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Hydrological data modelling in LT pilot rivers on the base of climate change scenarios

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PROJECT CONFERENCE, RIGA | 21/01/2026



This study aims to prepare rare probability of annual maximum discharge (**amaxd**) projections for the pilot rivers (Mūša and Lėvuo) according to climate scenarios.

What is the HBV Model?

Conceptual Model

The HBV model is a semi-distributed hydrological model to simulate catchment discharge.

Key Components

It represents various hydrological processes, including snowmelt, soil moisture, groundwater, and surface runoff, using simplified equations.

Advantages for Lithuania

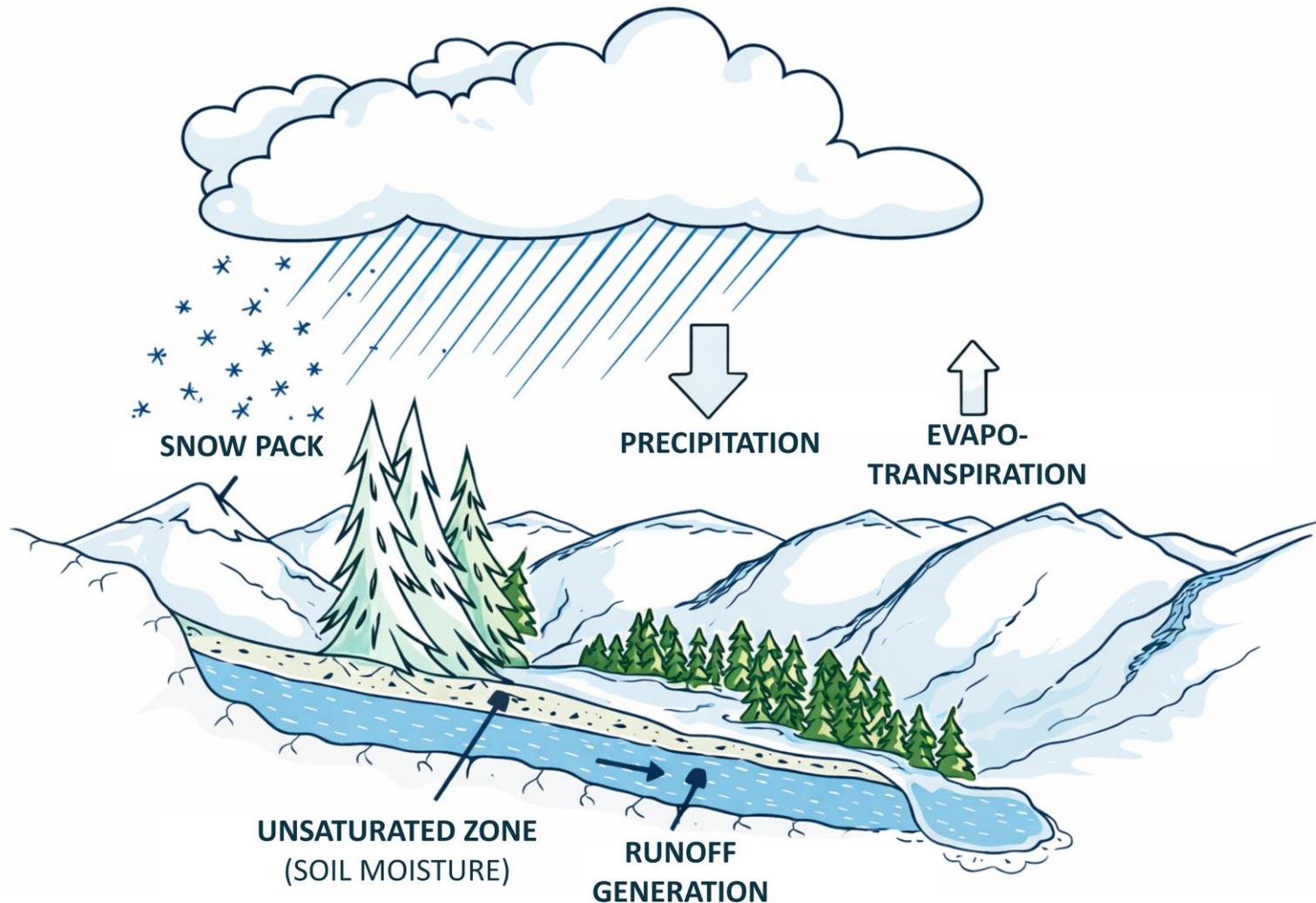
The HBV model's adaptability to different climates and simple parameterization can be suitable for Lithuanian conditions.



