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Latvia – Lithuania

ICEREG

Report on Pilot rivers cross-sections for development of rivers' geometry for the HEC-RAS model

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LVĢMC

LIETUVOS ENERGETIKOS INSTITUTAS

Lietuvos hidrometeorologijos tarnyba

Contents

Abbreviations

ERDF	European Regional Development Fund
HEC-RAS	Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System
HPP	Hydropower plant
LEI	Lithuanian Energy Institute
LEGMC	Latvian Environment, Geology and Meteorology Centre
Q	Water discharge, m^3/sec
shp	Shapefile format (*digital vector storage format*) for storing geographic location and associated attribute information
X	Latitude of geographical coordinates
Y	Longitude of geographical coordinates

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1. Introduction

Within the frame of the “Ice-jam flood risk management in Latvian and Lithuanian regions with respect to climate change” project (ICEREG) LL-00136 financed by the Interreg V-A Latvia–Lithuania Programme 2014-2020 (ERDF support – 523 266,00 EUR), ice-jam floods will be modelled for both countries in the pilot territories, for the purpose of implementation of ice-jam flood risk management plans and protection measures.

An important element in hydraulic modelling with the HEC-RAS hydrodynamic model is the topography data of the riverbed and the floodplain area of rivers. While floodplain elevation can be obtained directly from digital terrain models, the riverbed topography often is not available. Since in the airborne survey only the elevation of the water surface is recorded, information on the riverbed topography can be gained only from field measurements.

River cross-section measurements were carried out in four pilot rivers: Mūša River and Lėvuo River with Sanžilė Channel in Lithuania, and Daugava and Lielupe rivers in Latvia. Measurement results are described in the present Report.

Report is prepared by the project partners – Latvian Environment, Geology and Meteorology Centre (LEGMC) and Lithuanian Energy Institute (LEI); responsible partner LEGMC.

2. Cross-sections of Lithuanian pilot rivers

The results of the river cross-section measurements are reviewed separately for each pilot river. These reviews include a map showing the location of cross-sections along the selected river stretch, a table with geographical coordinates for each cross-section, and shapes of the measured profiles. Cross-section data in .shp format are available in the project materials.

2.1. Cross-sections of Mūša River

The cross-sections were used to determine the profiles across the selected stretch of Mūša River from the Pantakoniai village islands (downstream the tributary of Skirmanta) to the Gaidelis tributary (380 meters downstream Ustukiai bridge) within the Pasvalys District Municipality.

The cross-sections were measured during field surveys. These measurements indicated the geometry of river cross-sections at certain locations, as well as the slope of the longitudinal profile of the river. These parameters are essential for the hydrodynamic modelling of ice-jam flood because they describe the change of profile area in connection with river discharge, and determine the average velocity of the streamflow at a certain profile.

For the Mūša River, 25 cross-sections were measured along river segment of 15 km (Fig. 2.1.1). Measured cross-section coordinates (XY) for the Mūša River are given in the Table 2.1.1.

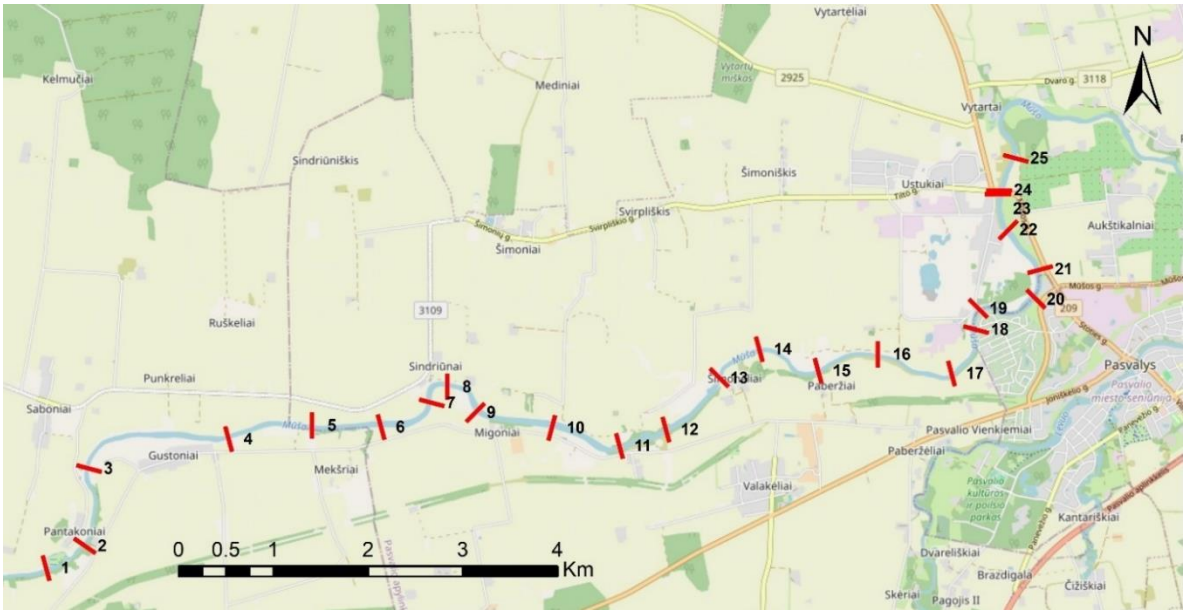


Figure 2.1.1. Location of cross-sections in Mūša River (see numbering in the Table 2.1.1)

Table 2.1.1. Coordinates (LKS-94) of Mūša River cross-sections

No. of cross-section	Longitude	Latitude	No. of cross-section	Longitude	Latitude
1	513250.31	6212169.50	14	520780.18	6214483.02
2	513662.51	6212404.84	15	521399.22	6214254.22
3	513703.07	6213222.26	16	522029.16	6214428.65
4	515178.62	6213534.37	17	522807.43	6214225.29
5	516056.53	6213678.32	18	523069.97	6214690.45
6	516788.07	6213660.46	19	523096.20	6214912.89
7	517321.43	6213916.73	20	523703.42	6215011.23
8	517484.92	6214085.01	21	523744.08	6215326.61
9	517787.23	6213814.10	22	523413.12	6215744.38
10	518590.92	6213651.48	23	523297.22	6216124.06
11	519304.20	6213460.34	24	523310.02	6216163.25
12	519795.91	6213633.69	25	523488.41	6216501.62
13	520360.53	6214179.81			

In Figure 2.1.2, the profiles of each measured cross-section of the Mūša River are displayed. The blue points show the measured values of riverbed profiles. The vertical axis represents the height above sea level in meters, and the horizontal axis shows the width in meters from the left-side bank towards the right-side. Part of cross-sections have regular U-shape of river bottom; however, there were some profiles with curved riverbed structure and indicated intensive erosion and accumulation processes at those cross-sections (Fig. 2.1.2). The most dangerous place for ice-jam flood formation in Muša River is located near the Ustukiai bridge, therefore two additional cross-sections before (cross section No. 23) and after the bridge (cross section No. 24) were measured.

