An attempt of ensemble modelling of future hydrological regime for selected river basin

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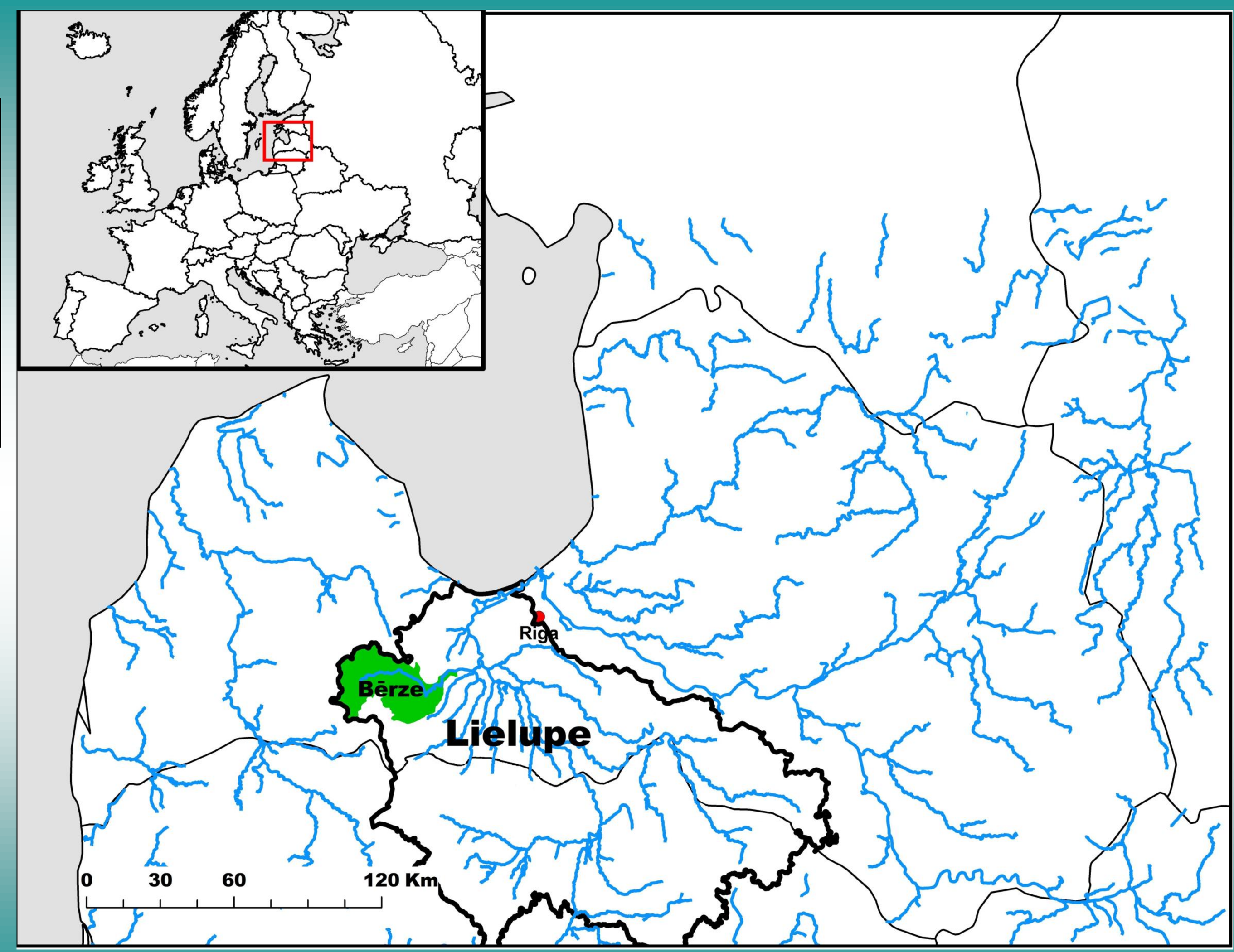
Abstract

