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LIETUVOS ENERGETIKOS INSTITUTAS

ICEREG

Ice-jam flood hazard and risk maps for the pilot territories in Lithuania

VYTAUTAS AKSTINAS | HYDROMORPHOLOGY EXPERT
SERHII NAZARENKO | FLOOD MODELLING EXPERT
PROJECT CONFERENCE, RIGA | 21/01/2026

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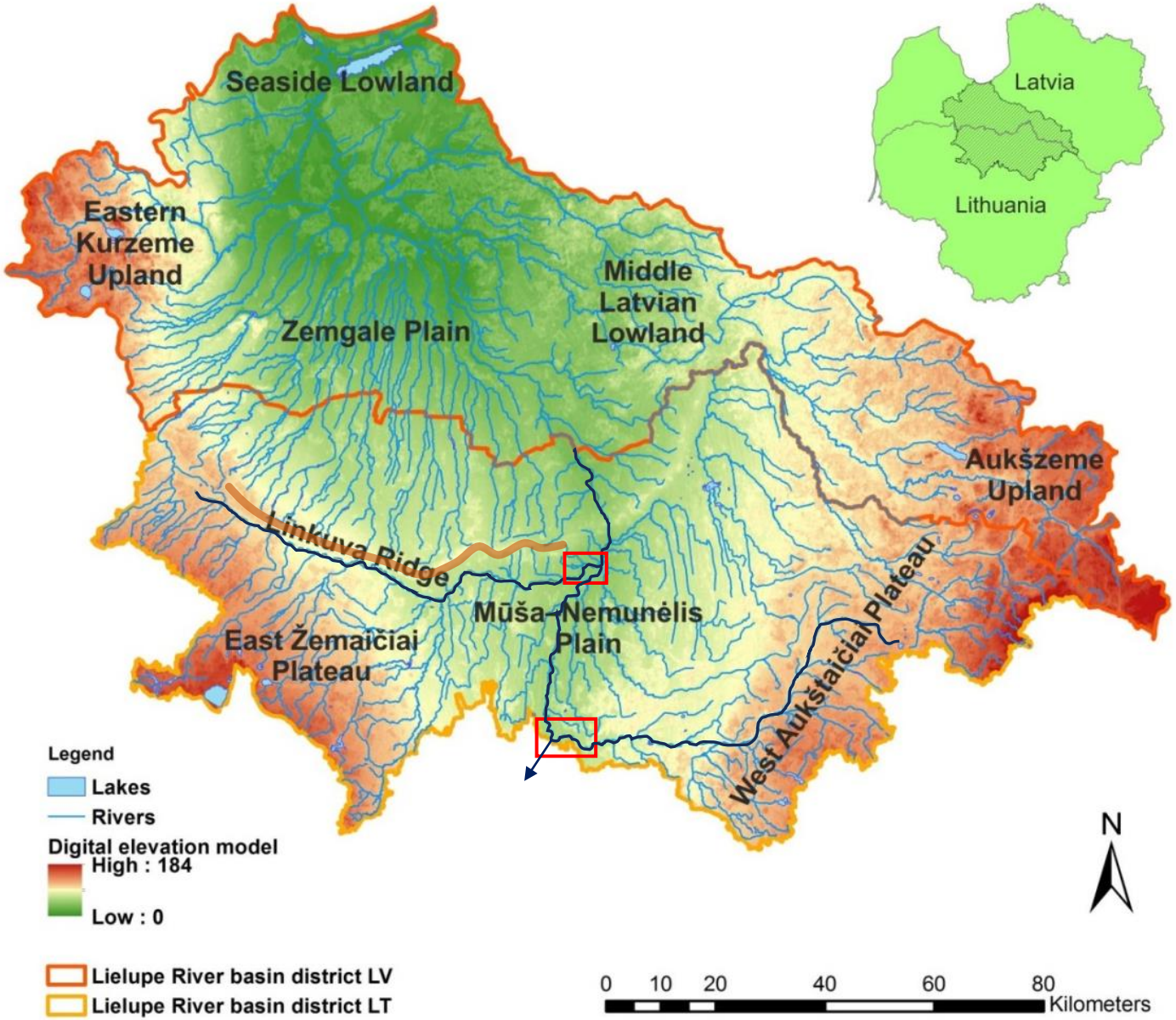
Study area– Lielupe RBD



Topographic map according to:
[Lietuvos reljefo žemėlapis]

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Changes in the ice regime in the rivers of northern Lithuania

River – Station	Ice phenomena start date		Number of days with ice cover		Break-up date	
	1961–1990	1991–2020	1961–1990	1991–2020	1961–1990	1991–2020
Svyla-Guntauninkai	12.12	**12.25**	92	59	03.14	02.22
Nemunėlis-Tabokinė	12.24	12.27	87	54	03.21	02.19
Mūša-Ustukiai	12.16	**01.01**	86	58	03.12	03.01
Lėvuo-Bernatoniai	12.26	01.03	80	52	03.16	02.24
Tatula-Trečionys	12.19	**01.07**	73	36	03.02	02.11
Venta-Papilė	12.29	**01.11**	76	36	03.15	02.17

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Ice-jam floods in Northern part of Lithuania

In 2010 and 2013, ice-jams caused huge floods in the upper reaches of the Mūša River

In the spring of 2010, maximum water level in the Mūša River at the Ustukiai water gauging station reached 30.25 m above sea level (90 cm above the critical level) due to ice-jam

Ice drift in Mūša at Narteikiai village. Photo by Jonas Vitkauskas

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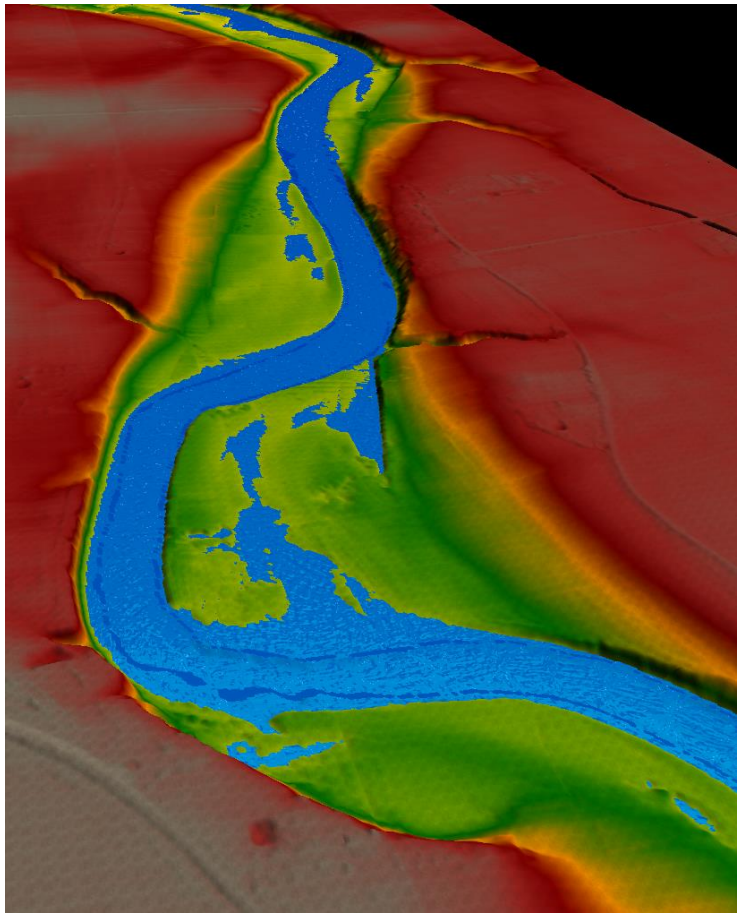
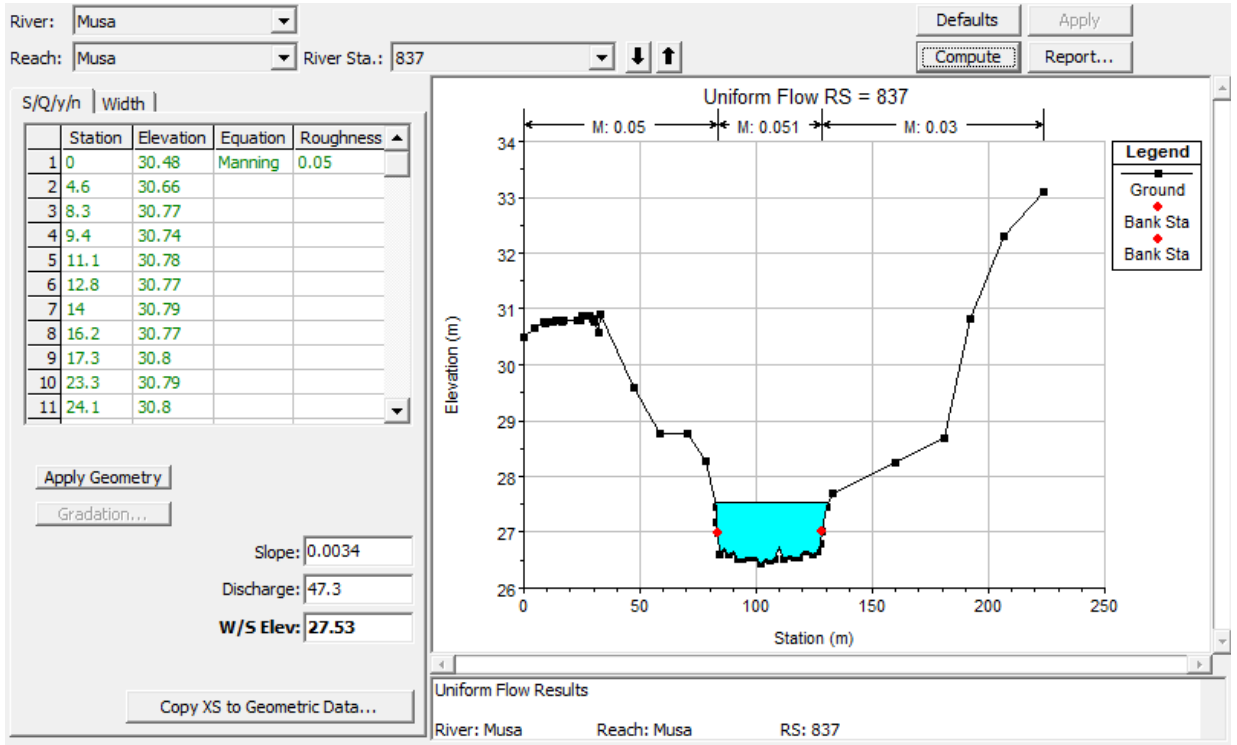
Methodology (HEC-RAS) (I)



HEC-RAS is a hydrodynamic model whose purpose is to estimate the distribution of water levels in relation to various hydrological scenarios



