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Hydrological data modelling in LT pilot rivers on the base of climate change scenarios – results and uncertainties

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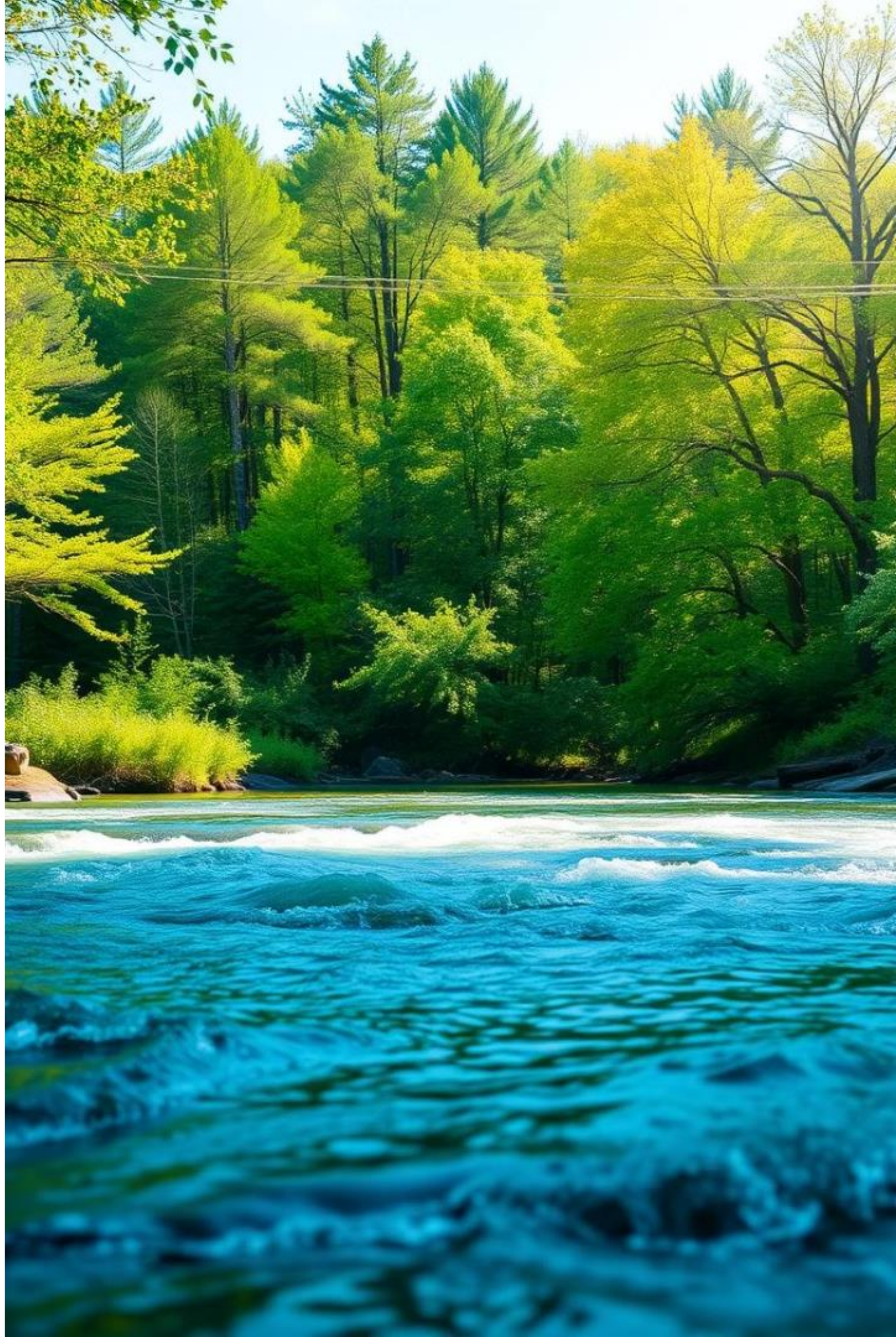

This study **aims** to prepare rare probability of annual maximum discharge (**amaxd**) projections for the Mūša and Lėvuo rivers according to climate scenarios.

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What is the HBV Model?