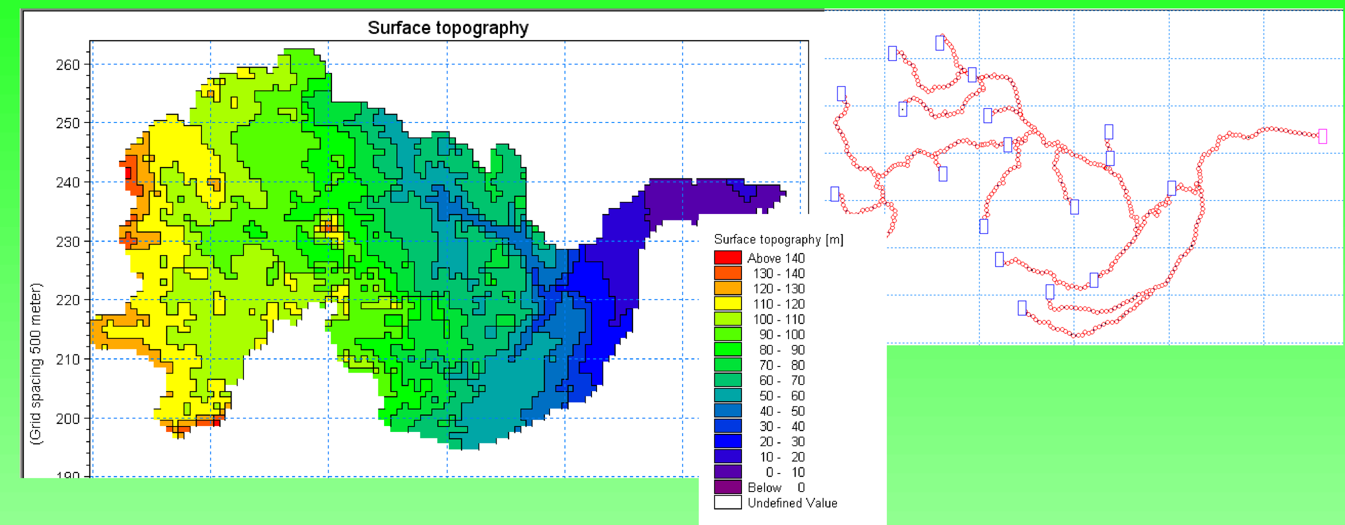
Ensemble modelling of hydrological regime may refer to usage of different Regional Climate Models (RCMs) coupled with one hydrological model, or usage of one RCM coupled with multiple hydrological models.
Our goal was to examine future flow regimes based on different hydrological models.
We conducted a river basin study based on one particular subbasin (Berze) of the river Lielupe basin. Lielupe is a lowland river with basin area of 17000 sq. km, situated in Latvia and Lithuania. Area of chosen subbasin is approximately 900 sq. km.
Ensemble of hydrological models consisted of MIKE SHE, and MIKE Basin by DHI, the runoff model embedded in RCM, and in-house FiBasin model.
MIKE SHE is grid based distributed hydrological model coupled with MIKE 11 flow routing model. MIKE Basin is, conceptual catchment based hydrological model which employs precipitation runoff model. FiBasin is spatially distributed, finite volume based hydrological model with hydraulic routing network.
The RCM and climate change scenarios are provided by “Prediction of Regional scenarios and Uncertainties for Defining European Climate change risks and Effects” (PRUDENCE) project. Time period for climate change scenarios is 2071-2100. Reference period is 1961-1990. All used hydrological models where calibrated using historical hydrometeorological and hydrological observation data from 1961-2007.