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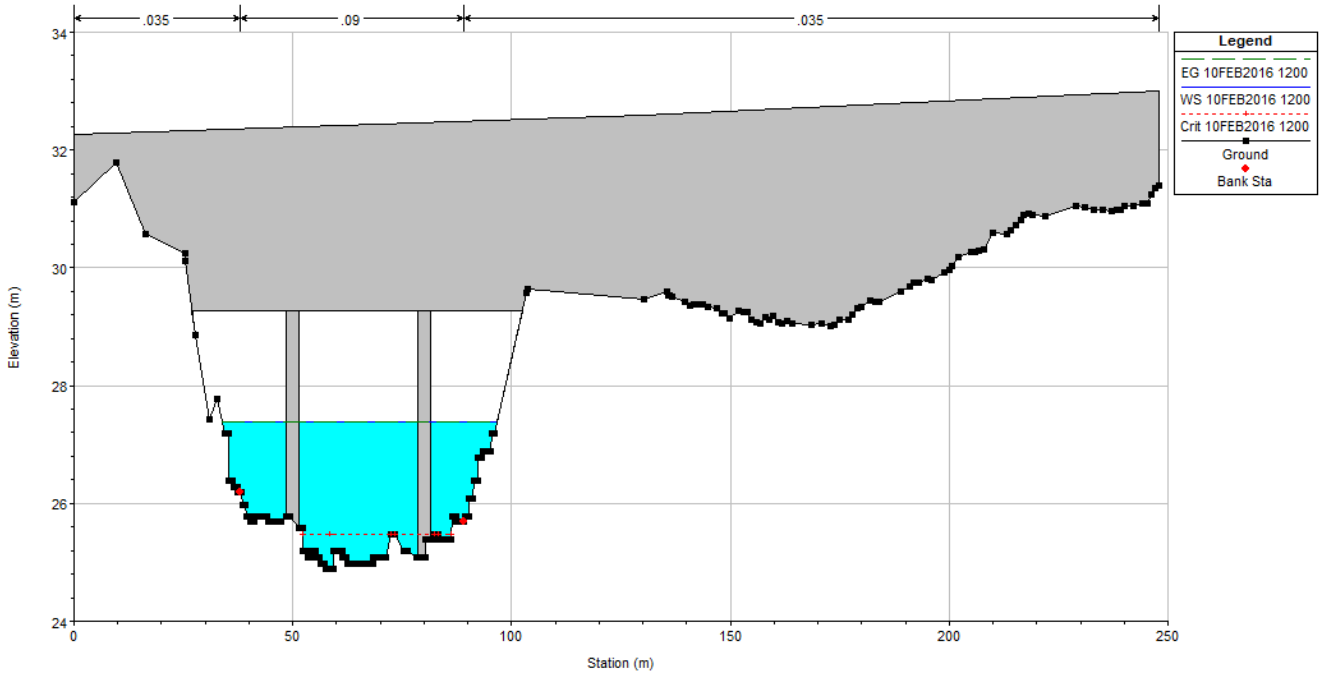
Methodology (HEC-RAS) (II)

Input data:

- Terrain
- Cross sections
- Bridges
- Culverts
- River discharge
- Water levels
- River network lines
- River centerlines
- Overbank flow paths
- Bank lines
- Manning's n values



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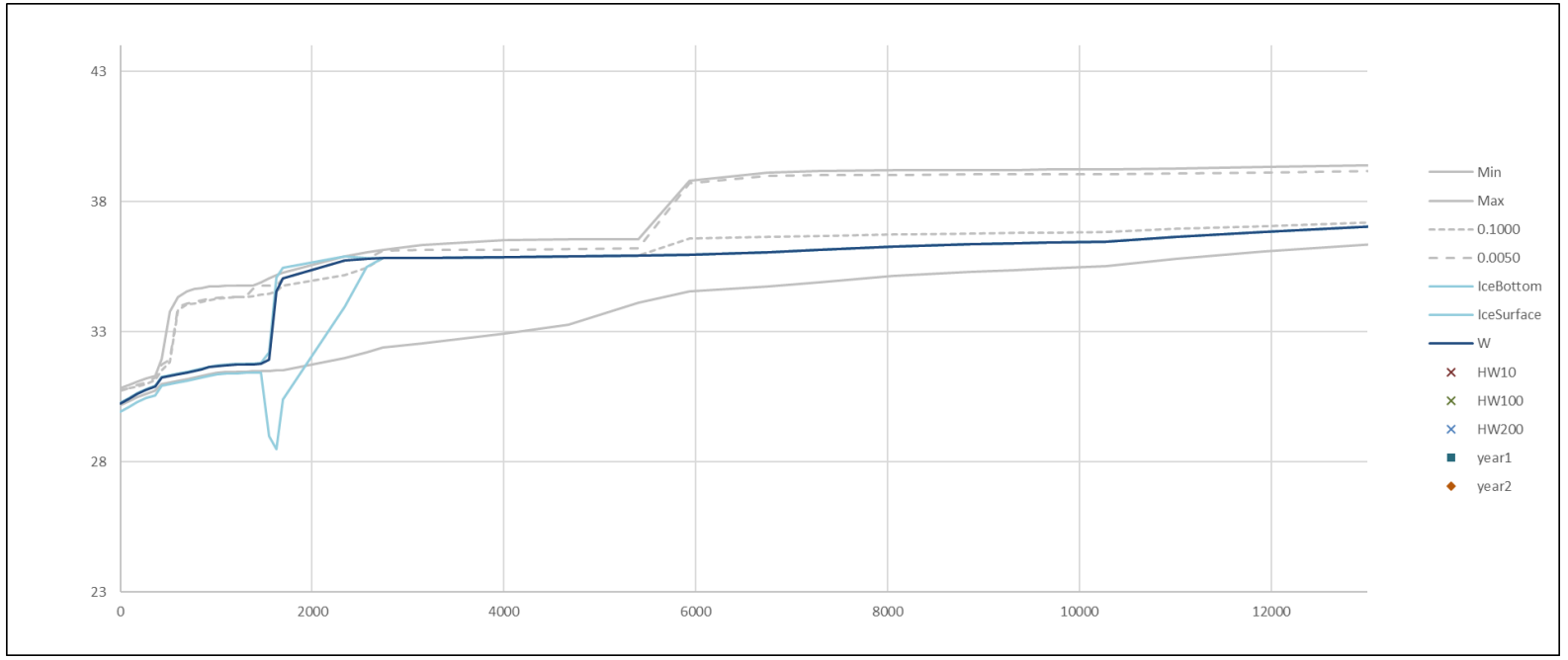
Methodology (SYKE model) (III)

Finnish Environment Institute (SYKE) ice-jam model (Excel-VBA based) is designed to evaluate different ice-jam scenarios by combining various input data combinations (ice-jam: location, length, ice volume; river discharge and Manning's roughness coefficient)



This tool allows to estimate the extent of ice-jam, ice thickness, maximum water level and maximum possible flooding area based on entered conditions from observed and measured data

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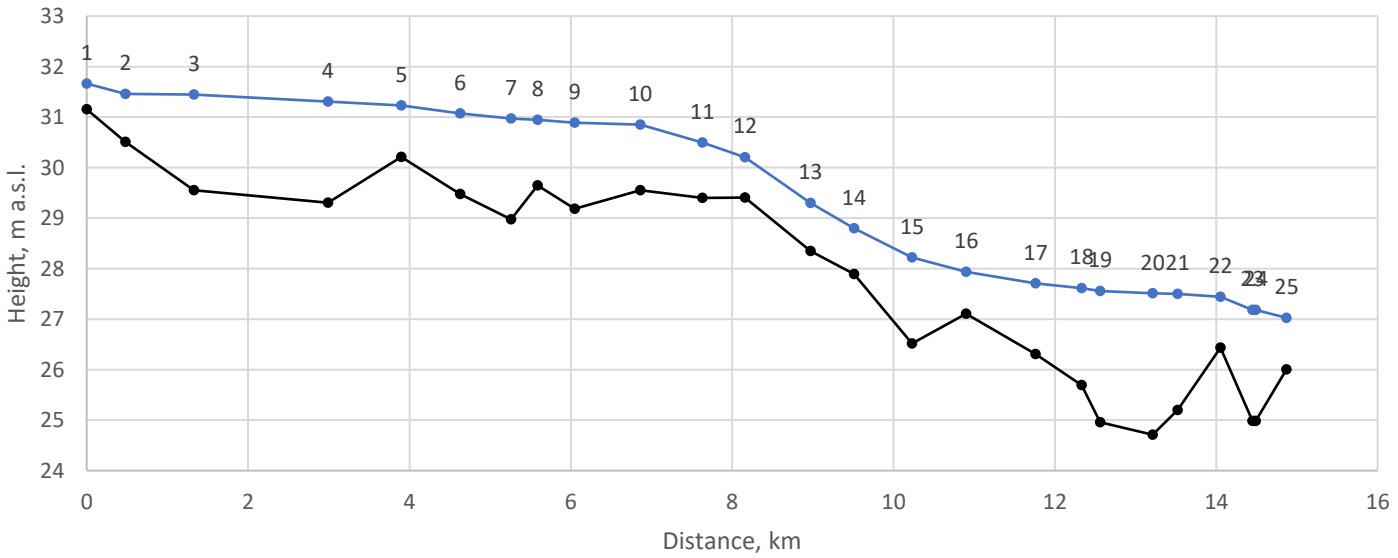
Input data: Mūša River



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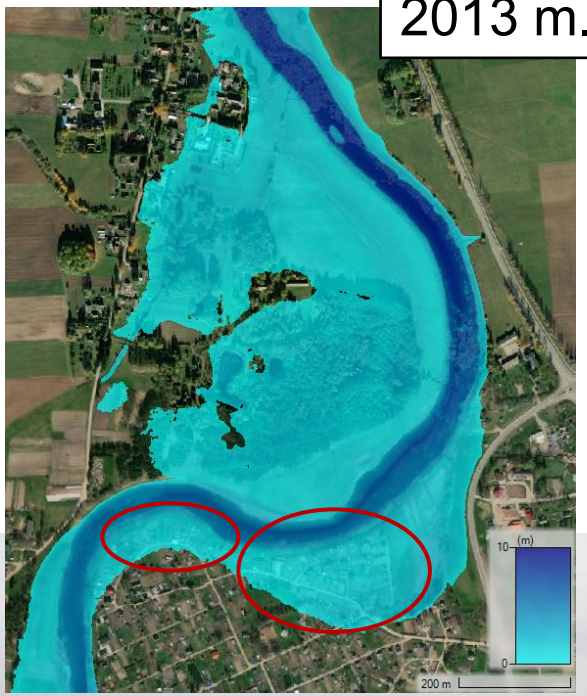
HEC-RAS model calibration: Mūša River

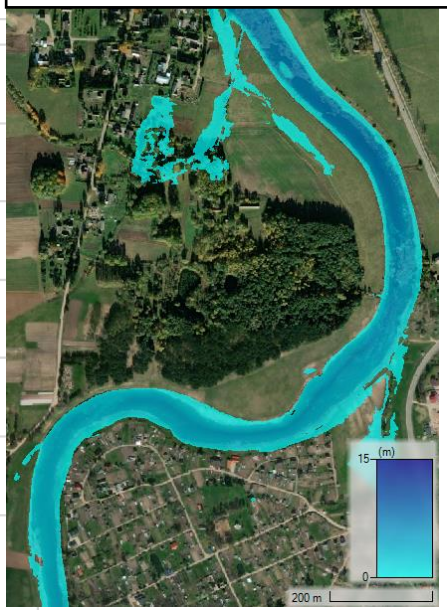
2013 m. ice-jam flood



Flooded Žemdirbiai and Bokštas streets
Q_{max}=93.3 m^3/s A≈1.72 km^2

Correlation	0.996
Nash-Sutcliffe Efficiency (NSE)	0.872
Root Mean Square Error (RMSE)	0.120
Relative Error (RE) (%)	-0.020