Conceptual Model

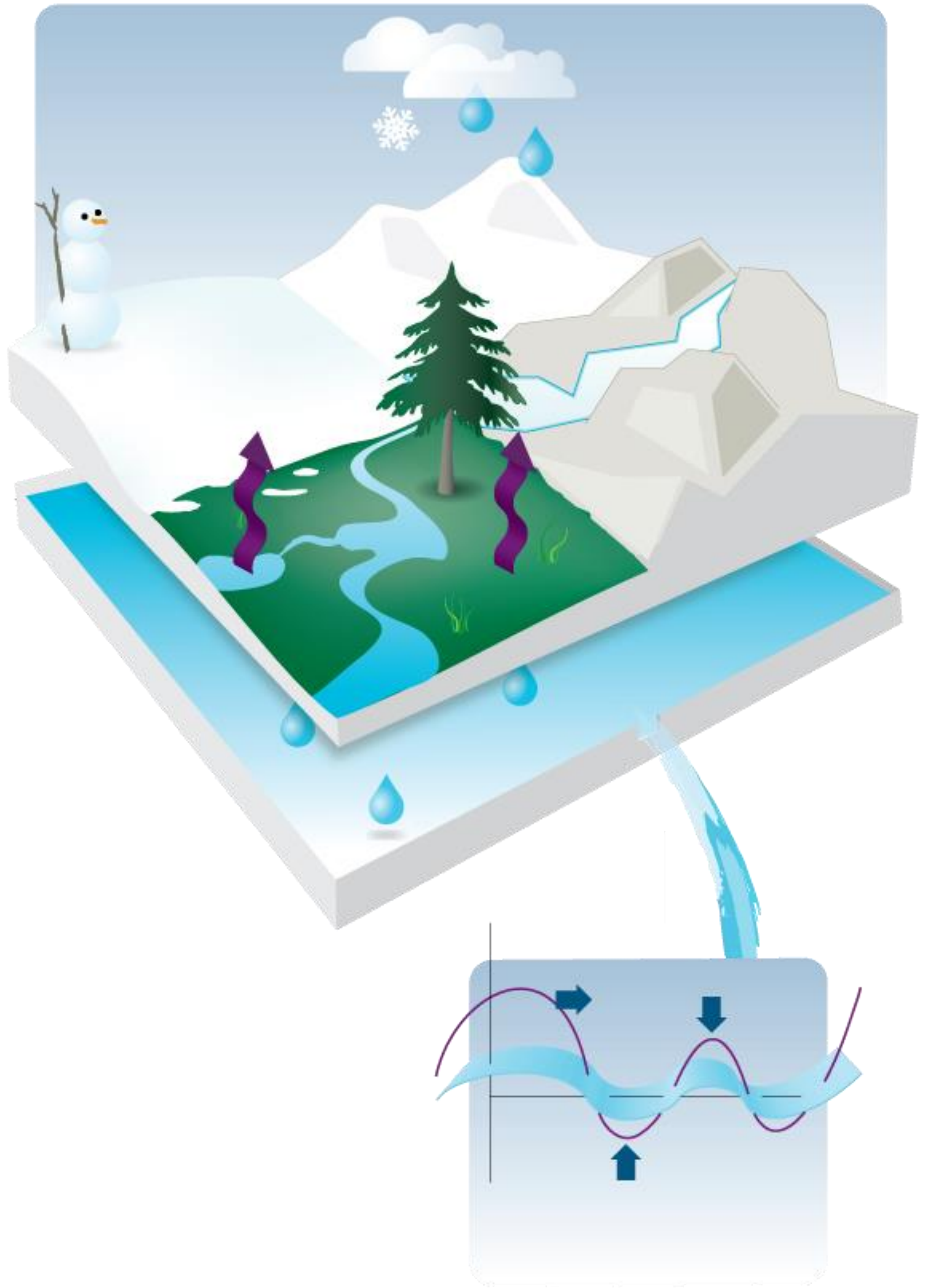
The HBV model is a semi-distributed hydrological model to simulate catchment discharge.

Key Components

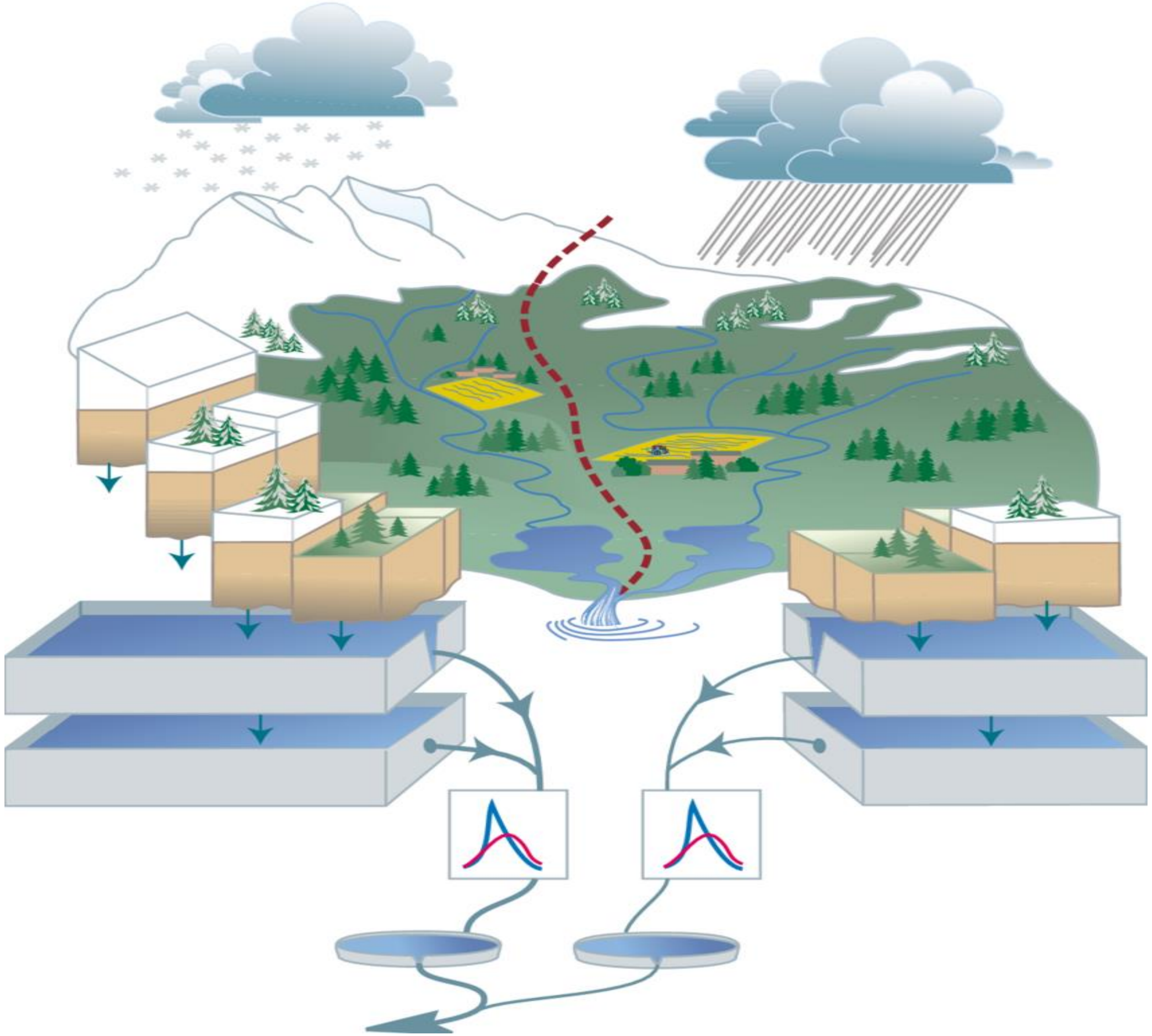
It represents various hydrological processes, including snowmelt, soil moisture, groundwater, and surface runoff, using simplified equations.