HBV Model Structure and Processes



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Precipitation and Snow pack

The model simulates snow accumulation and melt based on temperature and precipitation data.

Evapo-transpiration

Some precipitation evaporates and does not contribute to runoff.

Unsaturated zone

The model simulates the interaction between soil moisture and groundwater, influencing runoff generation.

Runoff Generation

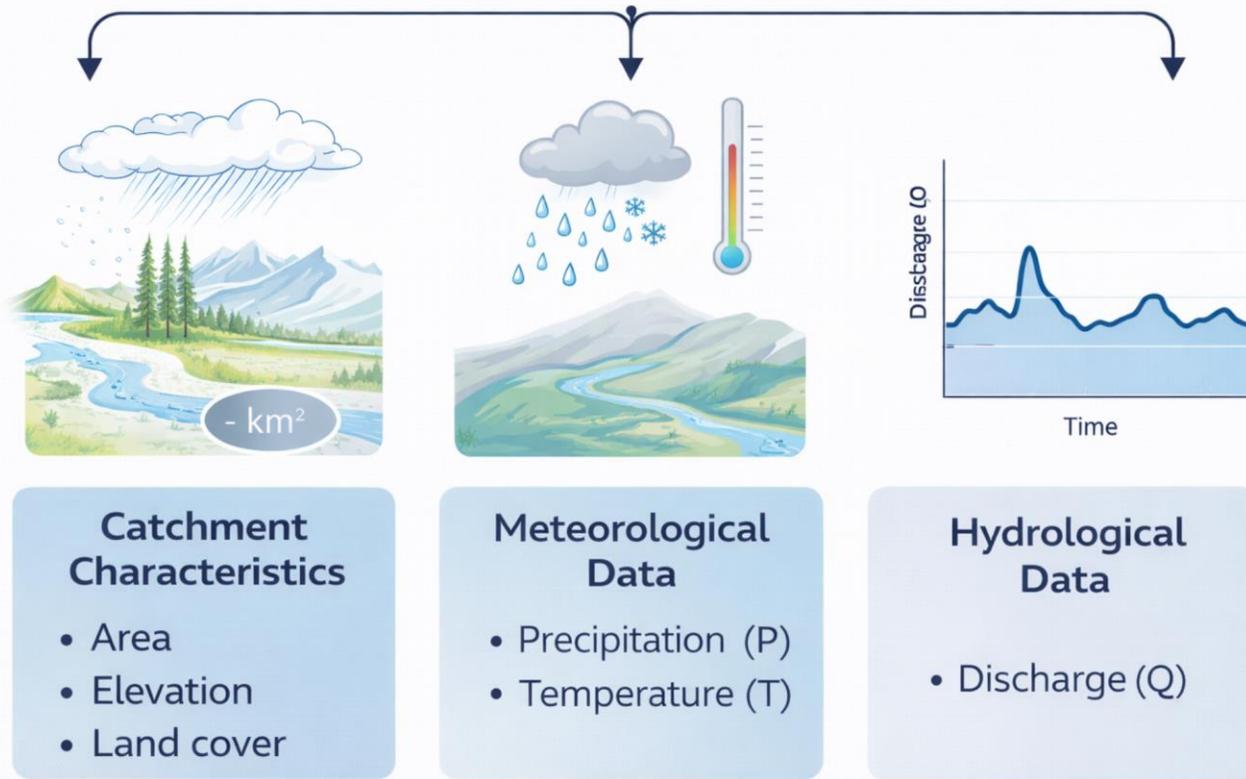
The model calculates river runoff based on the combined effects of surface runoff, interflow, and groundwater flow.