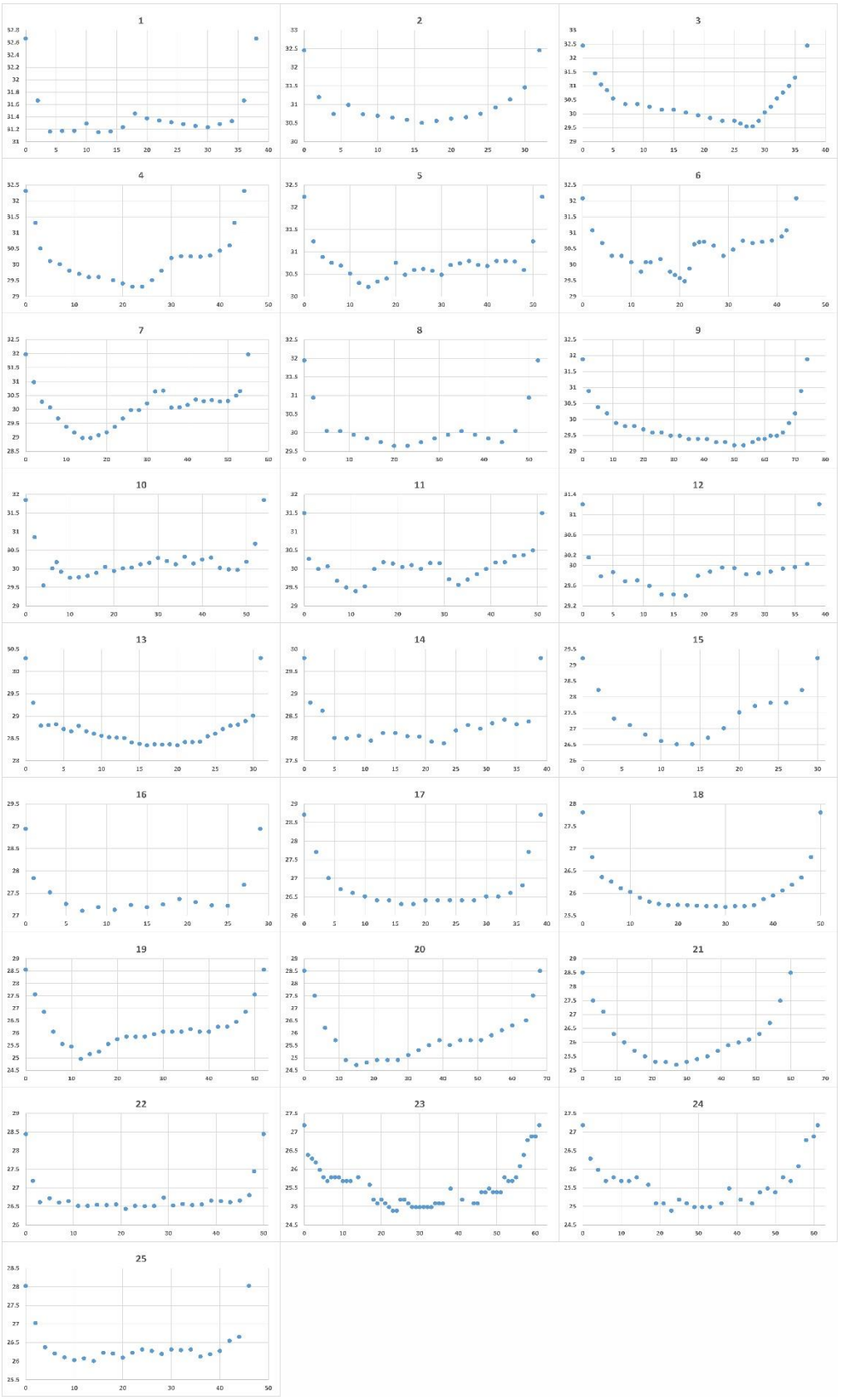


Figure 2.1.2. Profiles of the cross-sections (see numbering in the Table 2.1.1) of Mūša River

2.2. Cross-sections of Lėvuo River and Sanžilė Channel

The cross-sections were measured within the Panevėžys District Municipality in the Lėvuo River from the Pamarliškiai village (downstream the tributary of Vilktupis) to the Skaistgiriai village (100 meters downstream Skaistgiriai bridge) and in Sanžilė Channel from channel intake (from Lėvuo River) to second Bernatoniai bridge across the channel (1.5 km downstream the channel intake).

These measurements indicated the geometry and the elevation data of the river and channel cross-sections. For the Lėvuo River, 50 cross-sections (cross-sections No. 1–50) were measured along the river stretch of 20.5 km. Moreover, 5 additional cross-sections (cross-sections No. 51–55) were measured in Sanžilė Channel within 1.5 km channel stretch (Fig. 2.2.1).

Measured cross-section coordinates (XY) for the Lėvuo River and Sanžilė Channel are given in the Table 2.2.1.