2022 m. flood



Q_{max}=92.3 m^3/s
A≈0.5 km^2

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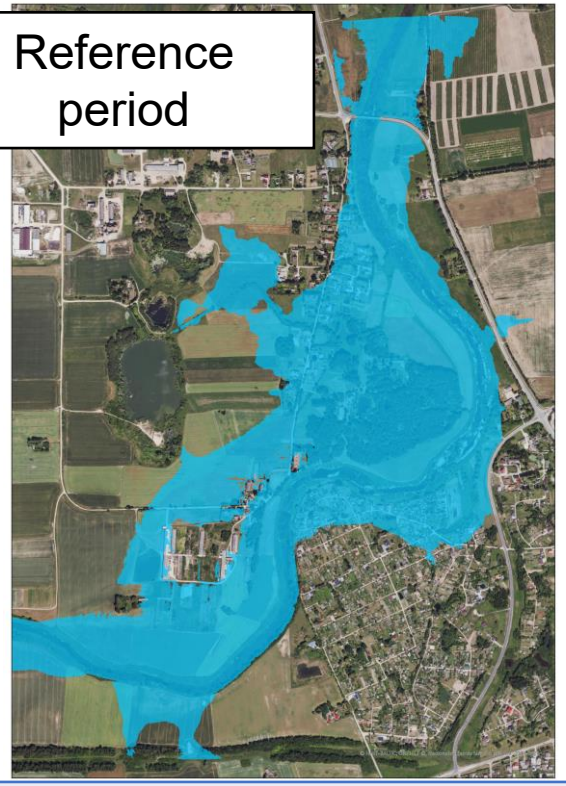
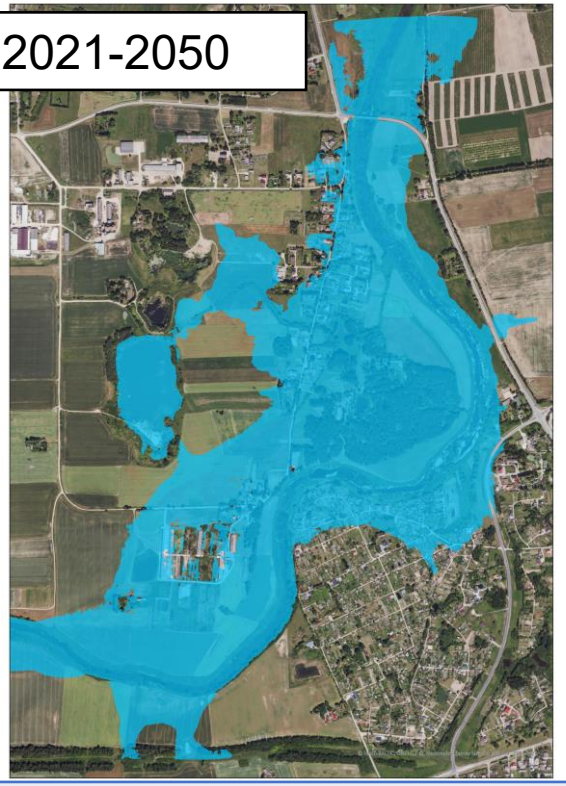
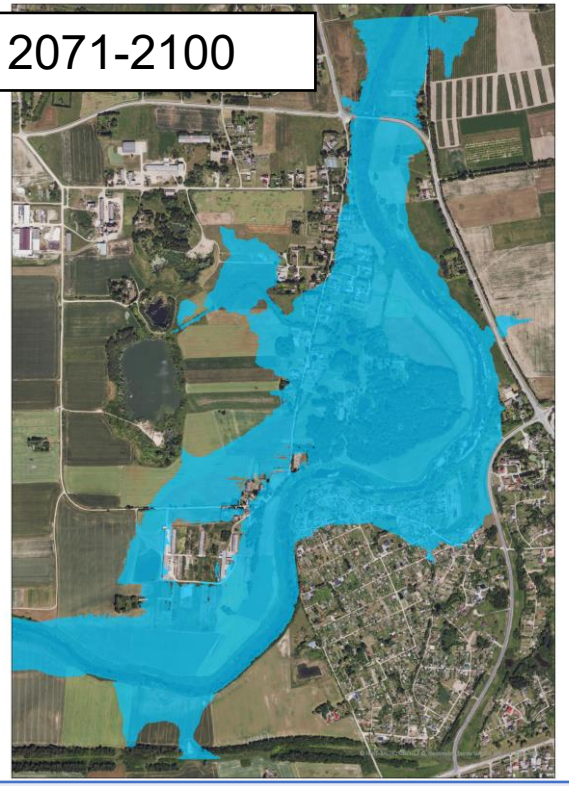
1% probability ice-jam flood in Mūša River: SSP245







Flooded area (km^2)	**3.34**	**3.61**	**3.30**

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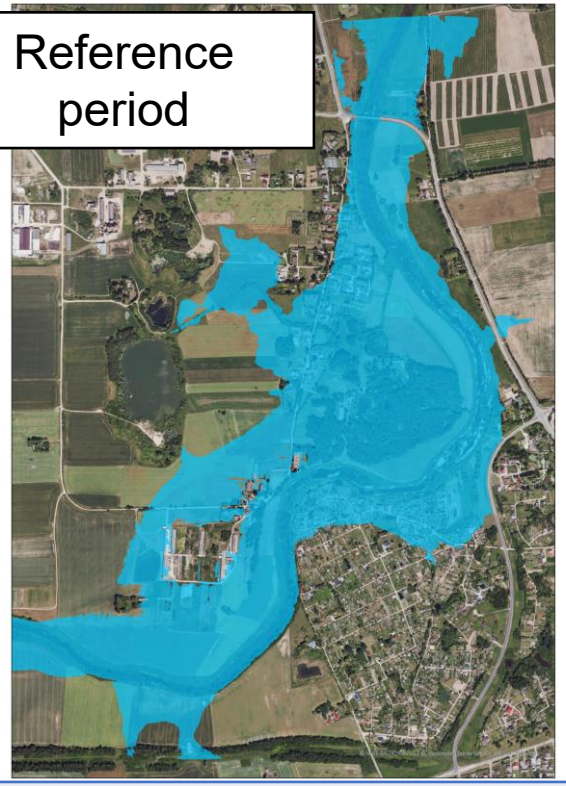
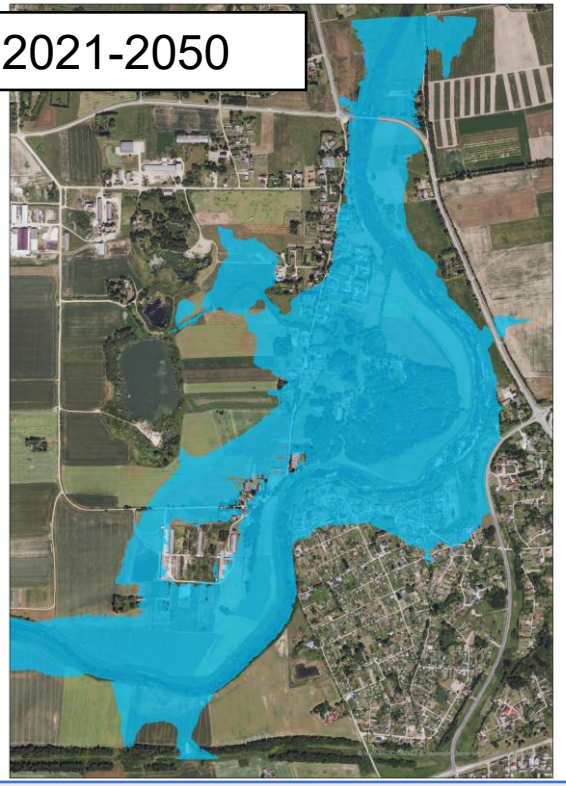
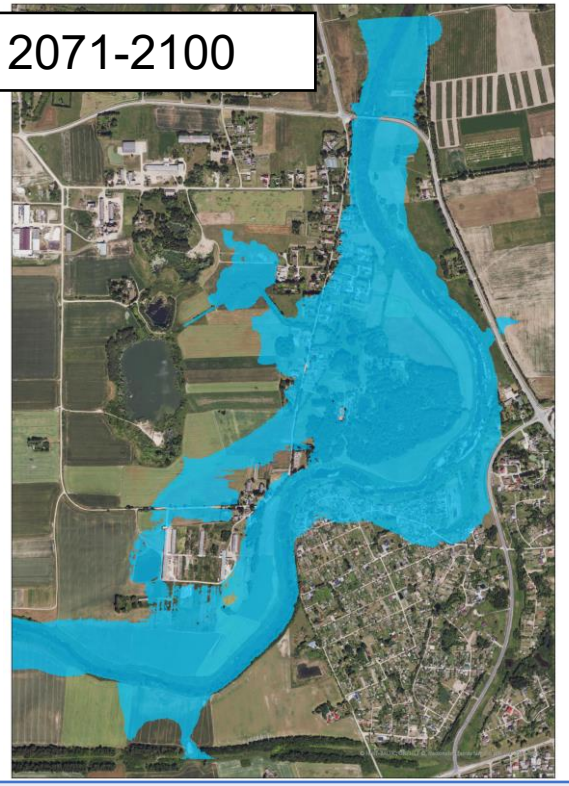
1% probability ice-jam flood in Mūša River: SSP370