Advantages for Lithuania

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



HBV Model Structure and Processes



Rain and Snow

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

Evaporation

Some precipitation evaporates and does not contribute to runoff.

Groundwater Response

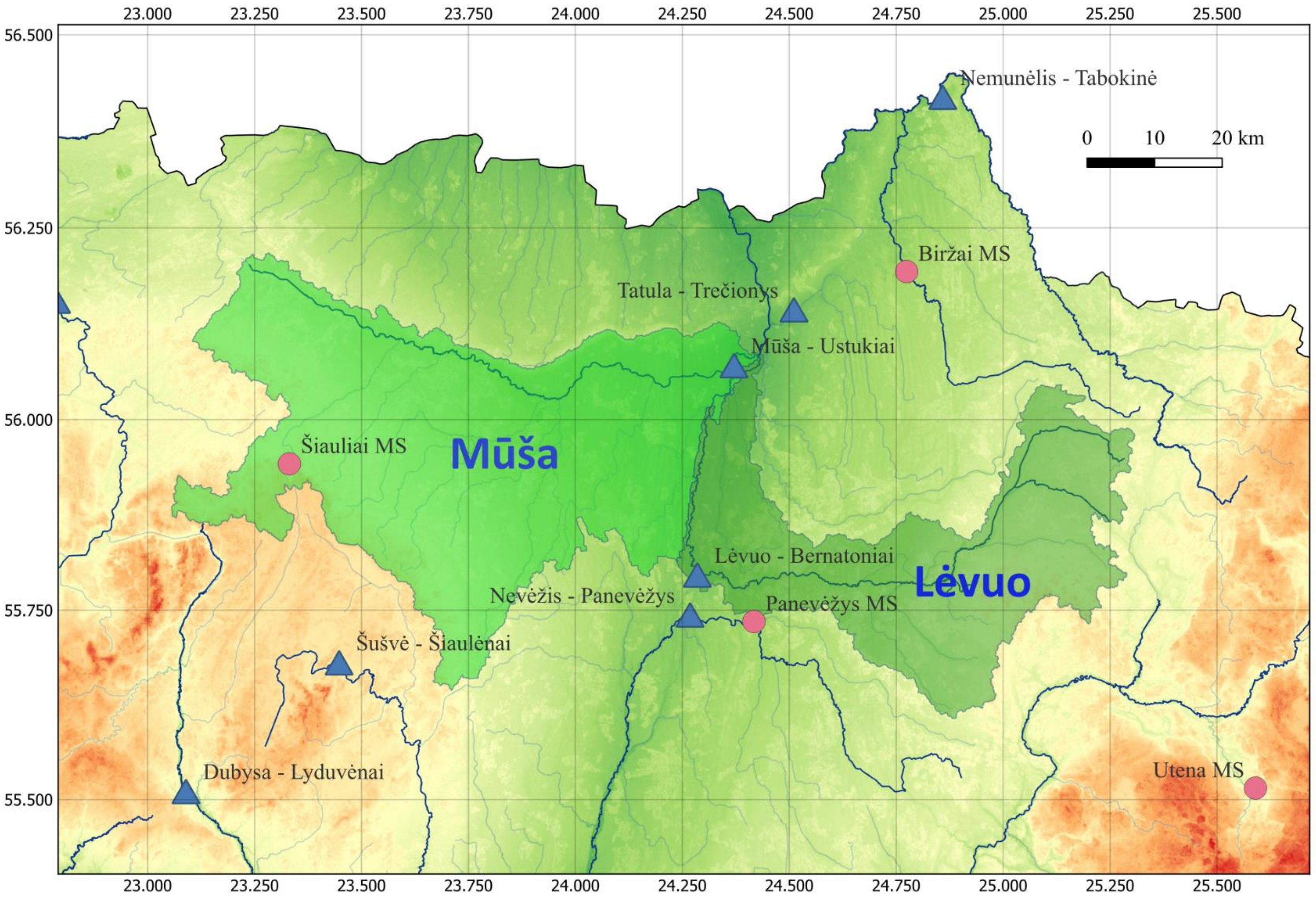
The model simulates the interaction between soil moisture and groundwater, influencing runoff generation.