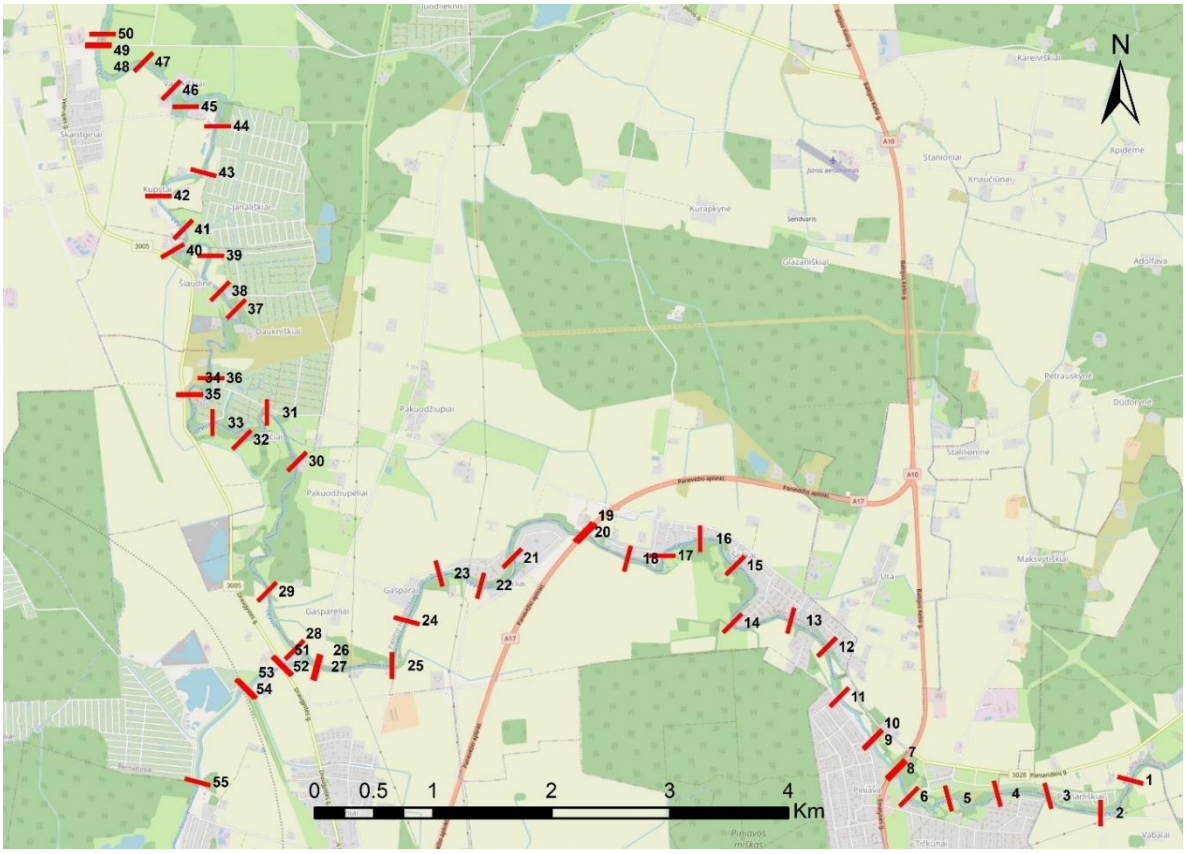


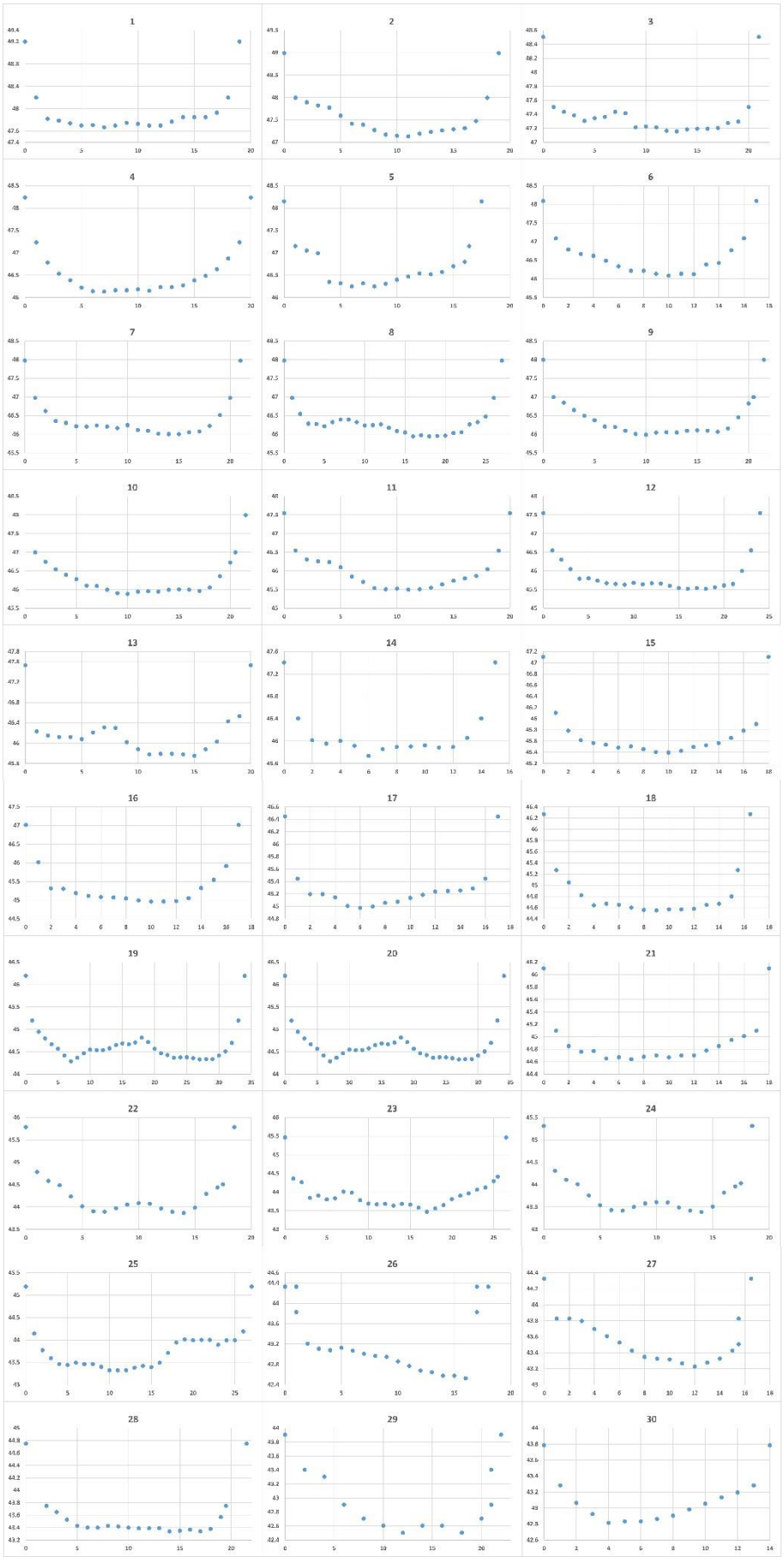
Figure 2.2.1. Location of cross-sections in Lėvuo River (cross-sections No. 1–50) and Sanžilė Channel (cross-sections No. 51–55) (see numbering in the Table 2.2.1)

Table 2.2.1. Coordinates (LKS-94) of the Lėvuo River and Sanžilė Channel cross-sections

No. of cross-section	Longitude	Latitude	No. of cross-section	Longitude	Latitude
1	524932.18	6183016.04	29	517645.74	6184607.84
2	524677.81	6182739.16	30	517898.44	6185707.45
3	524235.61	6182885.64	31	517637.98	6186118.11
4	523805.59	6182904.60	32	517431.31	6185889.84
5	523393.32	6182864.19	33	517179.66	6186032.72
6	523064.37	6182879.28	34	516985.74	6186269.06
7	522964.54	6183098.25	35	516985.40	6186273.45
8	522951.36	6183114.03	36	517166.34	6186410.62
9	522762.51	6183356.51	37	517384.52	6186993.81
10	522758.23	6183365.55	38	517248.86	6187143.67
11	522478.72	6183718.34	39	517164.03	6187444.60
12	522372.64	6184141.46	40	516845.27	6187486.51
13	522065.27	6184364.51	41	516936.69	6187663.31
14	521574.83	6184343.05	42	516723.97	6187948.33
15	521599.04	6184828.61	43	517106.36	6188144.33
16	521298.34	6185054.00	44	517223.08	6188536.13
17	520976.44	6184911.72	45	516954.47	6188700.82
18	520685.96	6184886.73	46	516836.18	6188839.65
19	520342.91	6185100.11	47	516600.61	6189077.25
20	520315.38	6185110.01	48	516214.57	6189214.75
21	519715.72	6184891.29	49	516216.64	6189225.46
22	519447.53	6184659.51	50	516250.47	6189314.46
23	519093.80	6184761.31	51	517779.51	6183982.13
24	518823.14	6184364.41	52	517767.36	6183976.76
25	518695.19	6183984.11	53	517476.33	6183788.42
26	518072.75	6183966.97	54	517456.83	6183786.78
27	518055.94	6183974.04	55	517055.08	6183001.51
28	517876.89	6184117.96			

Figure 2.2.2 displays the profiles of each measured cross-section of the Lėvuo River and Sanžilė Channel. The blue points show the measured values of riverbed profiles and indicate height above sea level in the vertical axis and width in meters from the left-side bank towards the right-side in the horizontal axis. Most of cross-sections have regular U-shape of river bottom, however, the depth varied from very shallow profiles up to few meters in depth (Fig. 2.2.2).