Flooded area (km^2)	**3.34**	**3.32**	**3.10**

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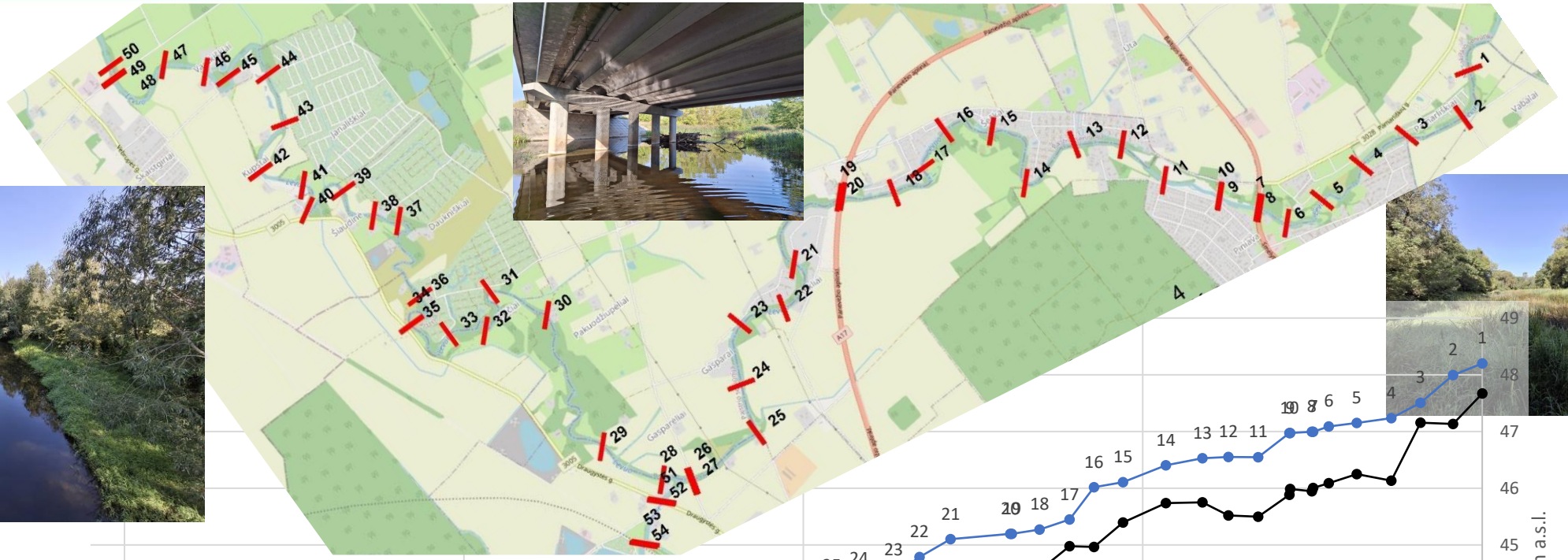
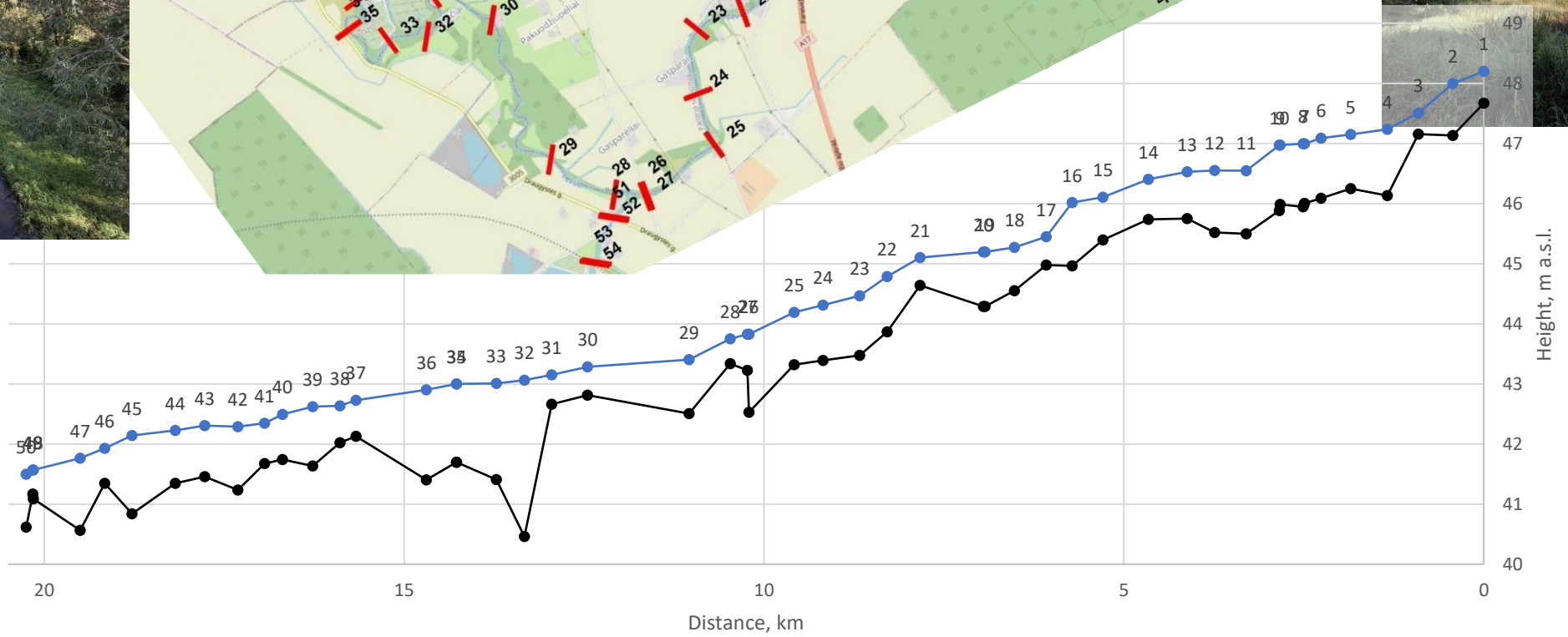
Input data: Lėvuo River





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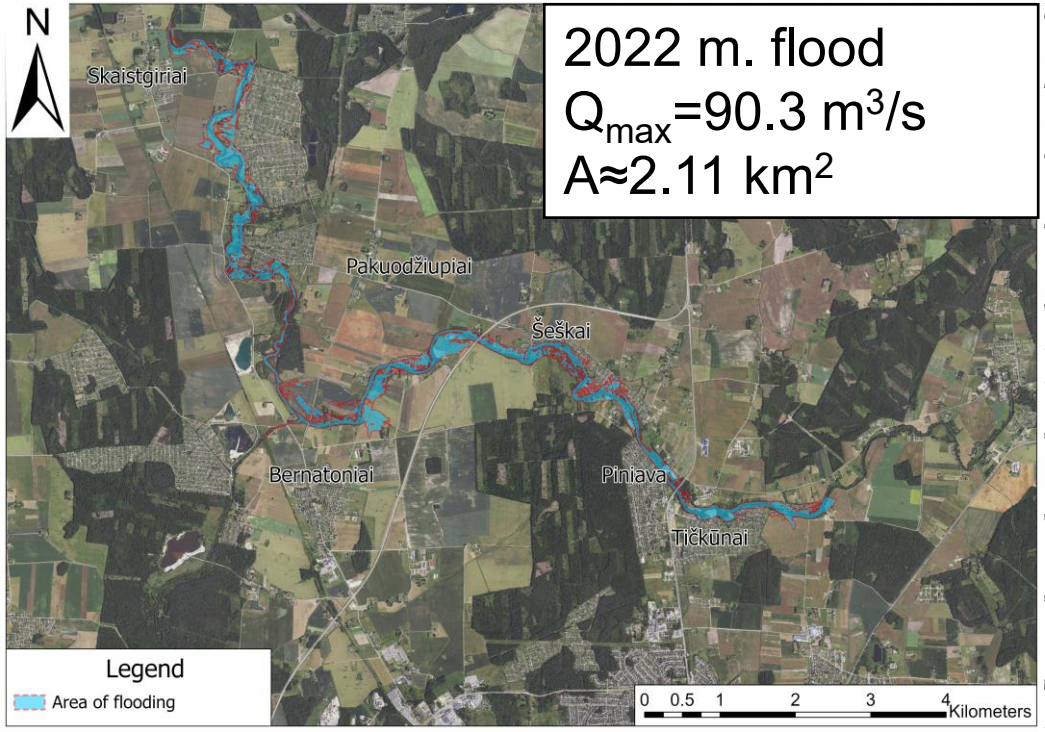
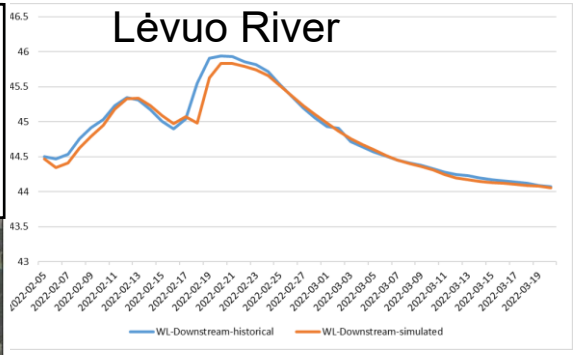
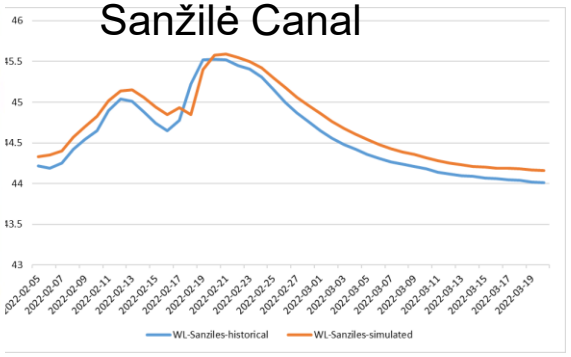
HEC-RAS model calibration: Lėvuo River

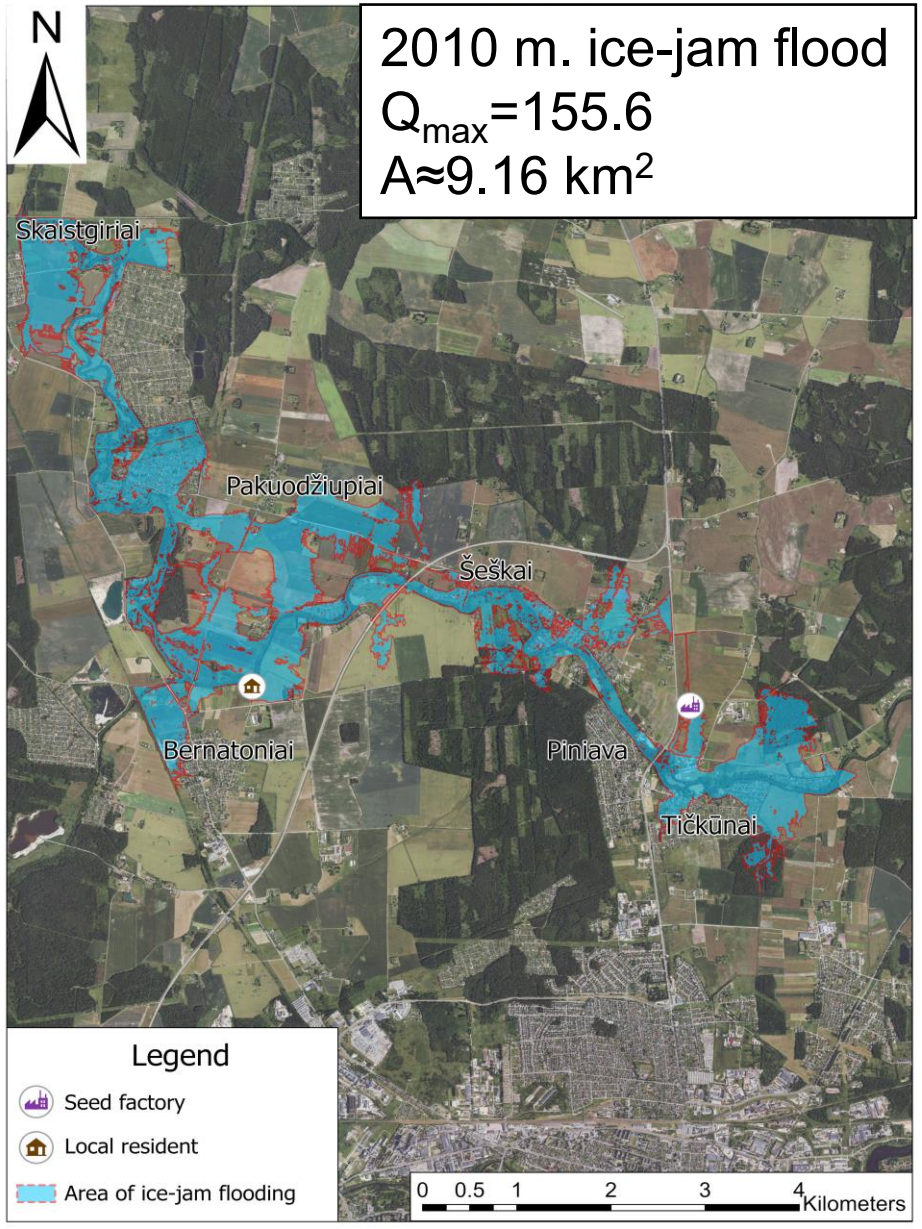


2022 m. flood
Q_{max}=90.3 m^3/s
A≈2.11 km^2





Lėvuo River		Sanžilės Canal	
Correlation	0.984	Correlation	0.982
NSE	0.961	NSE	0.887
RMSE	0.113	RMSE	0.161
RE%	-0.096	RE%	0.293