Runoff Generation

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

Model Input Data Requirements

Data Type	Description	Source
Catchment Characteristics	Area, elevation, land cover	GIS data, remote sensing
Meteorological Data	Precipitation (P) and Temperature (T)	Lithuanian Hydrometeorological Service
Hydrological Data	Discharge, Q	Lithuanian Hydrometeorological Service

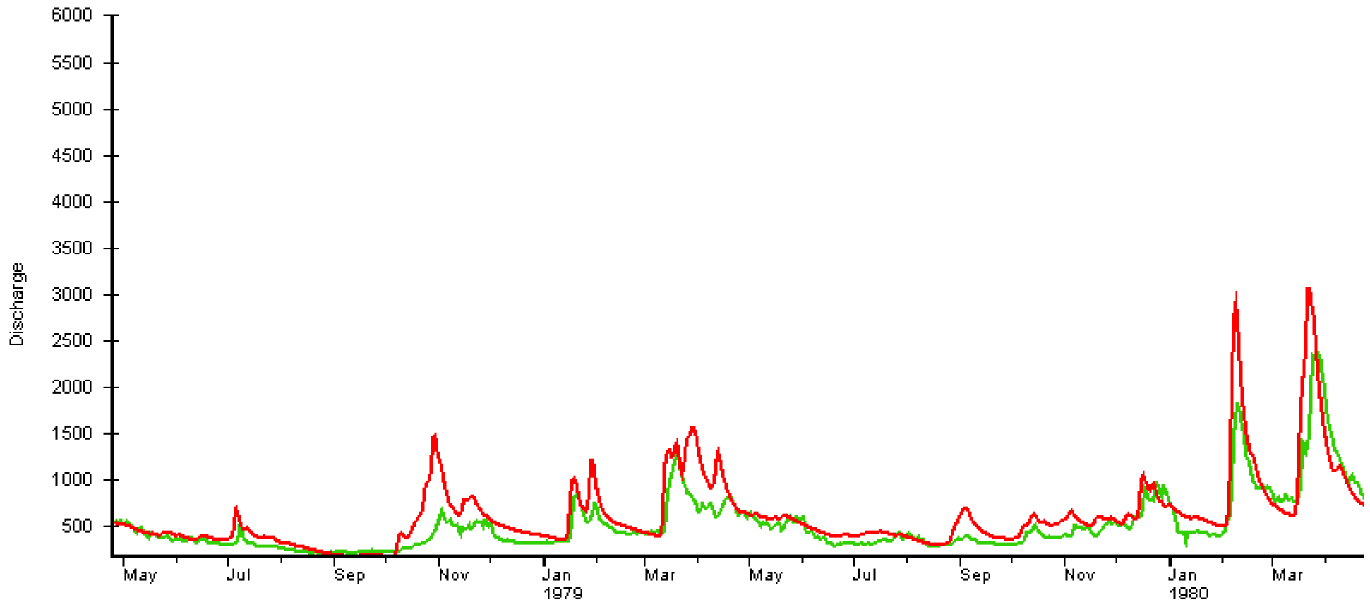


Calibration and Validation

Calibration Methods

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

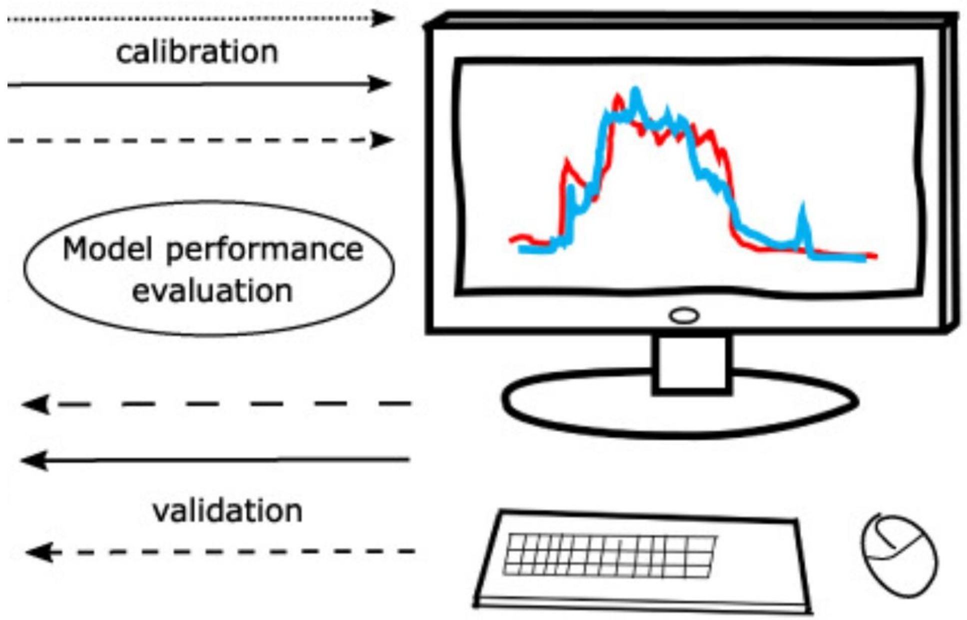
- 1985–1999 for calibration.