Model Input Data Requirements



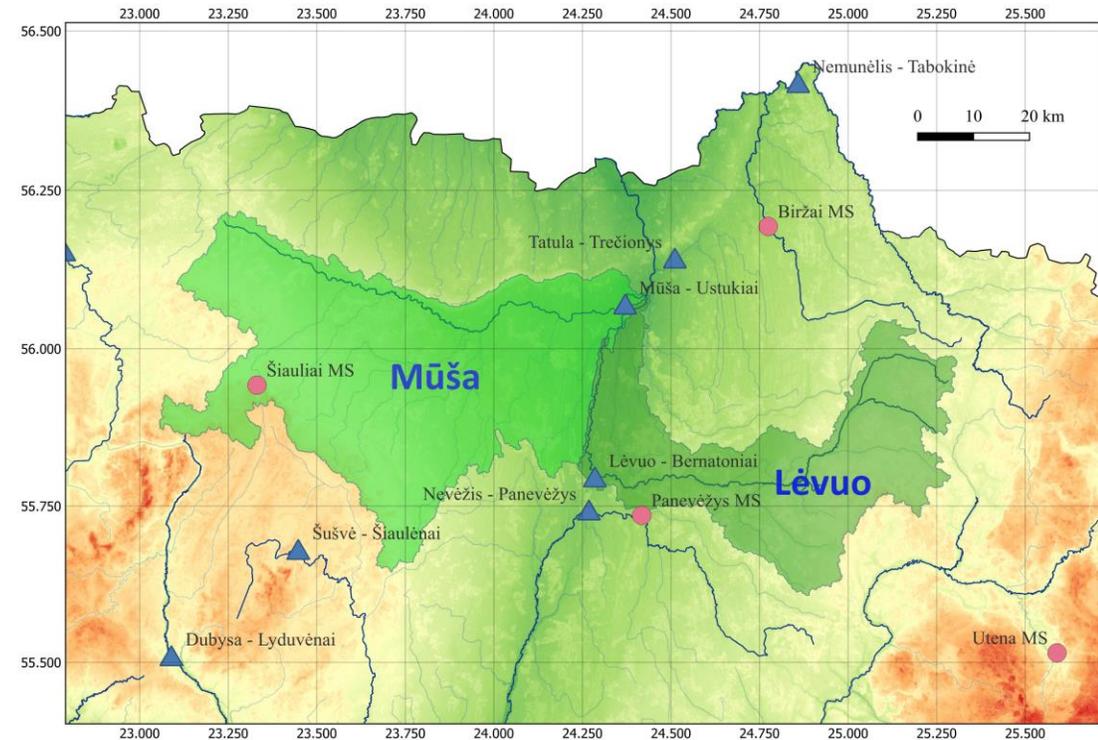
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Hydrological Model Input Data Requirements



GIS data, remote sensing

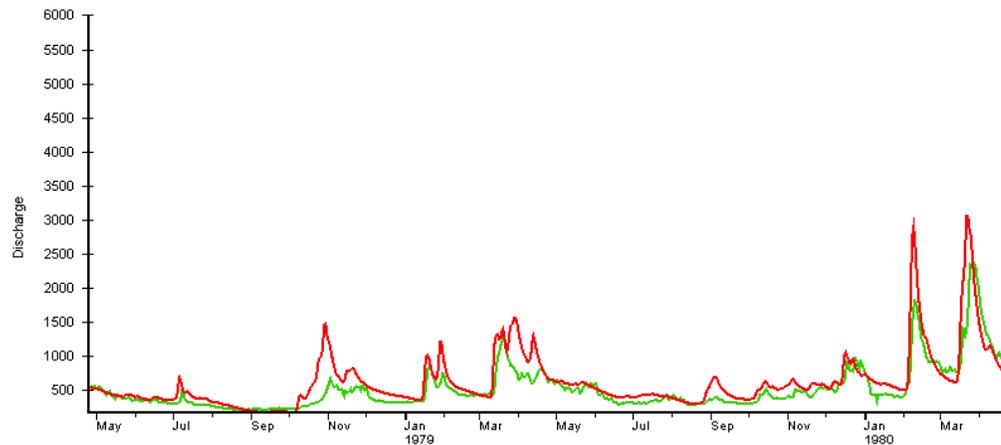
Lithuanian Hydrometeorological Service



Calibration Methods

Model parameters are adjusted manually to minimize the difference between simulated and observed river discharge.

- 1985–1999 for calibration.