2010 m. ice-jam flood
Q_{max}=155.6
A≈9.16 km^2

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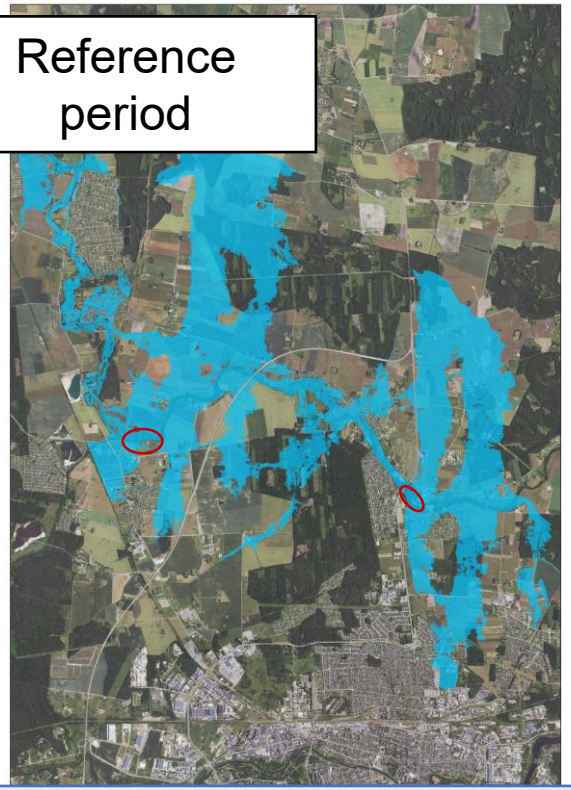
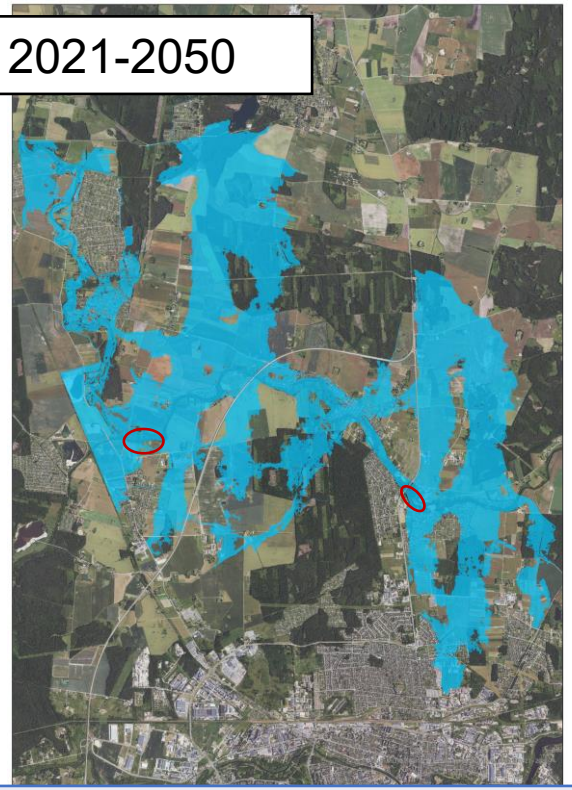
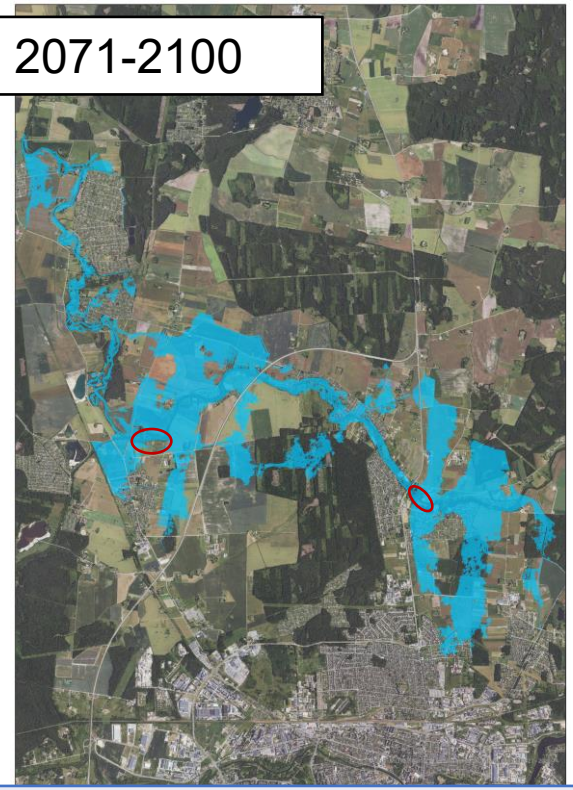
1% probability ice-jam flood in Lėvuo River: SSP245







Flooded area (km^2)	**21.80**	**25.36**	**10.96**

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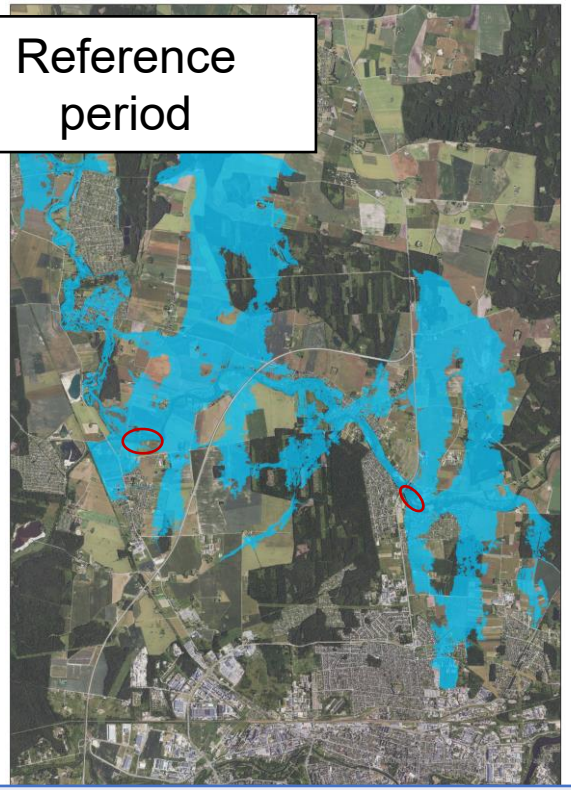
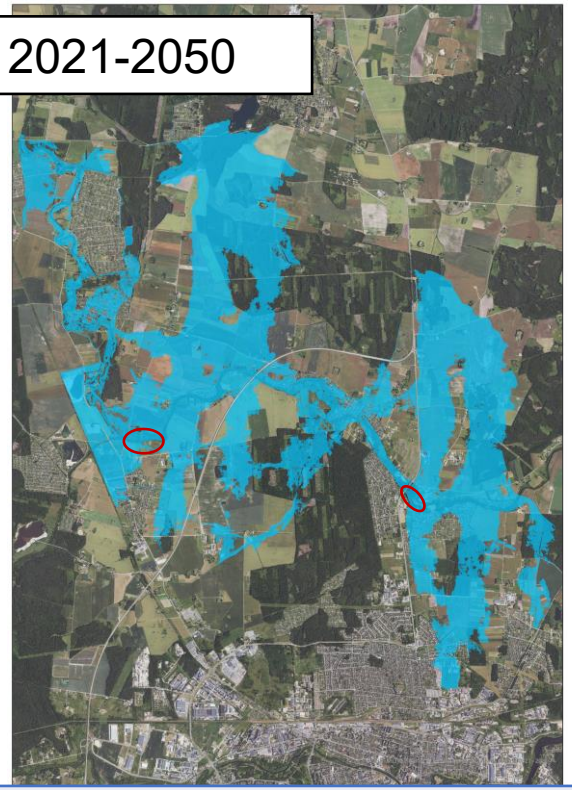
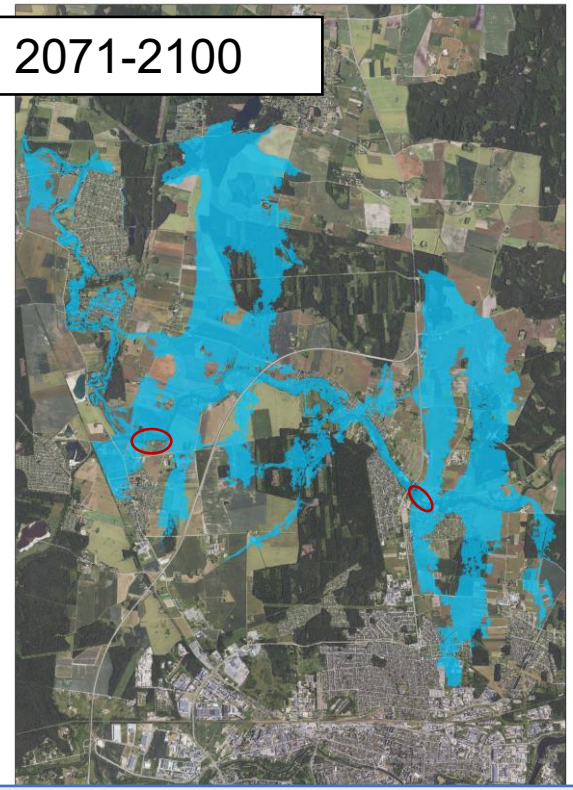
1% probability ice-jam flood in Lėvuo River: SSP370