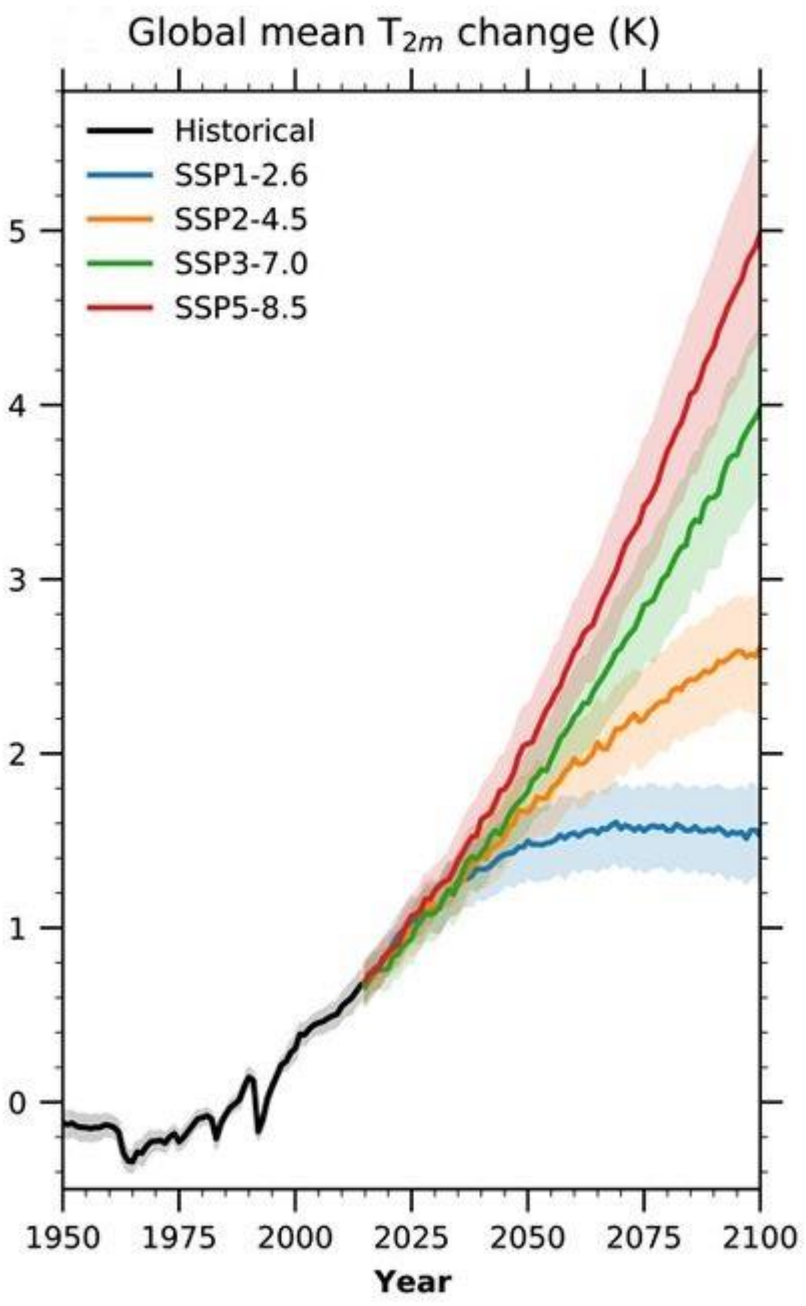
Validation Process

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.

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.

Climate Scenarios

Realistic - SSP 245 and pessimistic - SSP 370.

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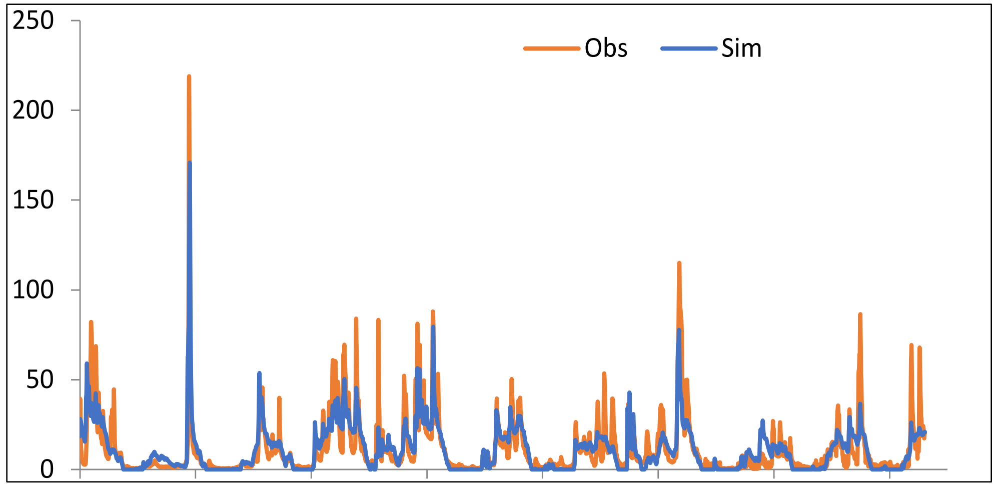
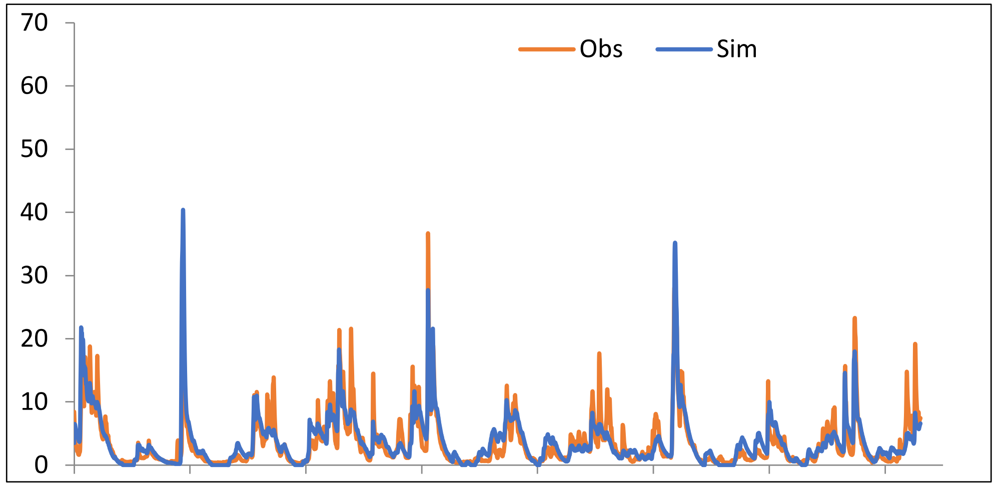
Development of hydrological models