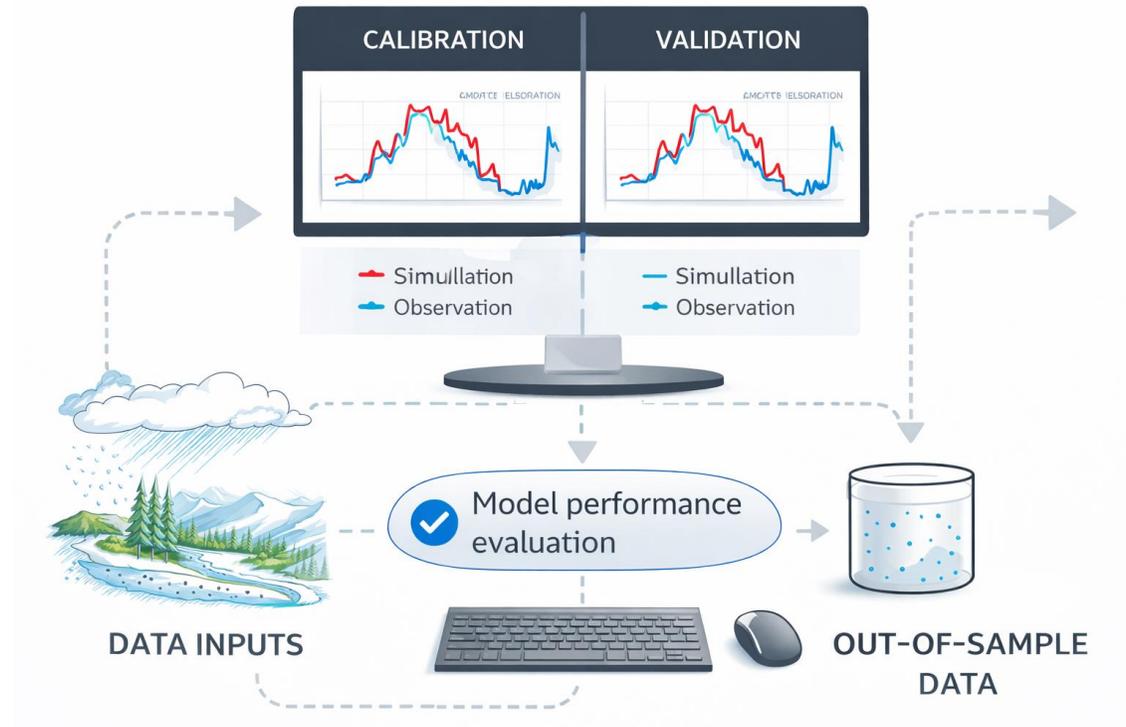


Calibration and Validation

Validation Process

The calibrated model is tested using independent data to assess its ability to predict runoff under different conditions.

- 2000–2014 for validation;
- R^2 , RE (%), and visual comparison of simulated and observed Q.



Input data



Observation

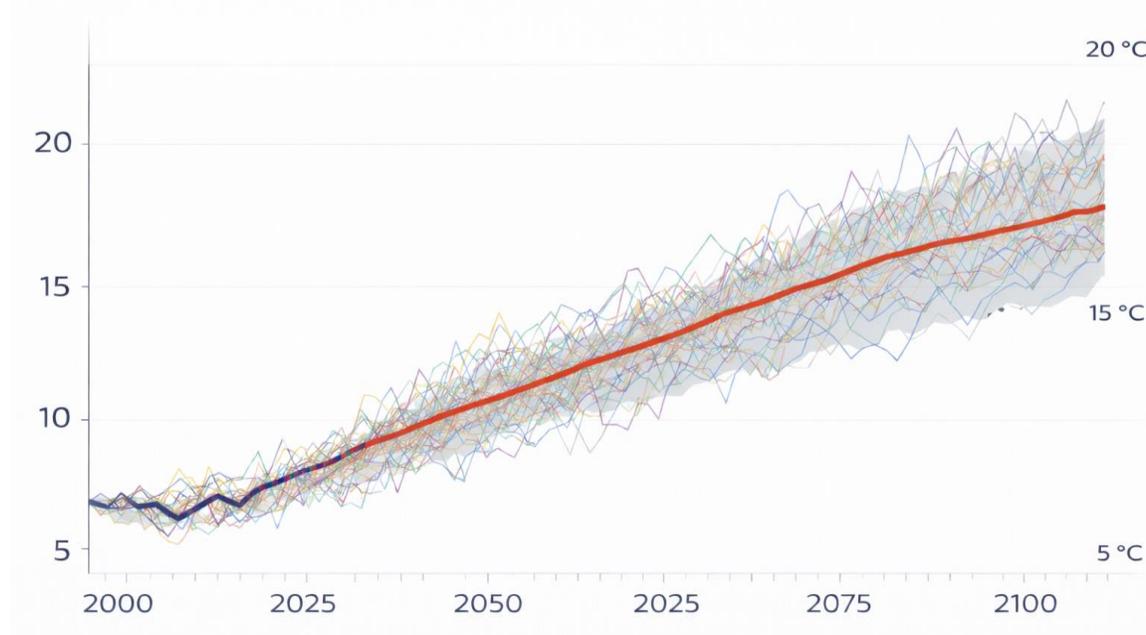
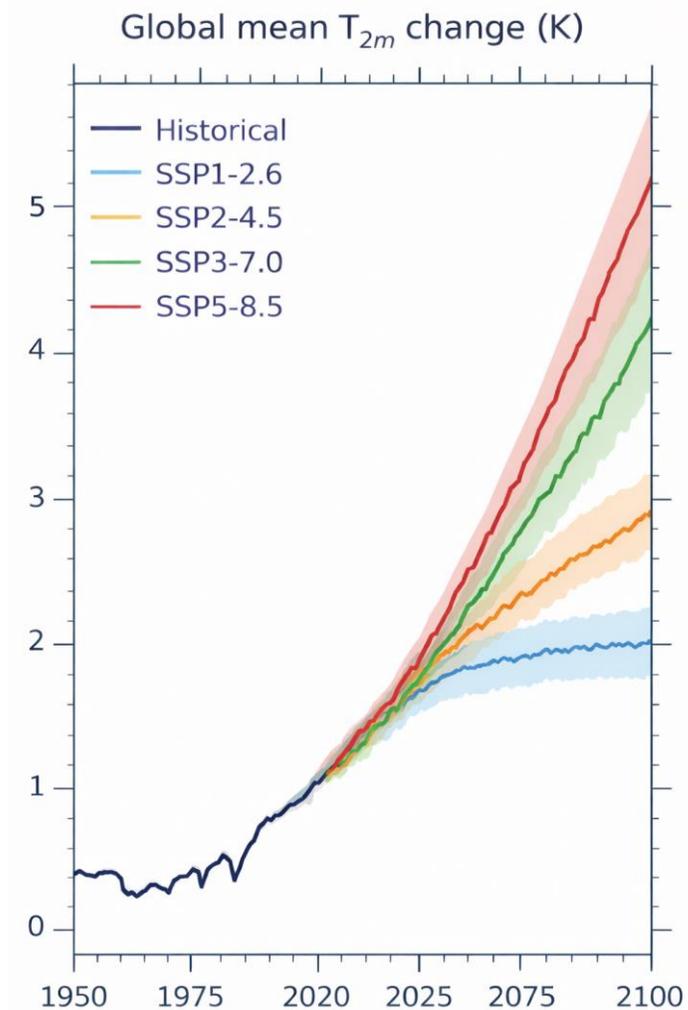
Daily discharge, air temperature and precipitation in the period of 1985–2014.