Flooded area (km^2)	**21.80**	**23.96**	**20.13**

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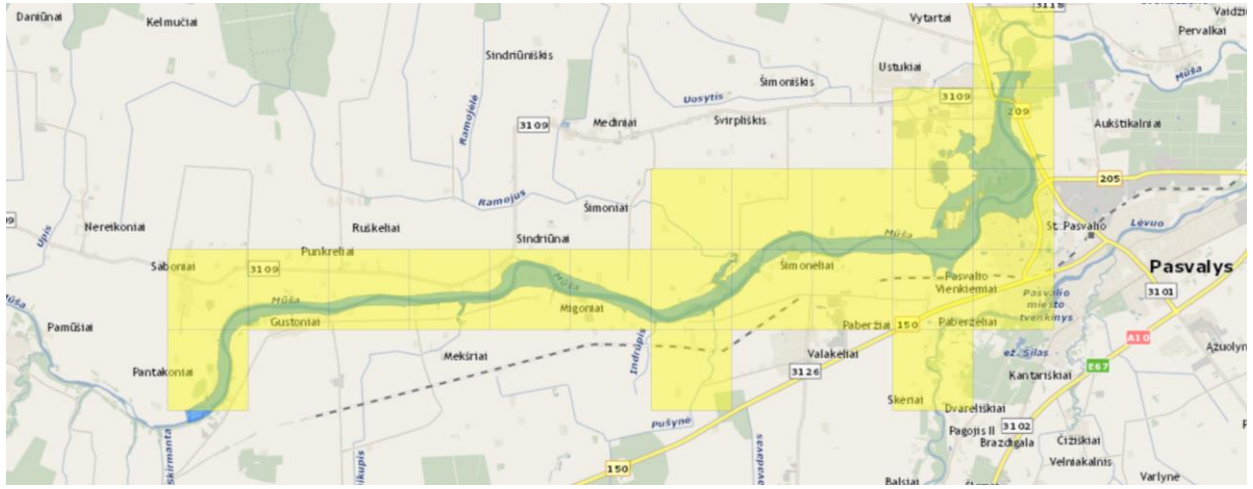
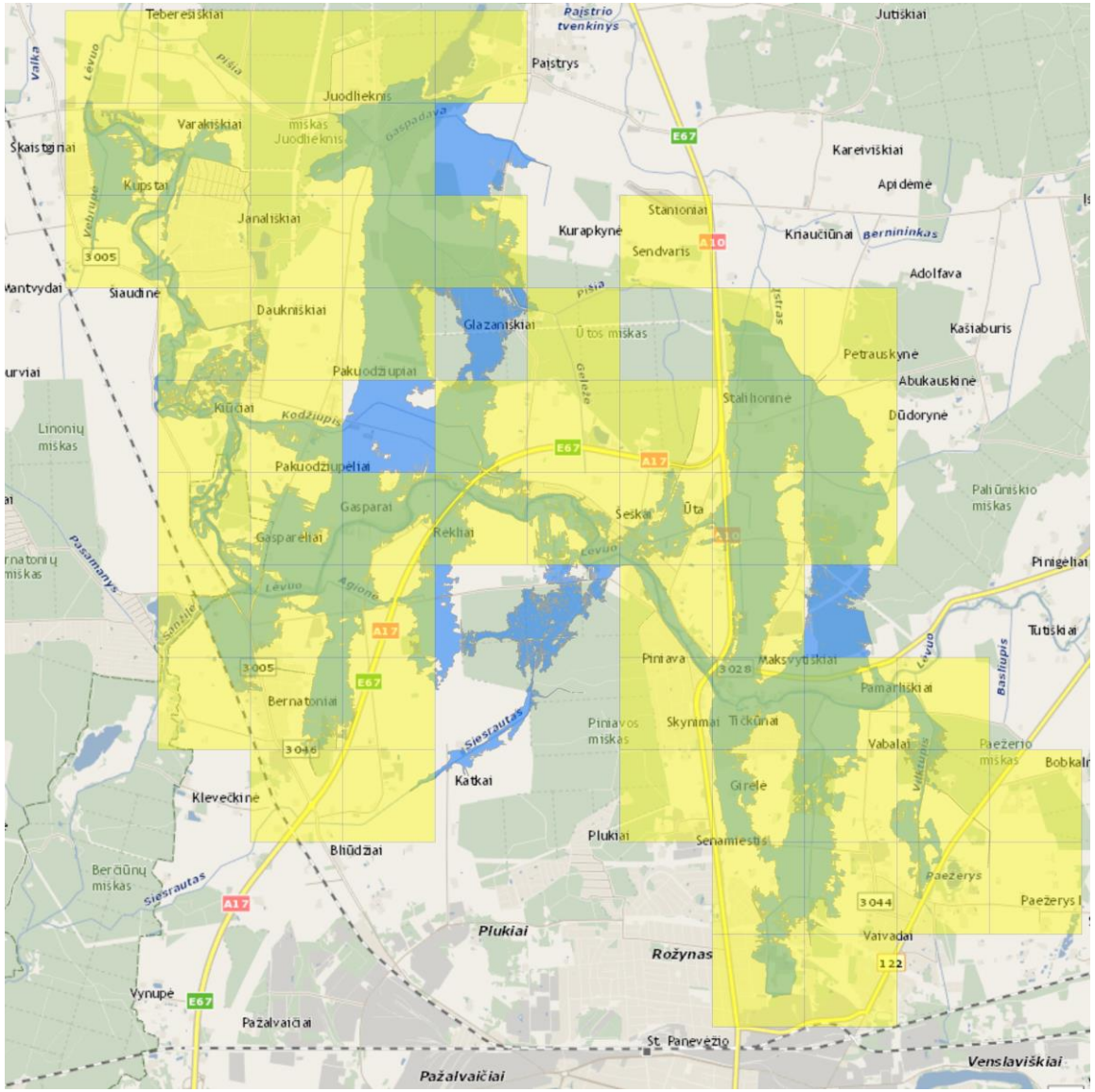
Risk to residents (I)

To assess the risk to residents, the following data was used:

- Population Census data of 2021 (1 x 1 km grid)
- Cadastral georeferential spatial dataset (GDR10LT)
- Registry Centre addresses





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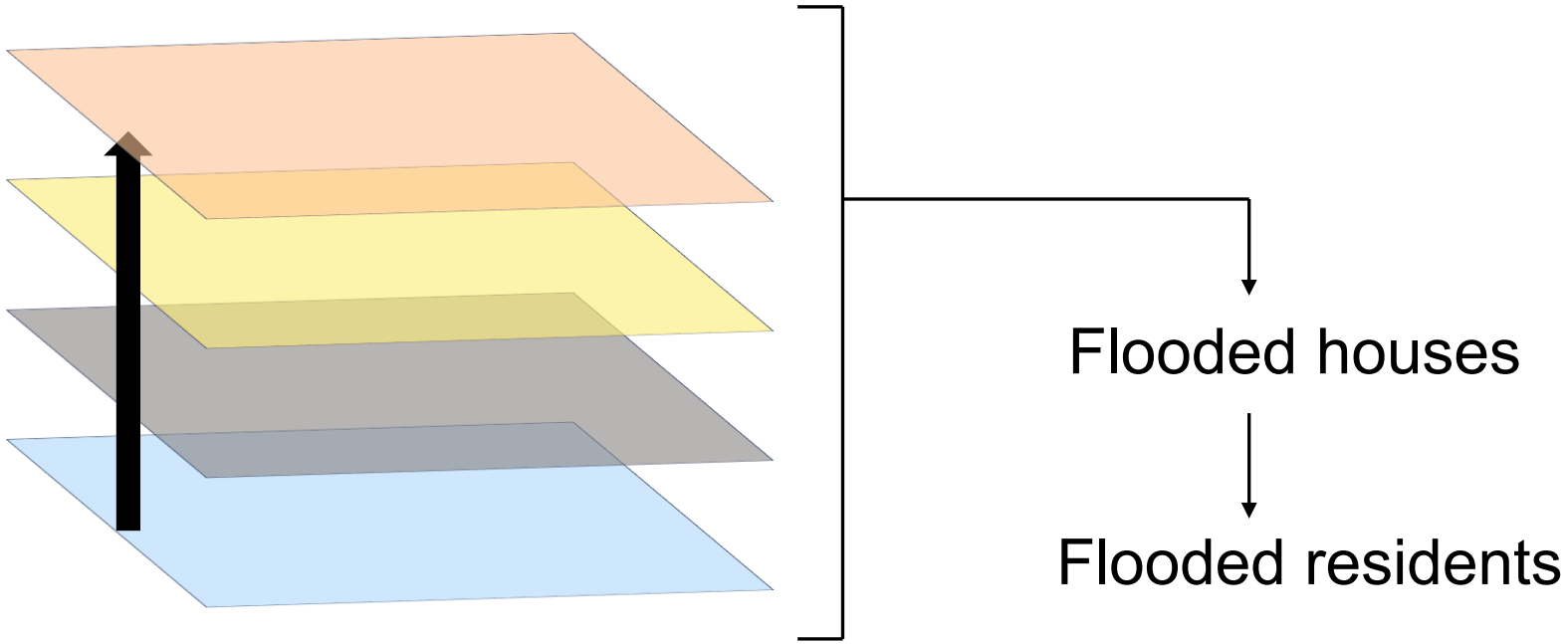
Risk to residents (II)

Residents' data

Registry addresses

Flooded buildings

Flooded area



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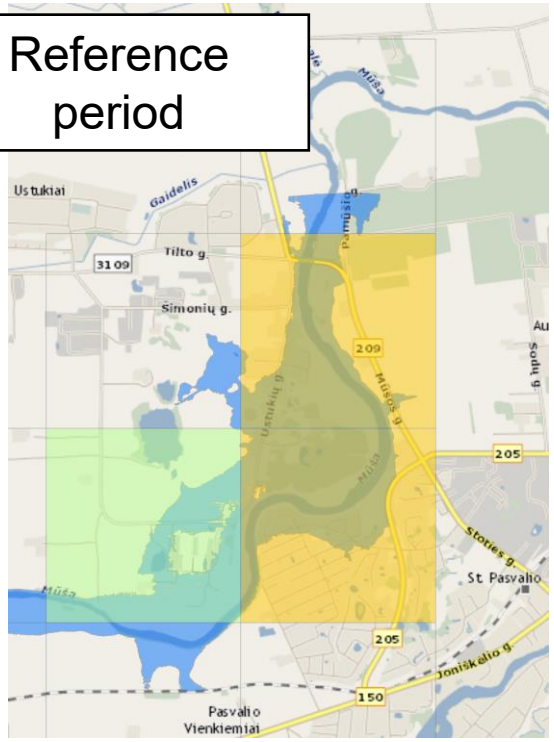
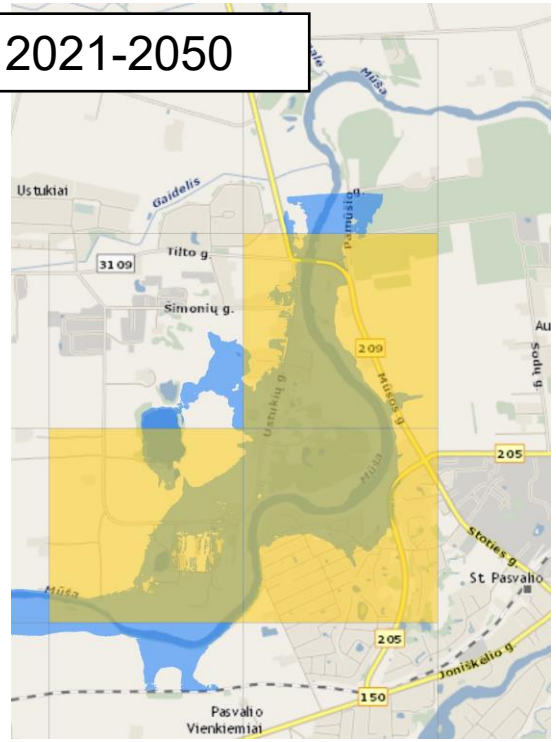
Risk to residents near Mūša River: SSP245

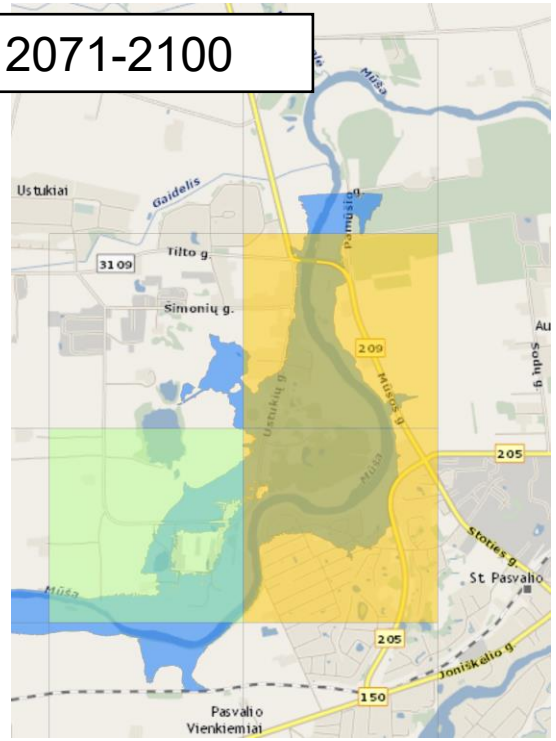
Reference period



2021-2050



2071-2100



Residents
- 0
- 1–2
- 3-10
- 11-50
- >50

Flooded area (km^2)	**3.34**	**3.61**	**3.30**
Flooded buildings	**236**	**277**	**231**
Flooded houses	**125**	**137**	**123**
Residents	**71**	**84**	**69**