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

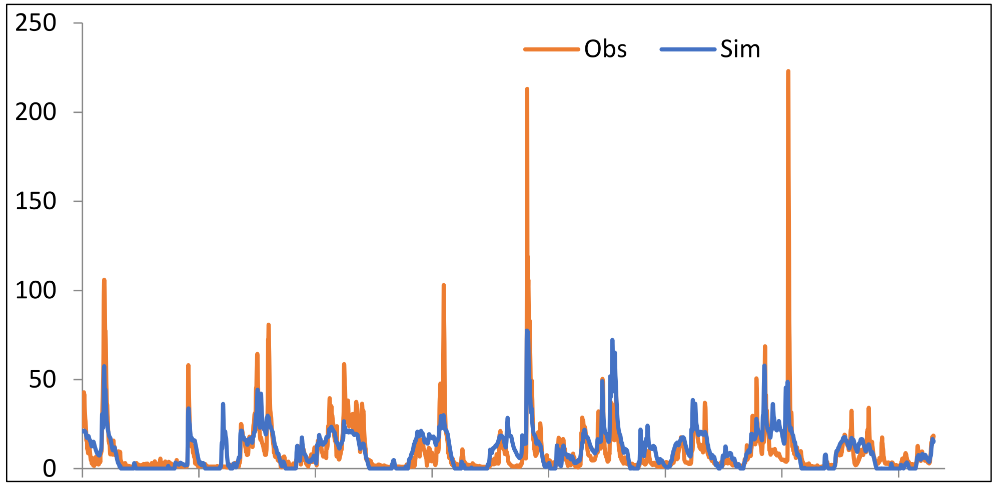
Calibration: R^2 – 0.87, RE – -3.2%. Validation: R^2 0.77, RE – -15.0%.