1. Area of study

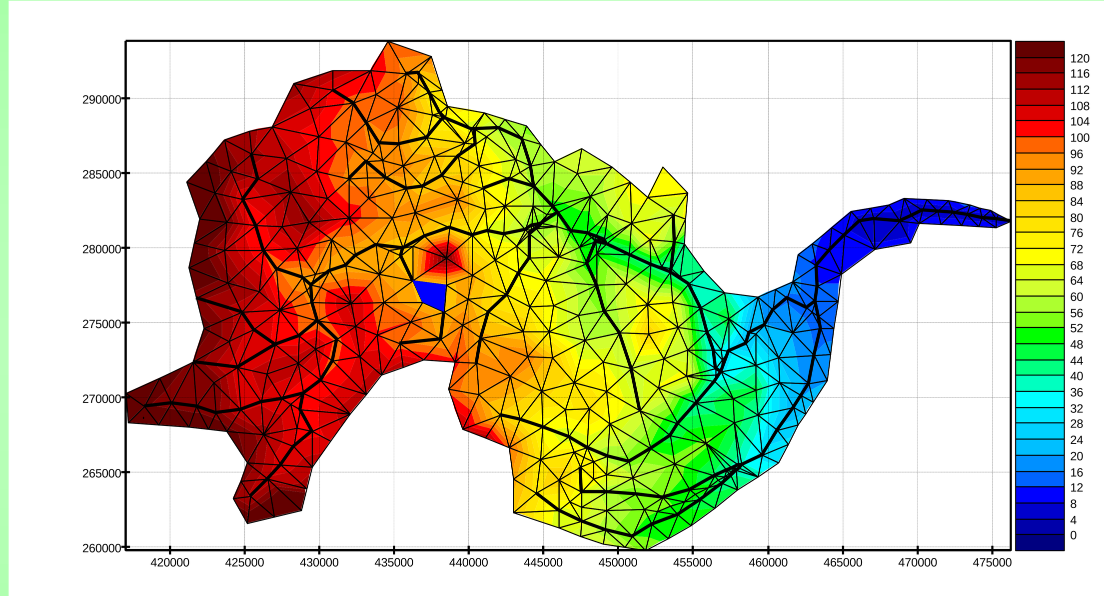
Position of Berze subbasin in river Lielupe basin.
Area of subbasin is 900 sq. km.
Elevation in subbasin changes from 140 to 3 m above sea level.



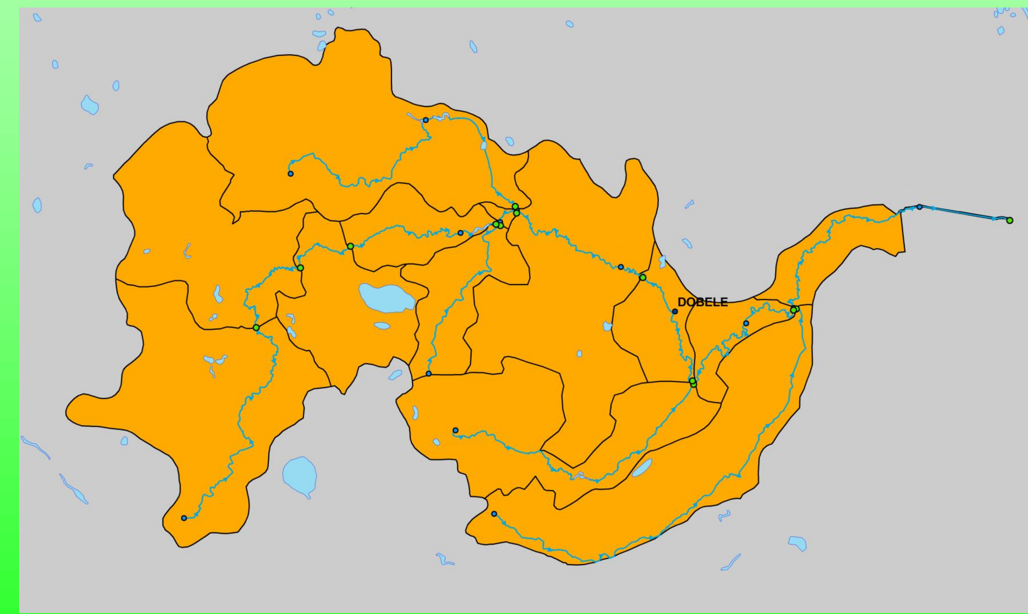
2. Hydrological models



Surface topography shown on Mike SHE calculation grid. Grid spacing 500m. River network in MIKE 11 hydraulic model. Grid spacing 2 km.



Surface topography shown on FiBasin calculation grid. River network and lake incorporated in network.



Berze subbasin divided in catchments for MIKE Basin conceptual model.

