_164.zlas [579,406]
- TM\_583\_164.zlas [1,150,87]
- j1038.tif
- Zdruzen PC.xyz [18,548,83]
- Mura 2.dxf [378 Features]
- Nove točke [37 Features]
- PLASTNICE IZ DXFI.dxf [5
- User Created Features [3 F





- Control Center (11 Layers, 1 Selected)
- Current Workspace <Hrastje Mota.gmw>
  - TM\_584\_164.zlas [579,406 Features, 6]
  - TM\_583\_164.zlas [1,150,784 Features, 6]
  - J1038.tif
  - Zdruzen PC.xyz [18,548,528 Features]
  - Mura 2.dxf [379 Features]
  - Nove točke [122 Features]
  - PLASTNICE IZ DXF1.dxf [55 Features]
  - Ploskve [27 Features]
  - TOČKE DEM
  - LIDAR
  - LIDAR+ TOČKE



**DEM from:**

- GPS points
- MESH from drone (March&sept.)
- CONTOUR LINES from sonar
- LIDAR



# DEADLINES FOR CONDUCTING THE STUDY

- The deadline for conducting the study is the end of February 2022. The project deadline for submitting the report on the sediment mobilization study is March 2022.



# OUR INPUT-SYNTHESIS REPORT

## Chapter 4.1 Morphology, sediment balance and transport

- Present morphology and conditions for sediment supply and transport for this part of Mura river.
- Grain sizes from our collected samples



# NEXT STEPS

- In contact with VGB
- Data from samples
- First results



# Thank you!

**POMGRAD**  
VODNOSPODARSKO PODJETJE