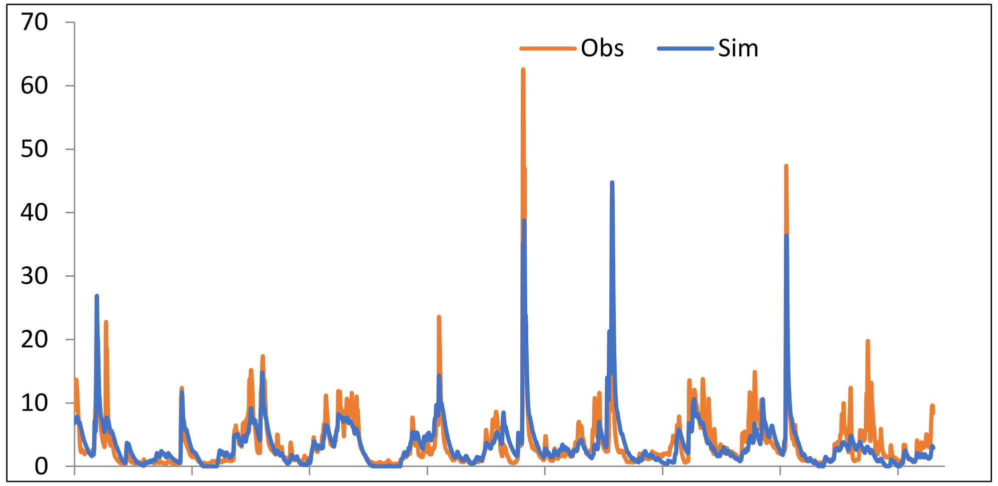


Mūša River

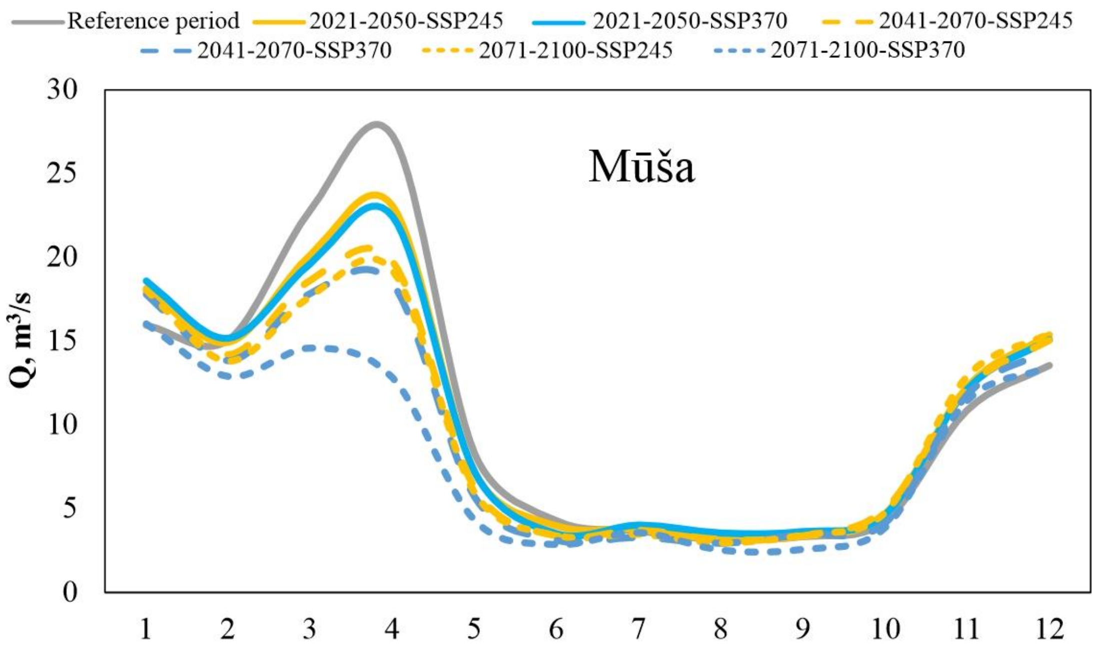


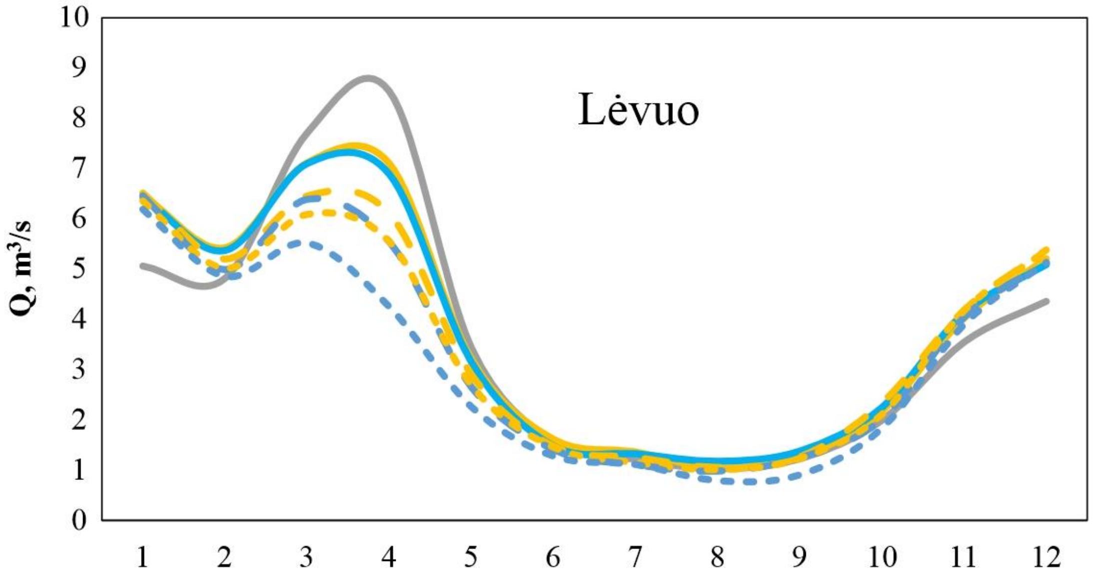
Lėvuo River





Projections of Mūša and Lėvuo discharge according to SSP scenarios





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

Distribution	Rank				
	Lėvuo River		Mūša River		Sum
	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

- 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.