At the most dangerous places for ice-jam flood formation (near the bridges), the cross-sections before and after the bridge were measured, and the technical characteristics of each bridge were evaluated. Such measurements were performed at cross sections No. 7, 8, 9, 10, 19, 20, 26, 27, 34, 35, 48, 49, 51, and 52.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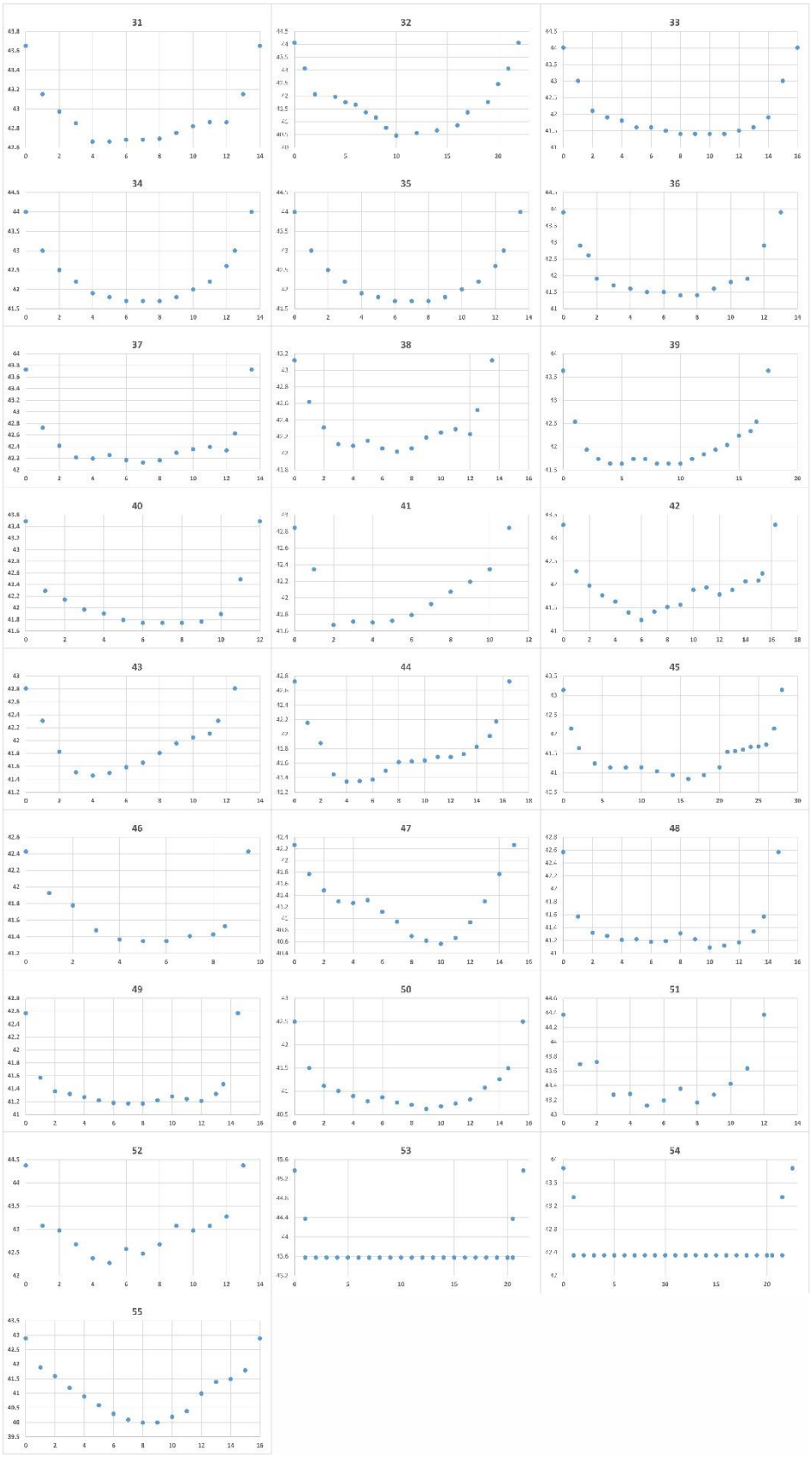


Figure 2.2.2. Profiles of cross-sections (see numbering in the Table 2.2.1) of Lėvuo River (cross-sections No. 1–50) and Sanžilė Channel (cross-sections No. 51–55)

3. Cross-sections of Latvian pilot rivers

The results of Latvian river cross-section measurements are also reviewed separately for each pilot river. These reviews include a map of location of cross-sections along the selected river stretch and shapes of the measured profiles, as well as geographical coordinates of every cross-section. Data in .shp format are available in the project materials.

3.1. Cross-sections of Daugava River

Cross-sections were designed to determine the profiles across Daugava River within Jēkabpils municipality. As LEGMC has measured some profiles for other purposes before and has obtained fully scanned riverbed of Daugava River starting from the sea and up to the Saka Island near Jēkabpils city, the measurements within the project were made between already existing profiles, to improve the coverage and density of measured riverbed as well as improve the coverage of riverbed information near Daugava River islands. Improved coverage of cross-sections will allow to get better modelling results.

Measurement results indicate the geometry of river cross-sections, as well as the absolute height of the riverbed. For the Daugava River, 97 cross-sections were measured (Fig. 3.1.1) along approximately 100 km river stretch. Measured cross-section coordinates (XY) for the Daugava River are given in the Table 3.1.1.