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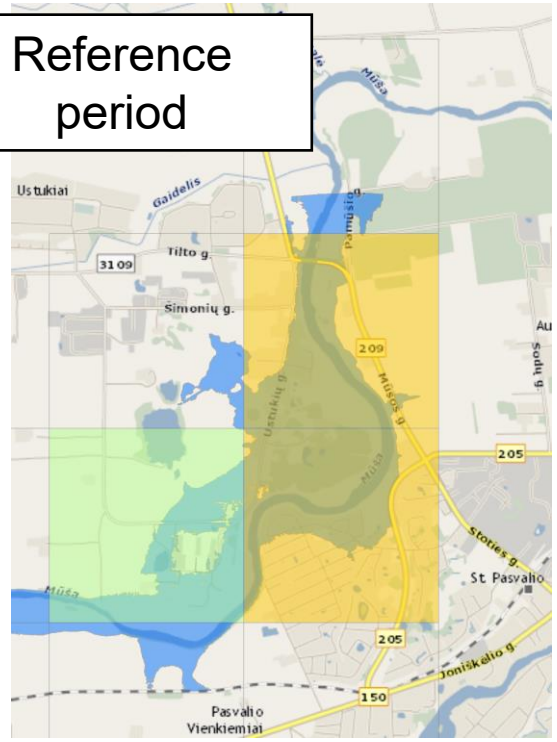
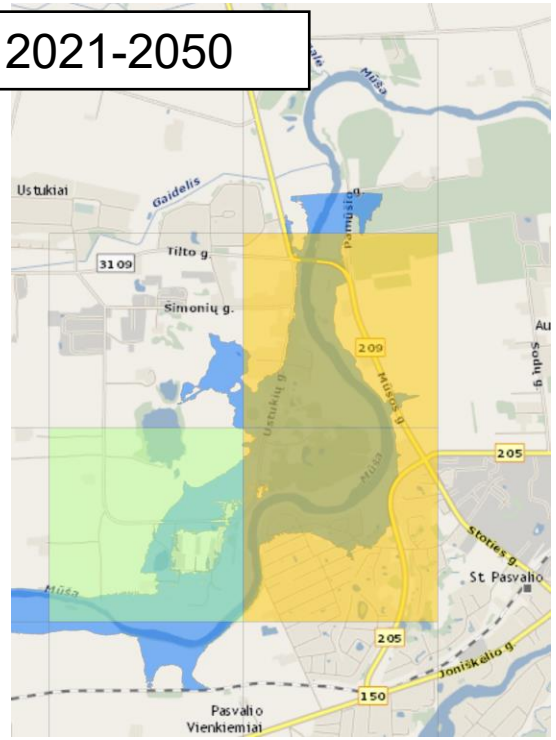
Risk to residents near Mūša River: SSP370

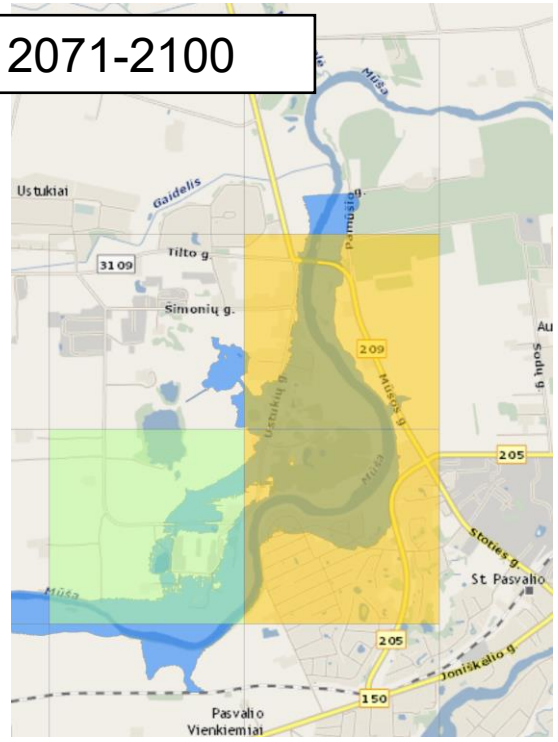
Reference period



2021-2050



2071-2100



Residents
- 0
- 1–2
- 3-10
- 11-50
- >50

Flooded area (km^2)	**3.34**	**3.32**	**3.1**
Flooded buildings	**236**	**232**	**195**
Flooded houses	**125**	**123**	**109**
Residents	**71**	**69**	**57**

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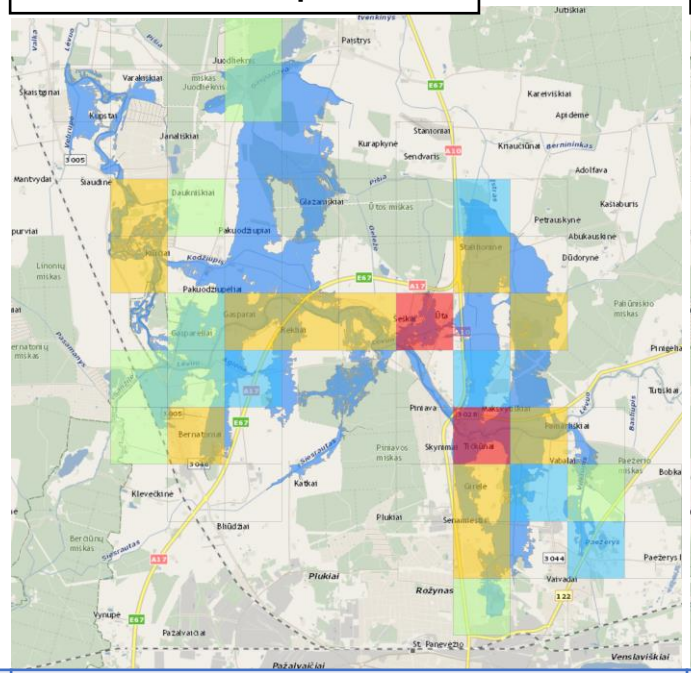
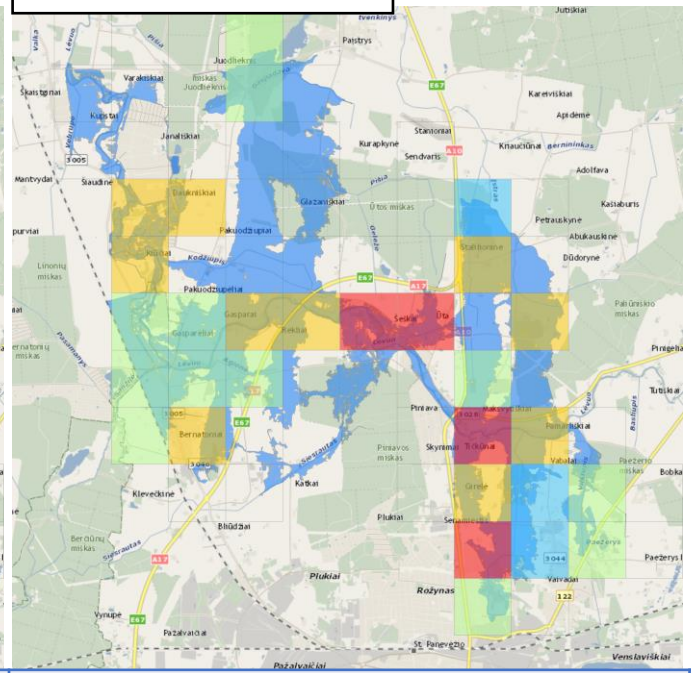
Risk to residents near Lėvuo River: SSP245

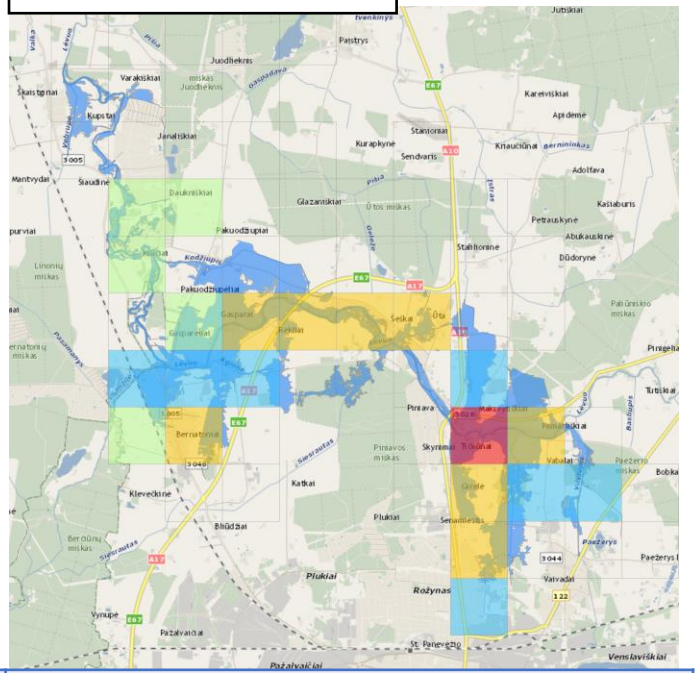
Reference period



2021-2050



2071-2100



Residents
- 0
- 1–2
- 3-10
- 11-50
- >50

	Reference period	2021-2050	2071-2100
Flooded area (km^2)	**21.80**	**25.36**	**10.96**
Flooded buildings	**2373**	**2780**	**1590**
Flooded houses	**1320**	**1582**	**913**
Residents	**547**	**670**	**376**

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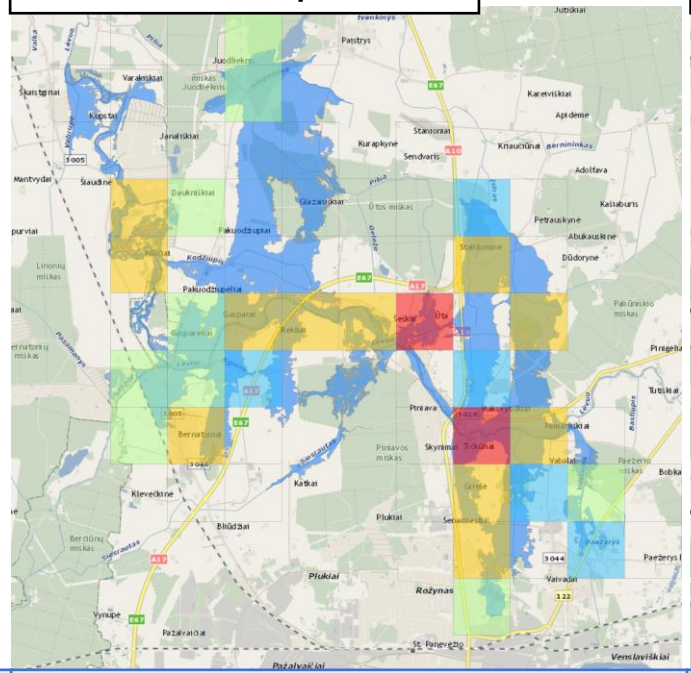
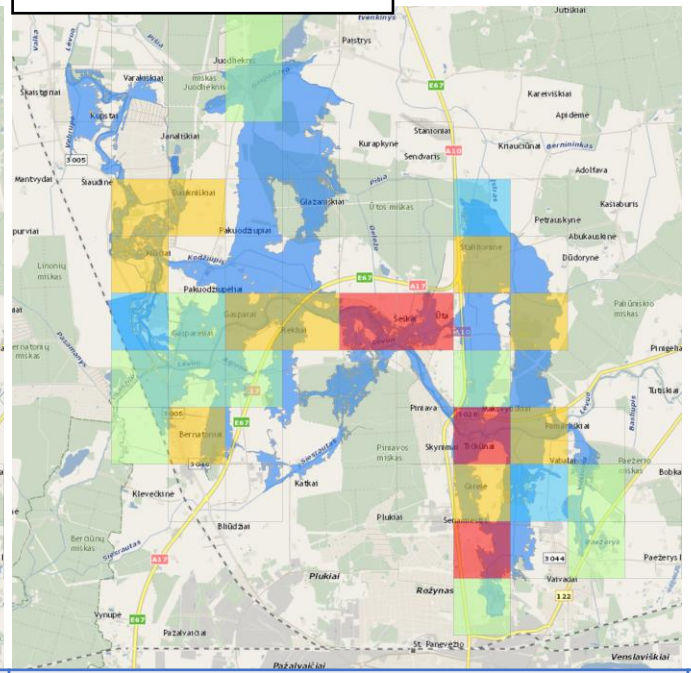
Risk to residents near Lėvuo River: SSP370