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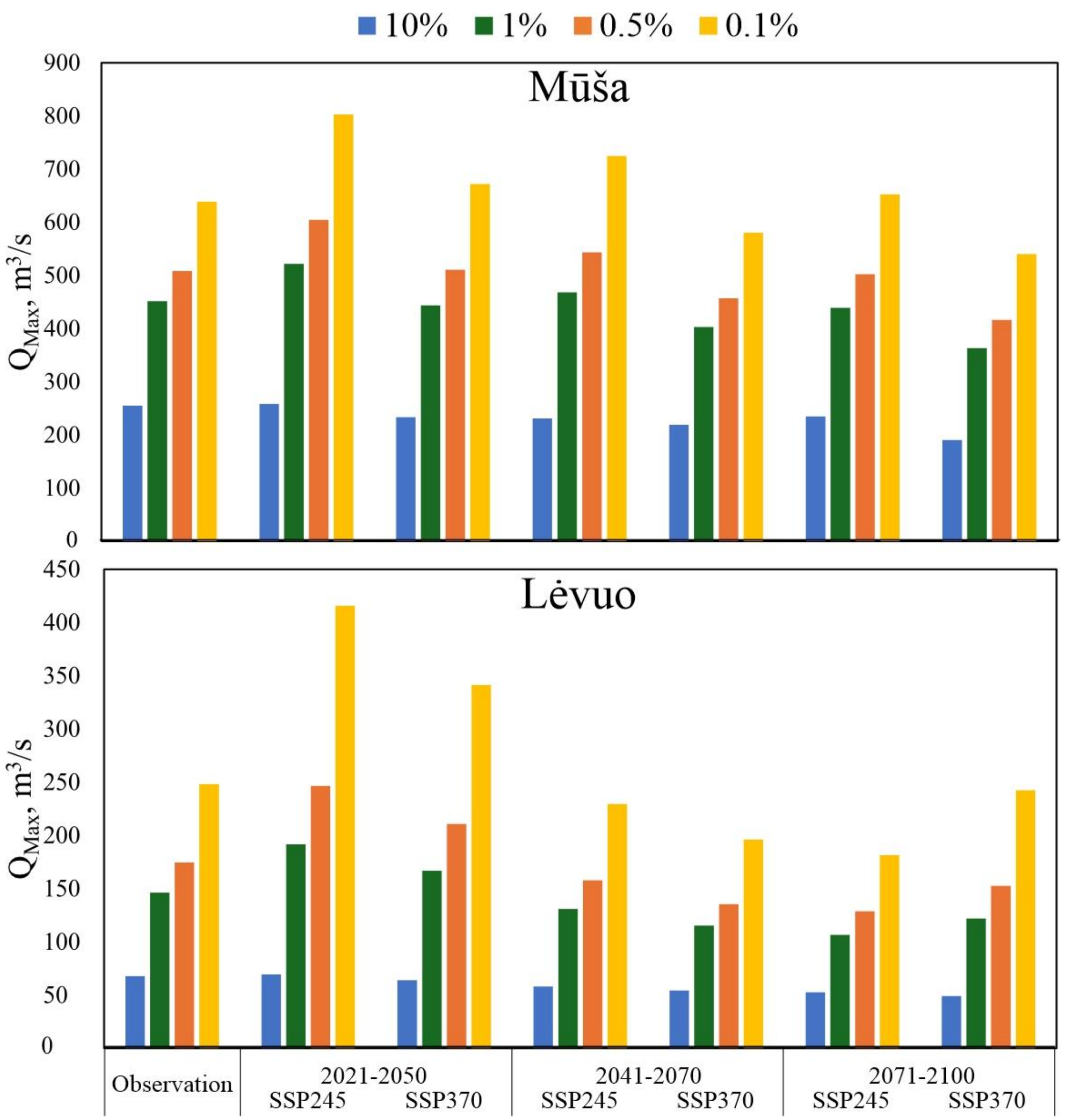
Tendencies of amaxd



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

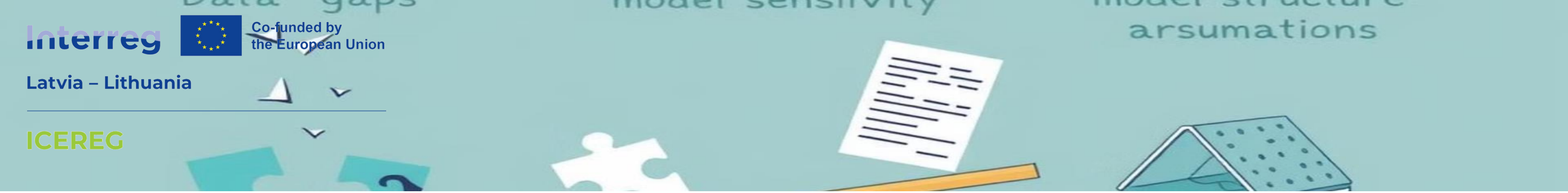
Mūša River: from -9% (SSP370) to +13% (SSP245).

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)



Uncertainties

1 **Hydrological model (HBV)**

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

2 **Climate models**

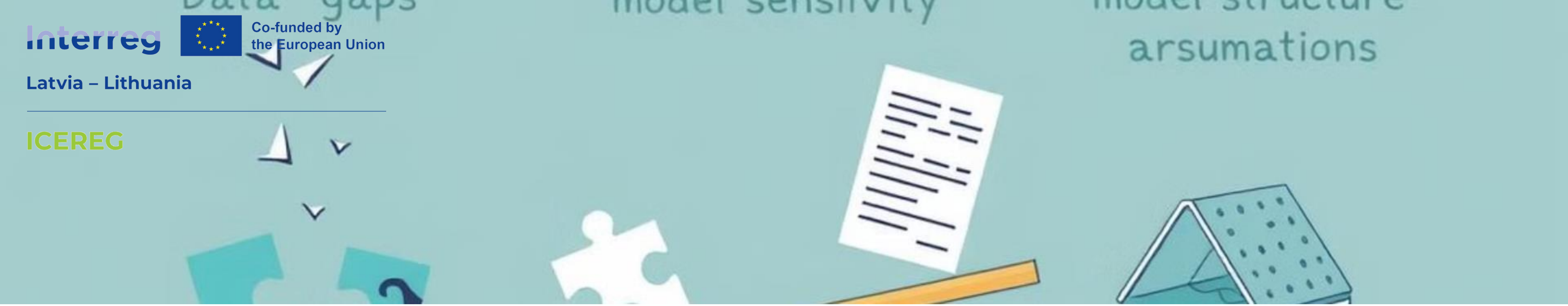
Apply an ensemble or select several „representative“ models.
SSP scenarios.
Climate models data down-scaling methods.
Etc.

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 ?!?