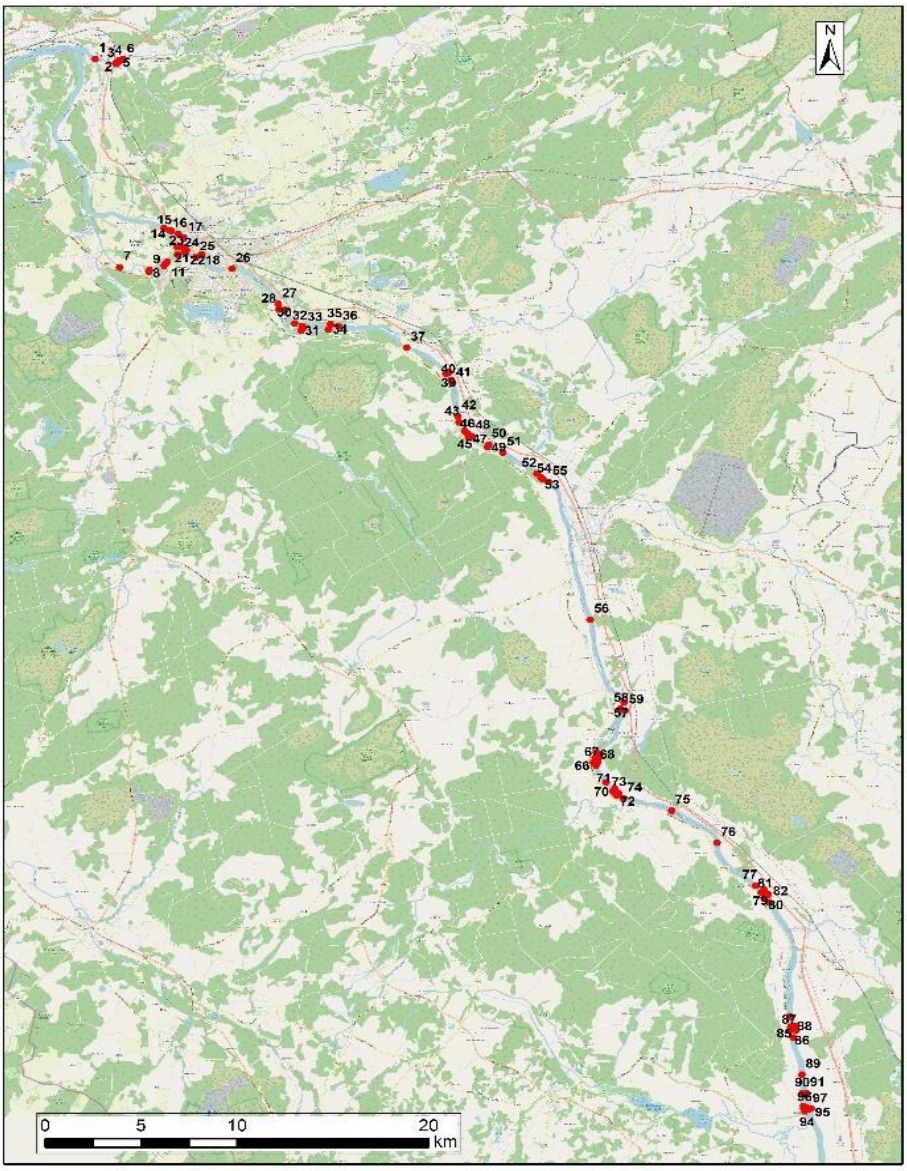


Figure 3.1.1. Location of cross-sections in Daugava River (see numbering in the Table 3.1.1)

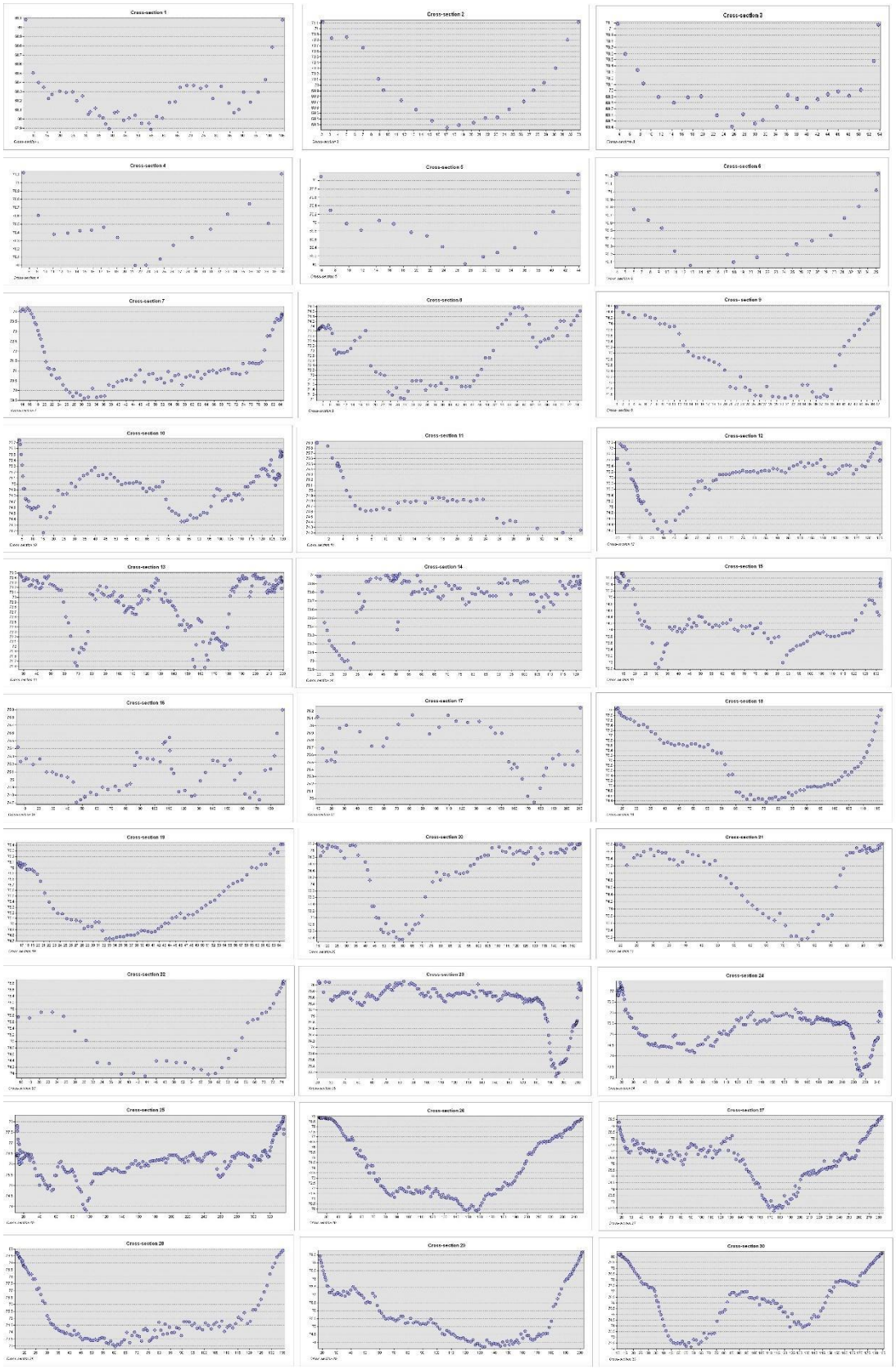
Table 3.1.1. Coordinates (LKS-92) of the Daugava River cross-sections