SSP-based scenarios

Realistic - SSP 245
Pessimistic - SSP 370.

Climate models

ACCESS-CM2, CNRM-CM6-1, CNRM-ESM2-1; GFDL-ESM4; IITM-ESM; INM-CM4-8; INM-CM5-0; MIROC-ES2L; MIROC6; MPI-ESM1-2-LR; MRI-ESM2-0; NorESM2-MM.



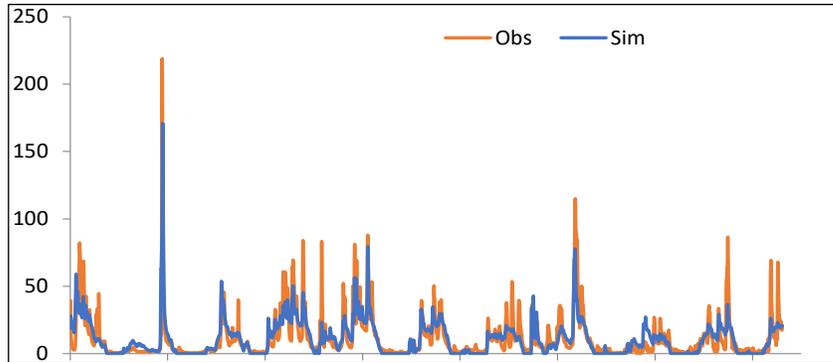
Development of hydrological models



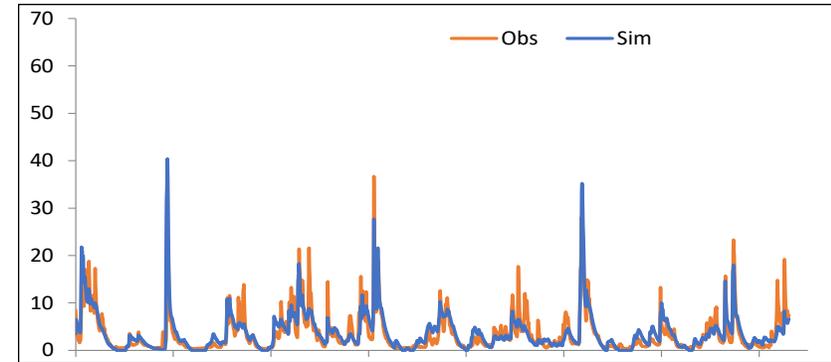
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Calibration: $R^2 = 0.82$, RE = -1.0%. Validation: $R^2 = 0.66$, RE = -9.1%.