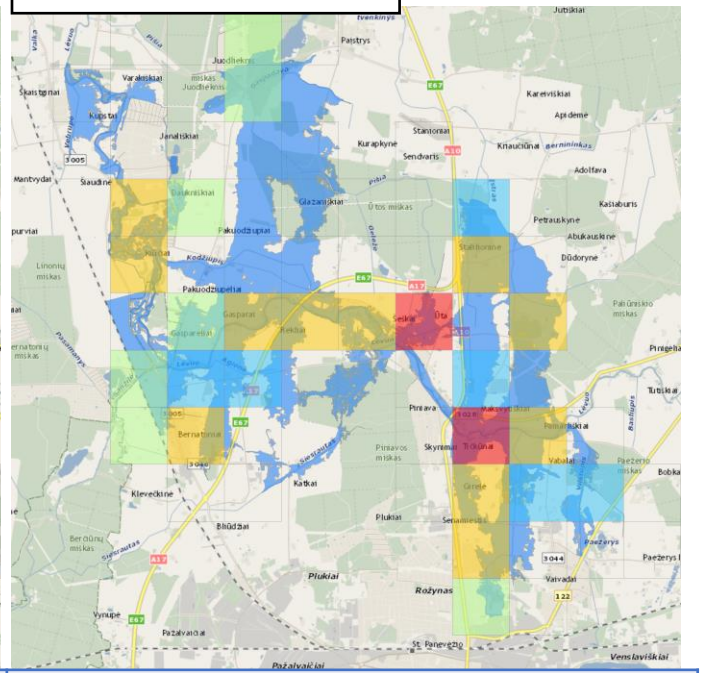
Reference period



2021-2050



2071-2100



Residents
- 0
- 1–2
- 3-10
- 11-50
- >50

	Reference period	2021-2050	2071-2100
Flooded area (km^2)	**21.80**	**23.96**	**20.13**
Flooded buildings	**2373**	**2607**	**2151**
Flooded houses	**1320**	**1457**	**1178**
Residents	**547**	**615**	**482**

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Hazard and risk maps within ICEREG project

https://www.meteo.lt/klimatas/hidrologija/ledo-sangrudu-sukeltu-potvyniu-gresmes-ir-rizikos-zemelapiai/

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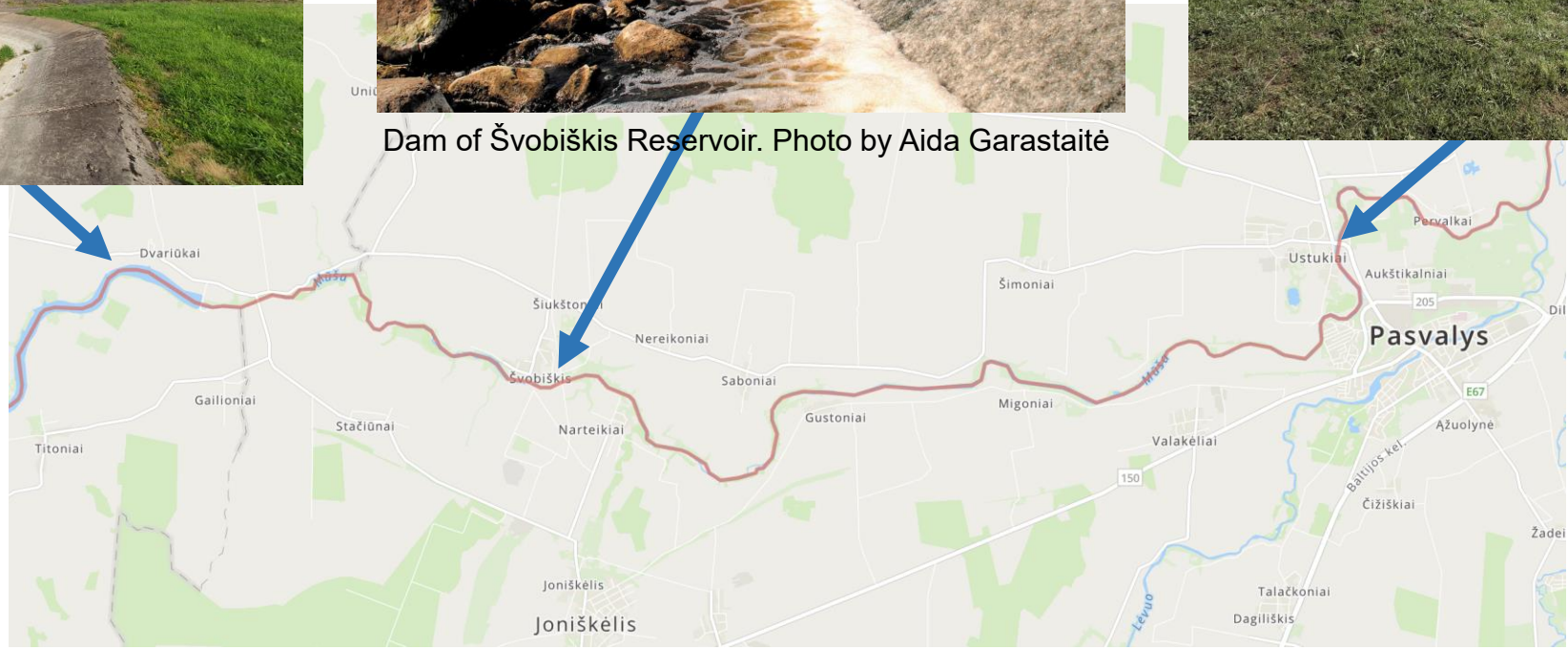
Discussion: Where is a source of origin for massive ice floes?

Dam of Švobiškis Reservoir. Photo by Aida Garastaitė

Mūša case



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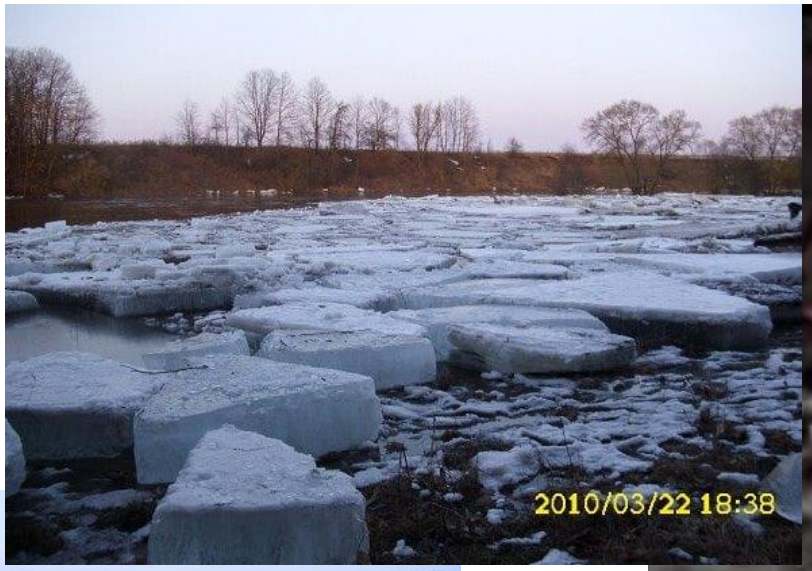
Low head dam effect



Ice drift in Mūša at Narteikiai village. Photo by Jonas Vitkauskas

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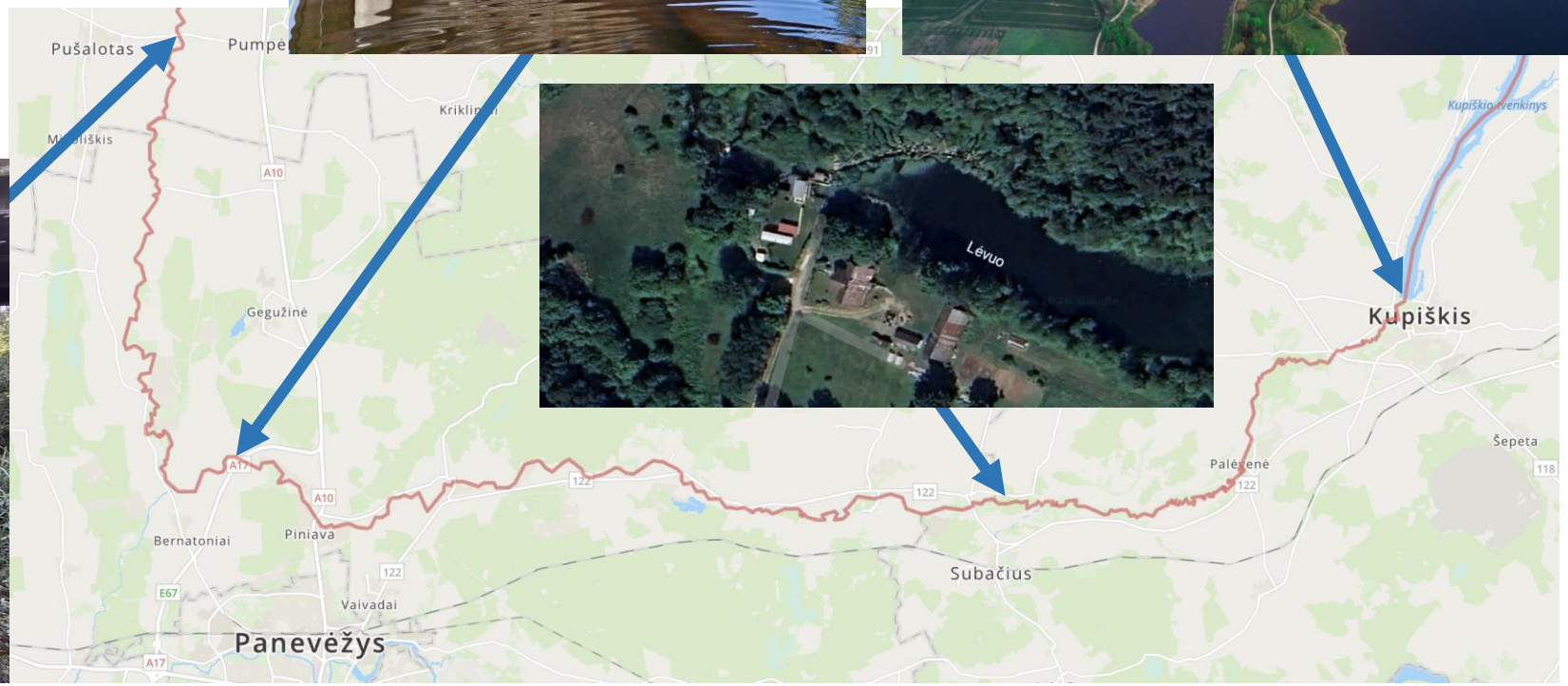
Discussion: Where is a source of origin for massive ice floes?

Lėvuo case



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Conclusions

- HEC-RAS hydrodynamic and SYKE ice-jam models-based modelling system has been adapted for the rivers of the Lithuanian lowlands. This system is intended for the modelling of ice-jam floods and flood hazard maps.

- Assessing flood inundation areas, it is necessary to take into account the causality of the flood – river discharge, ice-jam or a combination of these factors, since flood inundation zones can vary substantially depending on the reasons for their formation.

- In the near future, the areas flooded due to ice-jam floods may increase, respectively, affecting a larger part of the population living near the river. Meanwhile, in the far future, a trend of decreasing floods has been established, due to which the flooded areas may slightly decrease.

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https://www.lei.lt/darbuotojas/
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Breslaujos st. 3, Kaunas

vytautas.akstinas@lei.lt