3. Meteorological input

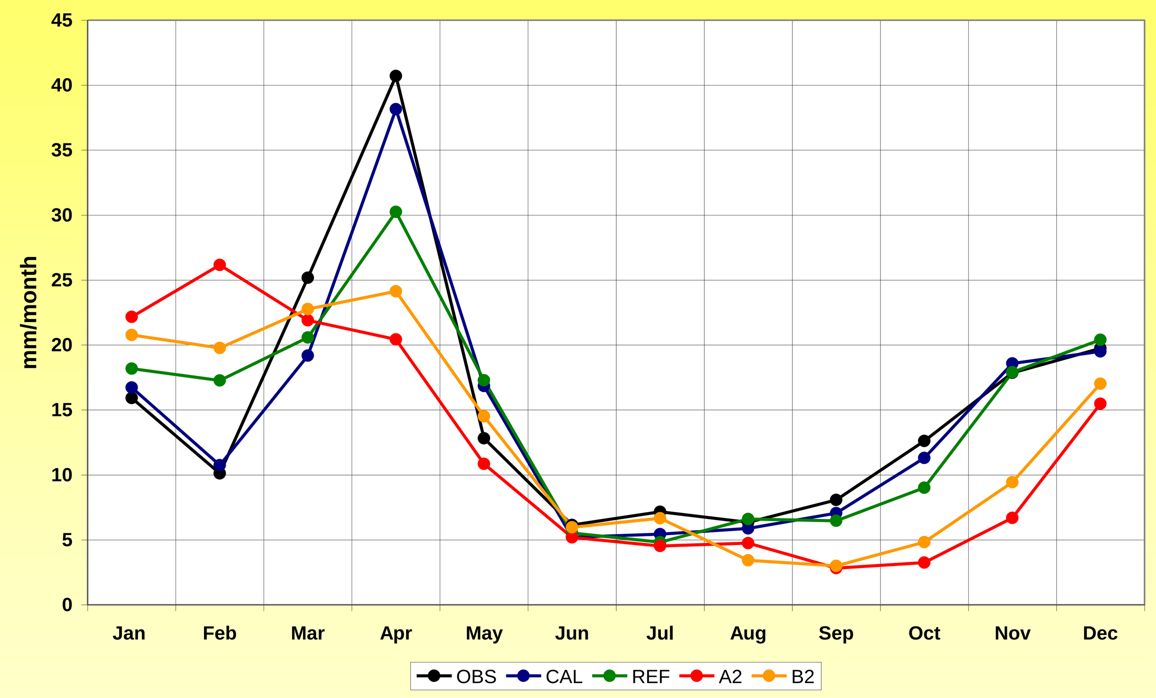
We use Regional Climate Model by SMHI (Swedish Meteorological and Hydrological Institute) RCAO HadAM3H. From this RCM references scenario (REF) and two future climate scenarios (A2) and (B2) are derived via downscaling method which equalises model and observed histograms for reference period.

4. Results

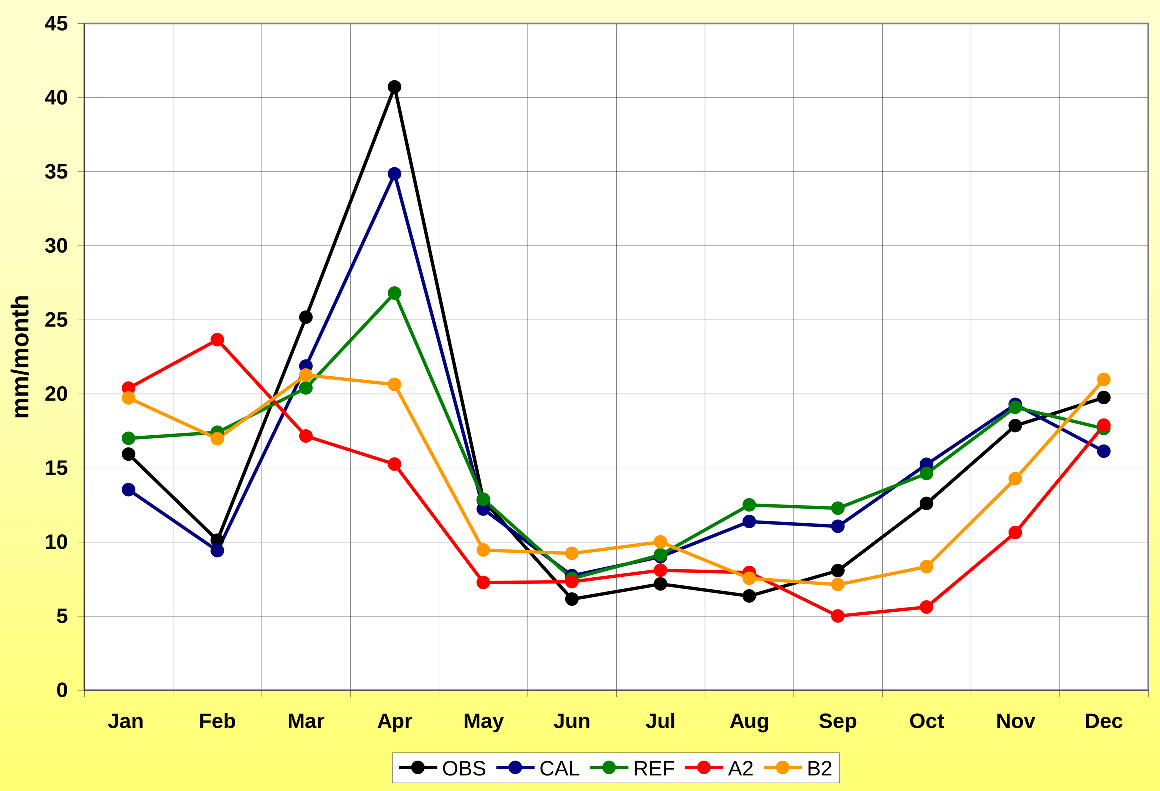
River Berze discharge monthly values (average over 30 years) are presented for different hydrological models, and climate scenarios. Observed values (OBS) are compared with calibration results (CAL). Reference scenario (REF) is compared with climate change scenarios (A2, B2).