No. of cross-section	Longitude	Latitude	No. of cross-section	Longitude	Latitude
1	608751.38	275370.99	50	629279.73	253233.83
2	609834.66	275118.29	51	630019.69	252768.68
3	609862.62	275080.69	52	631788.58	251553.84
4	610020.42	275223.55	53	631995.82	251325.60
5	609990.15	275285.10	54	632104.23	251236.48
6	610208.24	275331.14	55	632388.94	251083.53
7	610030.80	263412.87	56	634562.22	243177.62
8	611556.72	263167.65	57	636341.70	238435.98
9	611581.79	263237.33	58	636152.48	238064.05
10	612347.63	263500.26	59	636386.01	237964.56
11	612516.13	263713.45	60	634902.19	235553.61
12	613053.89	264125.25	61	635076.59	235480.66
13	612335.24	265646.74	62	634963.46	235432.78
14	612628.37	265537.13	63	634927.59	235326.81
15	612721.48	265487.68	64	634834.80	235258.65
16	613082.66	265319.57	65	634997.15	235221.90
17	613387.53	265092.13	66	634739.77	234967.93
18	614305.97	264165.25	67	634937.93	234950.42
19	614303.32	264090.18	68	634863.62	234798.09
20	613047.24	264558.44	69	635388.44	233842.15
21	613342.23	264538.87	70	635740.74	233312.33
22	613504.86	264393.50	71	635848.01	233447.52
23	613436.53	264295.10	72	635936.20	233085.69
24	613453.26	264203.14	73	636052.76	233223.91
25	614009.55	263975.88	74	636290.59	232904.40
26	615890.41	263321.54	75	638807.06	232216.76
27	618307.25	261287.71	76	641178.09	230360.81
28	618336.24	260983.00	77	643191.01	227907.54
29	618632.98	260946.23	78	643502.21	227527.90
30	619156.46	260181.12	79	643639.26	227651.21
31	619492.30	259783.23	80	643653.81	227256.09
32	619548.11	260009.50	81	643843.25	227400.49
33	619633.72	259933.30	82	643902.41	226953.86
34	620919.83	259828.93	83	644986.67	220389.08