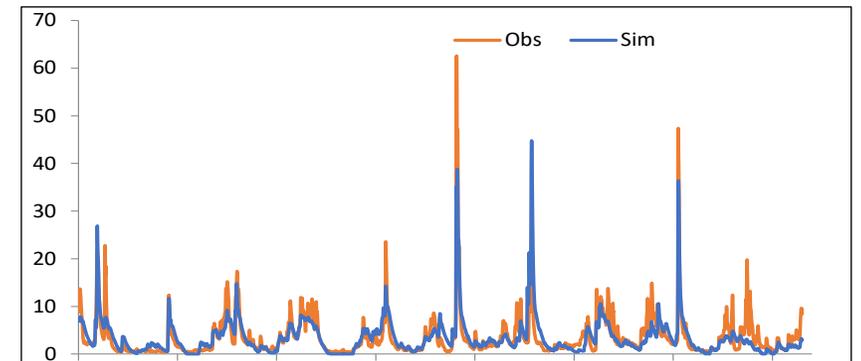
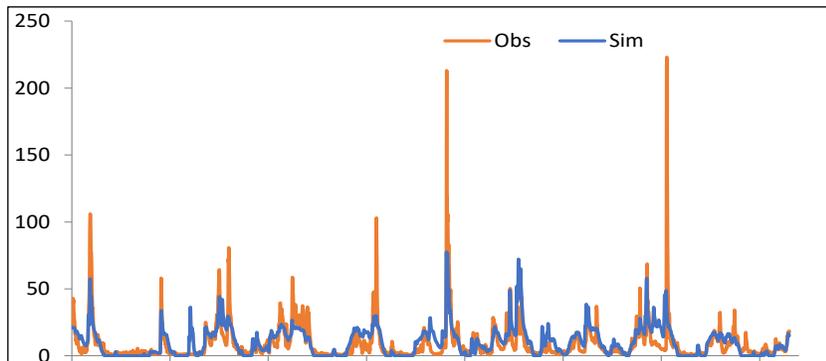
Calibration: $R^2 = 0.87$, RE = -3.2%. Validation: $R^2 = 0.77$, RE = -15.0%.



Mūša River



Lėvuo River

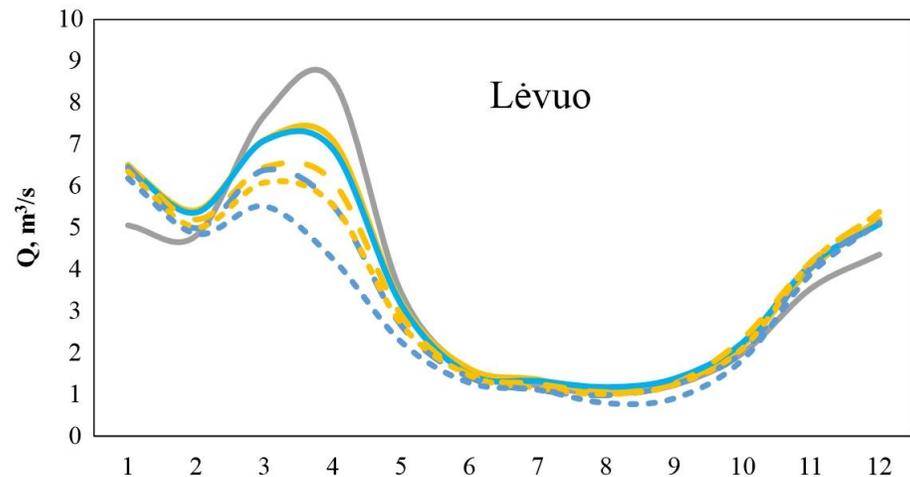
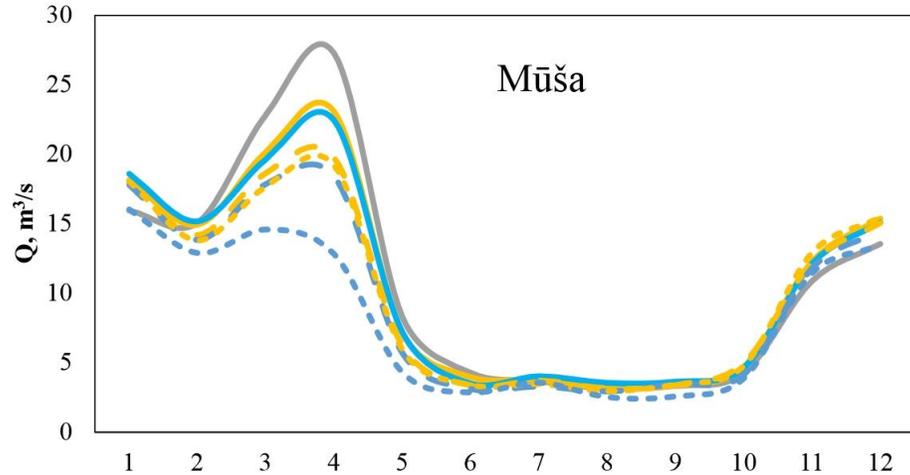