Coefficients of determination R^2 for different models comparing observed and calculated daily average discharge values are:

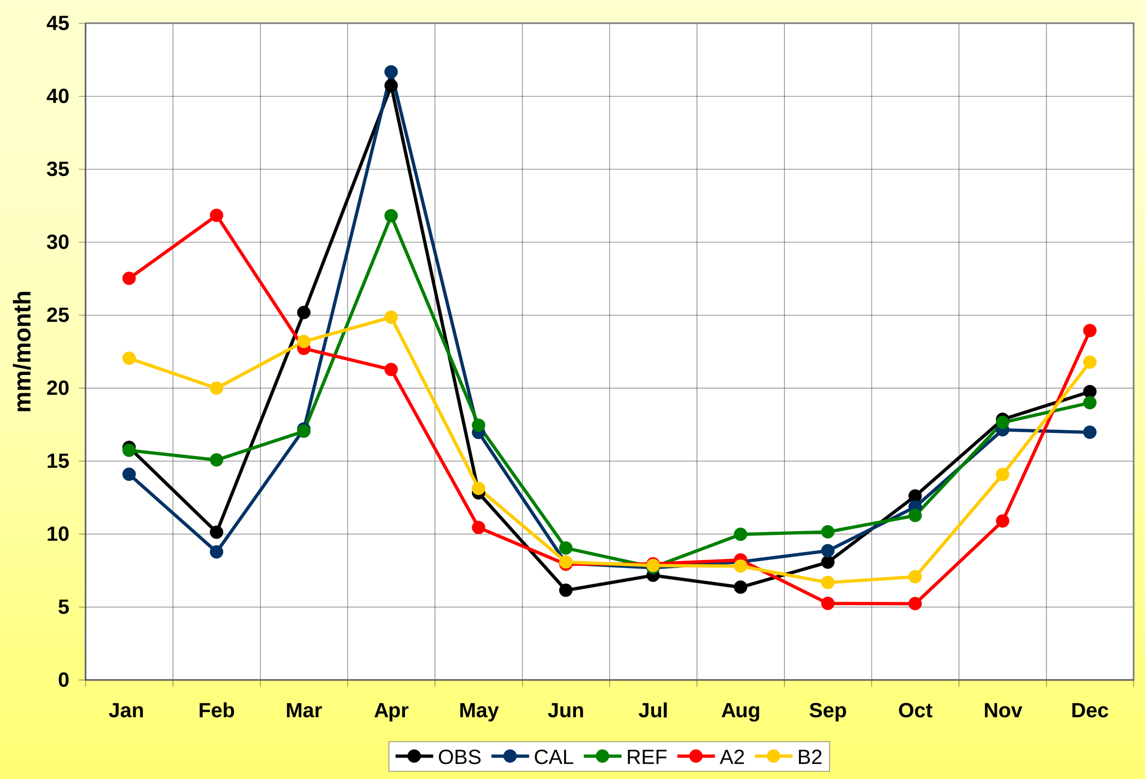
- MIKE Basin R^2=0.76
- MIKE SHE R^2=0.70
- FiBasin R^2=0.69