35	621022.60	260140.55	84	645019.77	219813.60
36	621458.63	260007.62	85	645269.68	219825.71
37	625002.50	258796.28	86	645028.95	219635.03
38	627050.62	257290.71	87	645302.38	219587.62
39	627186.13	257377.31	88	645153.73	219188.66
40	627325.91	256940.06	89	645598.72	217050.77
41	627386.35	256749.21	90	645609.14	215968.43
42	627667.16	254857.19	91	645837.03	215994.88
43	627742.87	254515.28	92	645686.20	215249.23

No. of cross-section	Longitude	Latitude	No. of cross-section	Longitude	Latitude
44	628029.82	254005.59	93	645707.72	215108.47
45	628150.53	253866.31	94	645760.23	214949.24
46	628211.41	253793.87	95	646088.20	215107.15
47	628233.58	253614.69	96	645861.36	215153.64
48	628383.58	253719.78	97	645959.86	215065.62
49	629204.55	253083.57			

Most cross-sections have U-shaped riverbed (Fig. 3.1.2). Some of the cross-sections are quite shallow, for example near islands, and the shallowest riverbed is near Jēkabpils city, next to Saka Island where the impact of Pļaviņu HPP ends and the probability for the ice-jams to form up is the highest one.

Similar situation with islands is downstream of city Līvāni, where some flood episodes tend to occur. More upstream cross-sections have flat or U-shaped riverbeds with stable depth and width. In Figure 3.1.2, the blue points show the riverbed profiles. Vertical axis represents the height above sea level in meters and horizontal axis – the river width.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Cross-section 3
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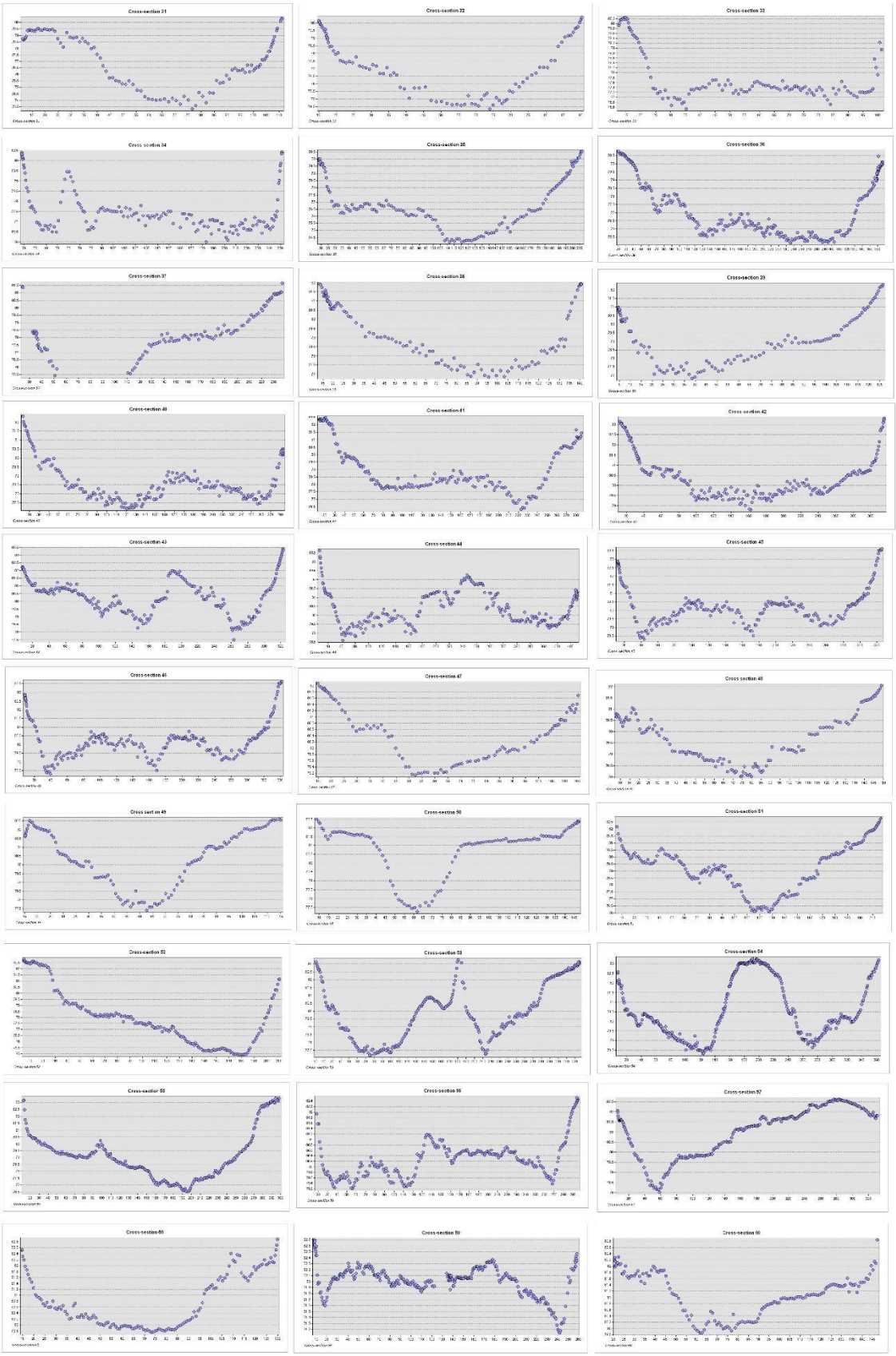
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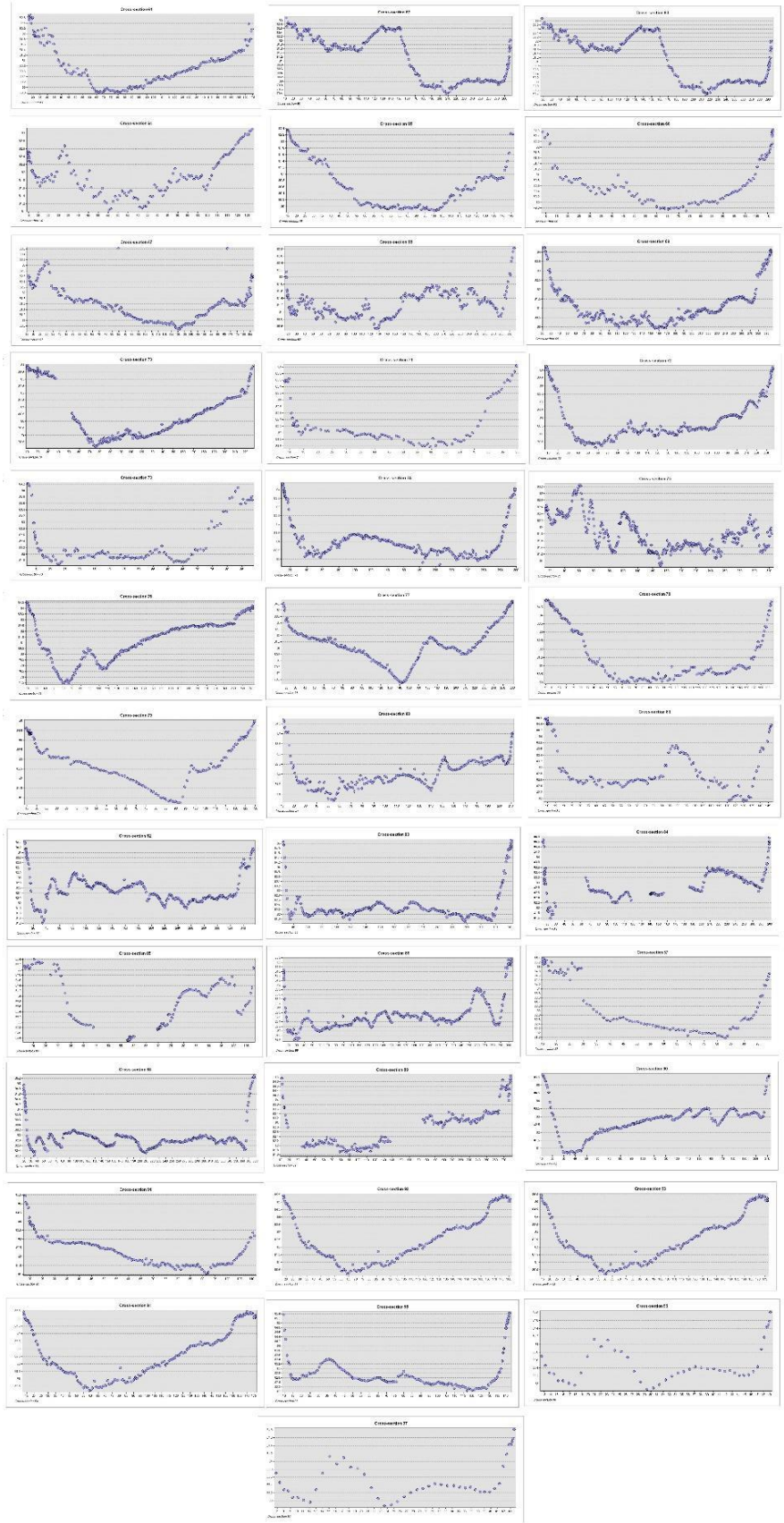