Projections of Mūša and Lėvuo Discharge according to SSP scenarios



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— Reference period — 2021-2050-SSP245 — 2021-2050-SSP370 - - 2041-2070-SSP245
 - - 2041-2070-SSP370 - - 2071-2100-SSP245 - - 2071-2100-SSP370



Projected Runoff Changes

The average annual discharge of the Mūša River will decrease:

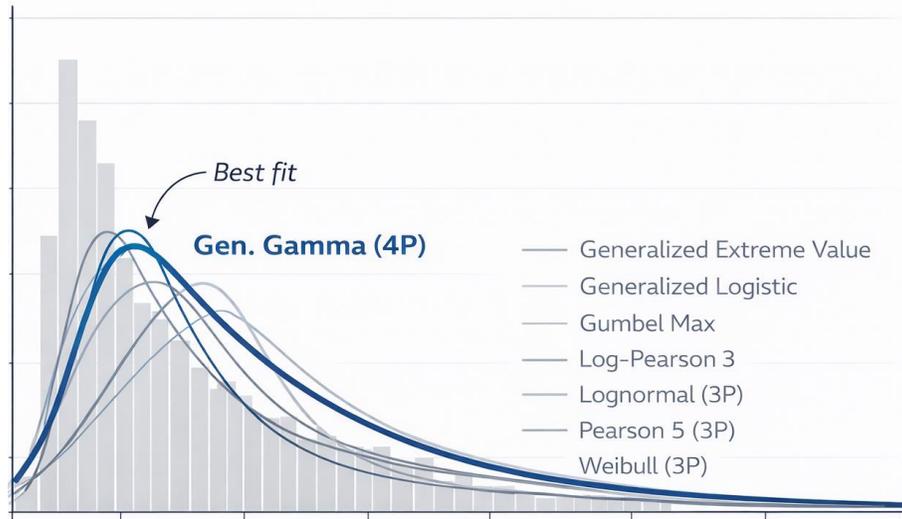
- by 2% in the near future,
- up to 12% in the mid future,
- up to 24% in the far future.

Slightly different changes have been identified in the Lėvuo catchment:

- In the near future Q will increase by 3%,
- In the mid and far future, it will decrease up to 6% and 15%, respectively.

Projections of the amaxd according to climate models

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- Historical discharge observations data (from 1958);
- The best-fitting distribution was selected from the 8 most commonly used distributions;
- It was determined that the amaxd of the Mūša and Lėvuo rivers was distributed according to the Gen. Gamma (4P) distribution.