MIKE SHE results



MIKE Basin results

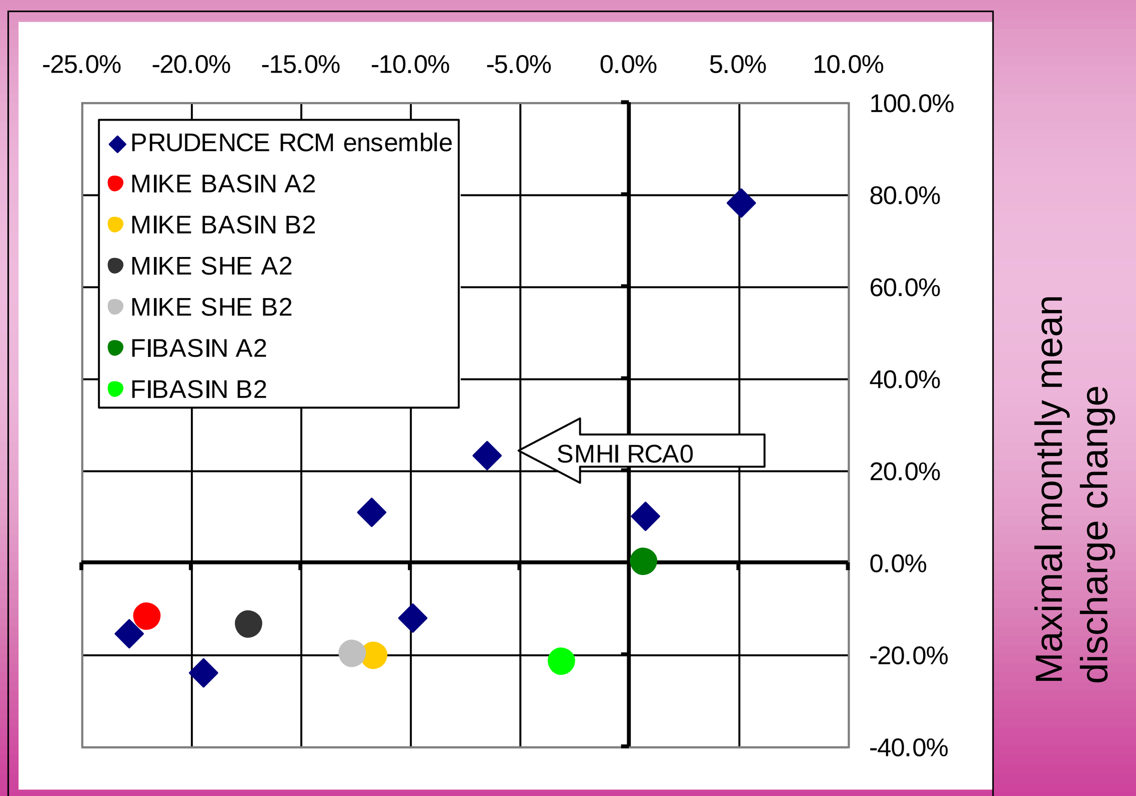


FiBasin results

5. Comparison between models

Hydrological modelling results compared with results obtained from ensemble of unmodified PRUDENCE RCMs.

Annual mean discharge change



6. Main conclusions

Uncertainty which exists regarding impact of climate change on river runoff prognosis can be diminished by choosing best climate model and evaluate uncertainty regarding the hydrological models.

By examining hydrological model results the impact of climate change on rivers situated in central Latvia can be evaluated.

That climate scenario B2 brings quantitative changes in river discharge while scenario A2 introduces profound qualitative changes. A2 shows spring discharge maximum (relented to snow melting) diminishing and merging with autumn precipitation maximum. In both future climate scenarios increase in duration of low water period can be observed.

KALME VALSTS PĒTĪJUMU PROGRAMMA KLIMATA MAIŅAS IETEKME UZ LATVIJAS ŪDEŅU VIDI