Figure 3.1.2. Profiles of cross-sections (see numbering in the Table 3.1.1) of Daugava River

3.2. Cross-sections of Lielupe River

The cross-sections were designed to determine the profiles across the Lielupe River between Jelgava and Bauska cities. As LEGMC has measured some profiles of Lielupe River before for spring flood modelling, the measurements within the project were made between already existing profiles, to improve the coverage and density of riverbed measurements, as well as improve the coverage of riverbed information at Lielupe River islands.

Measurement results indicate the geometry of river cross-sections, as well as the absolute height of the riverbed. For the Lielupe River, 38 cross-sections were measured (Fig. 3.2.1) within a river stretch of approximately 40 km.

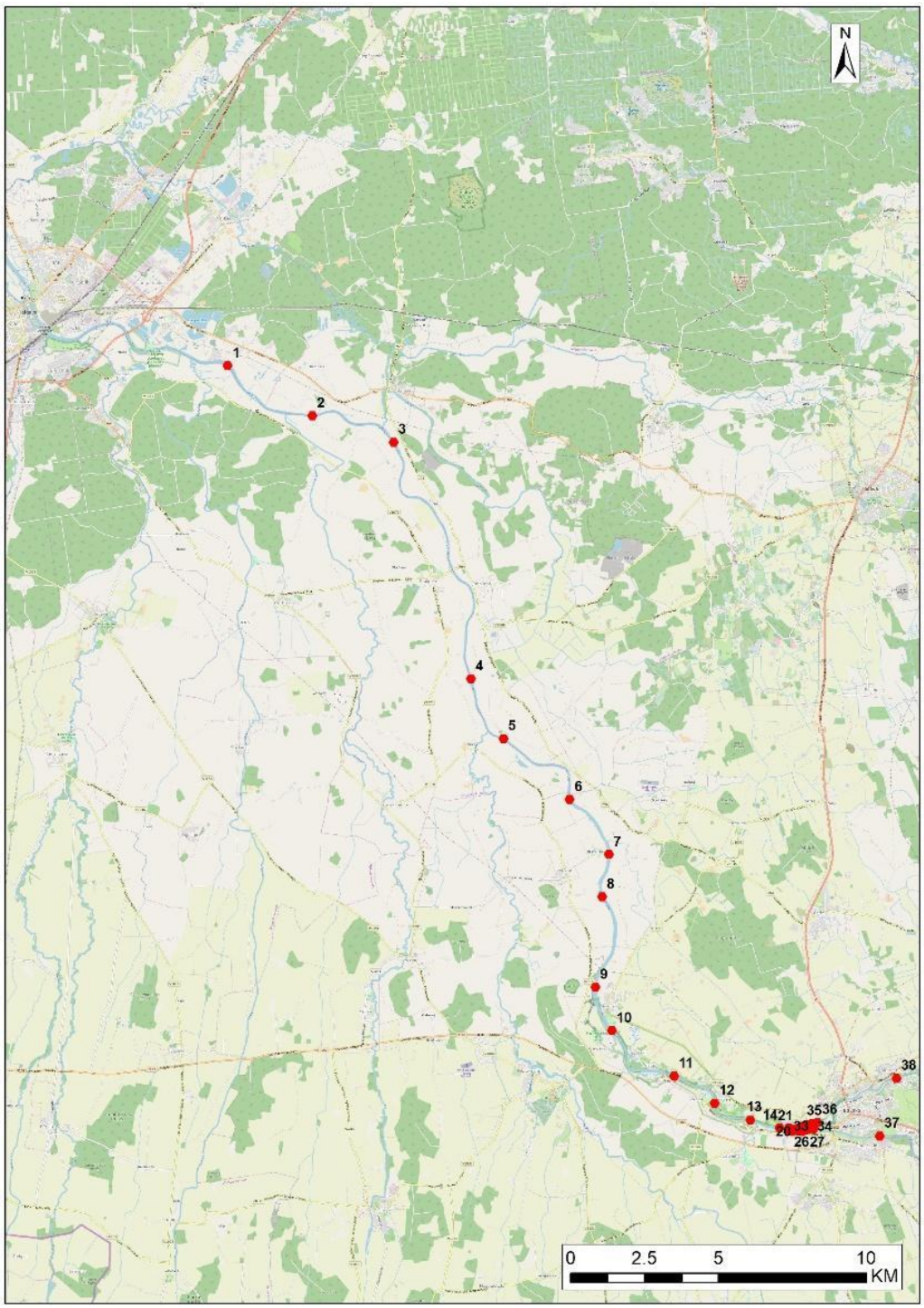

Figure 3.2.1. Location of cross-sections (see numbering in the Table 3.2.1) of Lielupe River

Measured cross-section coordinates (XY) for the Lielupe River are given in the Table 3.2.1. The geometry of each cross-section is displayed in Figure 3.2.2.

Table 3.2.1. Coordinates (LKS-92) of Lielupe River cross-sections

No. of cross-section	Longitude	Latitude	No. of cross-section	Longitude	Latitude
1	490426.35	276792.19	20	509681.83	250873.07
2	493286.05	275090.33	21	509719.82	250916.57
3	496045.54	274191.31	22	509756.96	250934.79
4	498665.55	266169.87	23	509764.47	250847.68
5	499770.39	264146.35	24	509897.44	250835.15
6	502011.02	262078.29	25	509902.56	250998.91
7	503334.88	260215.80	26	509950.58	250897.14
8	503106.70	258775.74	27	509984.29	250863.36
9	502883.62	255717.19	28	509978.53	251003.73
10	503446.61	254245.96	29	510021.01	251038.75
11	505549.15	252699.90	30	510041.71	251043.64
12	506922.97	251778.91	31	510122.43	250912.47
13	508123.64	251215.74	32	510164.96	250975.43
14	509117.00	250942.05	33	510274.38	250919.19
15	509424.20	250858.64	34	510243.79	251056.35
16	509426.98	250929.54	35	510228.02	251086.51
17	509547.72	250833.87	36	510408.71	251125.00
18	509551.90	250906.17	37	512508.50	250665.67
19	509577.65	250865.65	38	513080.60	252622.90

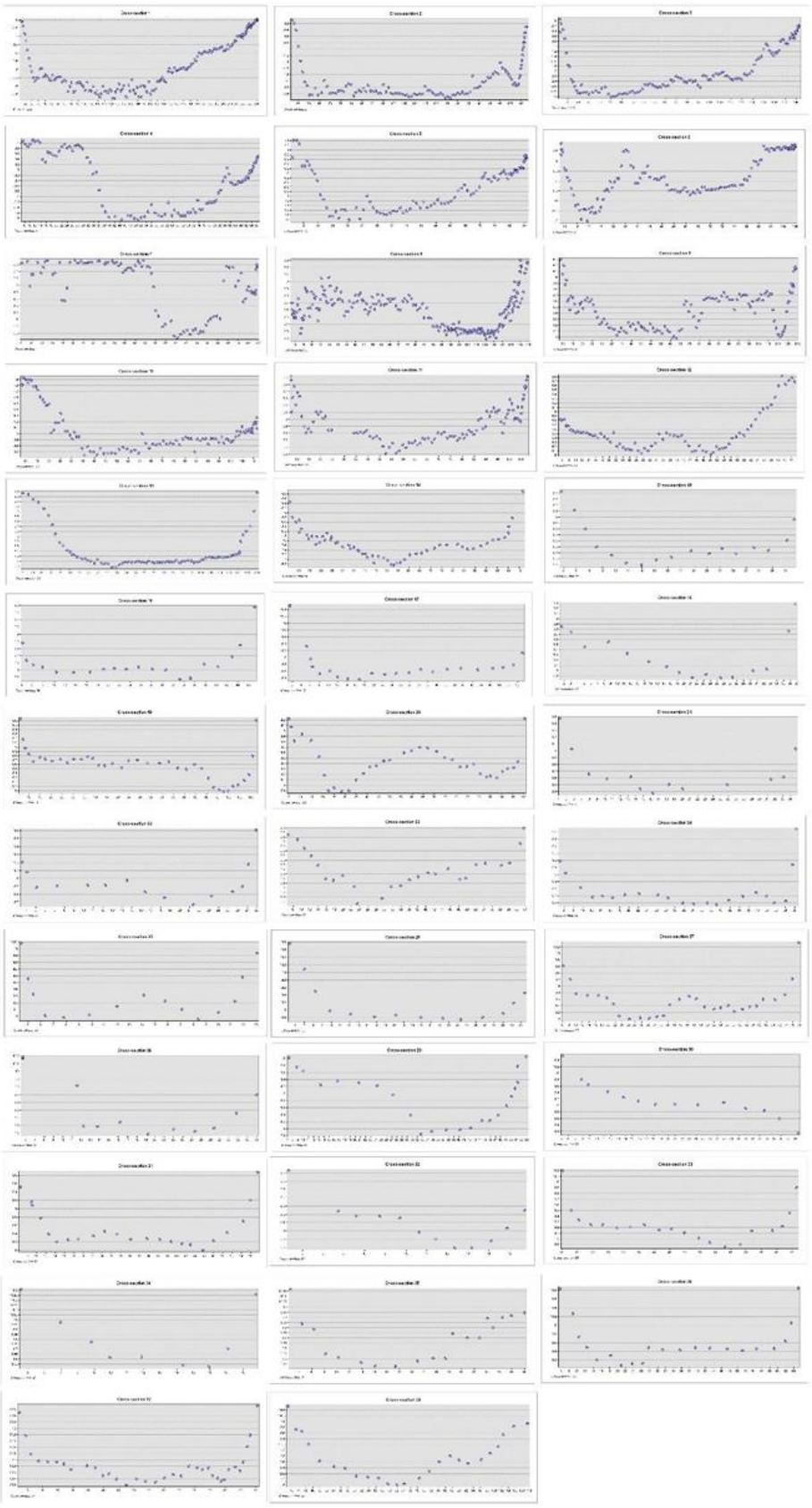

Figure 3.2.2. Profiles of cross-sections (see numbering in the Table 3.2.1) of Lielupe River