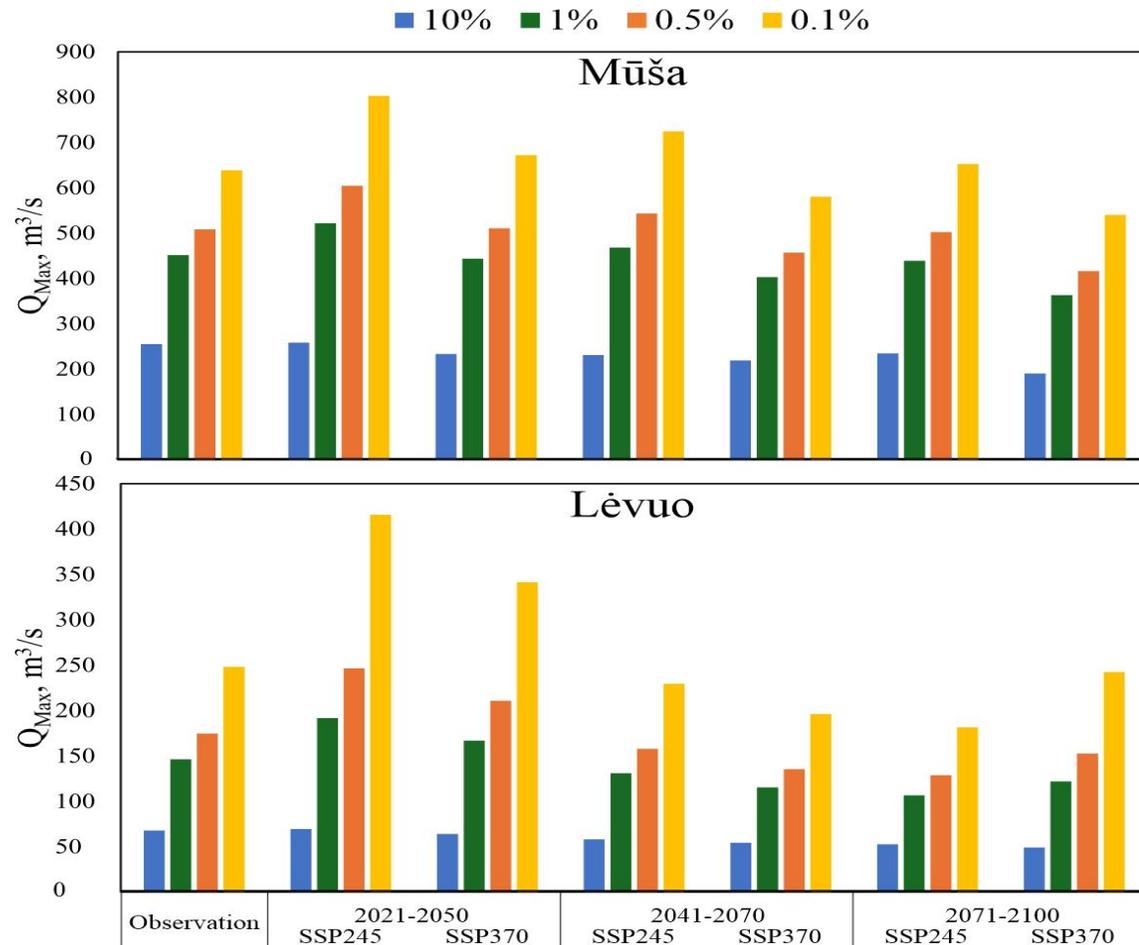
Distribution	Rank				Sum
	Lėvuo River		Mūša River		
	Kolmogorov-Smirnov	Anderson-Darling	Kolmogorov-Smirnov	Anderson-Darling	
Gen. Extreme Value	3	5	6	6	20
Gen. Gamma (4P)	1	1	2	1	5
Gen. Logistic	5	6	7	7	25
Gumbel Max	8	7	8	8	31
Log-Pearson 3	2	3	4	3	12
Lognormal (3P)	4	2	3	4	13
Pearson 5 (3P)	6	4	5	5	20
Weibull (3P)	7	8	1	2	18

Tendencies of amaxd



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Changes of 0.1% probability of amaxd.



Increase in the near future

Mūša River: from 5% (SSP370) to 26% (SSP245).

Lėvuo River: from 38% (SSP370) to 68% (SSP245).

Increase or decrease in the mid-future

Mūša River: from -9% (SSP370) to +13% (SSP245).

Lėvuo River: from -8% (SSP245) to -21% (SSP370).

Increase or decrease in the far-future

Mūša River: from +2% (SSP245) to -15% (SSP370).

Lėvuo River: from -2% (SSP370) to -27% (SSP245).

Return period

10% – 1 time per 10 yr; 1% – 1 time per 100 yr,

0.5% – 1 time per 200 yr; 0.1% – 1 timer per 1000 yr.

Uncertainties

1 Hydrological model (HBV)

Model development, calibration, validation, input data and etc.

2 Climate models

Apply an ensemble or select several „representative“ models. SSP scenarios. Climate models data downscaling methods. Etc.

3 Distributions

Is there enough data to select a distribution? Does the selected distribution correspond to the real observation?

Conclusion

- ✓ It is projected that in the future, the average annual discharge of the Mūša and Lėvuo Rivers will decrease up to 24% compared to the reference period;
- ✓ It was determined that the amaxd of the Mūša and Lėvuo rivers was distributed according to the Gen. Gamma (4P) distribution;
- ✓ Major positive changes in amaxd (0.1%) are expected in the near future.

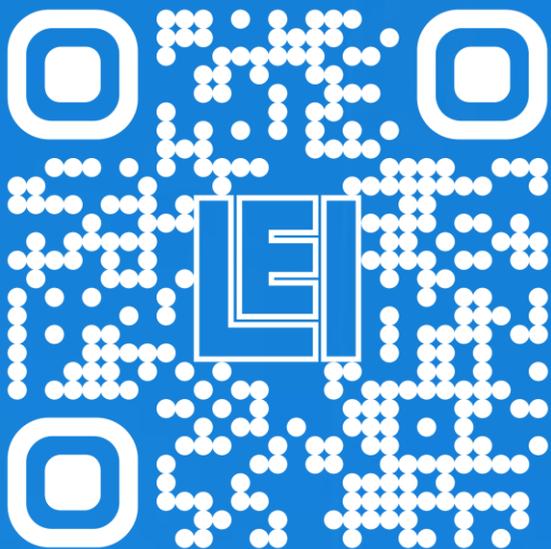




Questions ?!?



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