CES Nordic Project on Climate and Energy Systems

norden Nordic Energy Research

Climate Change Impacts on Hydrological Regime in Latvia

Līga Kurpniece

Latvian Environment, Geology and Meteorology Centre

hidro@lvgmc.lv

2010, June 01

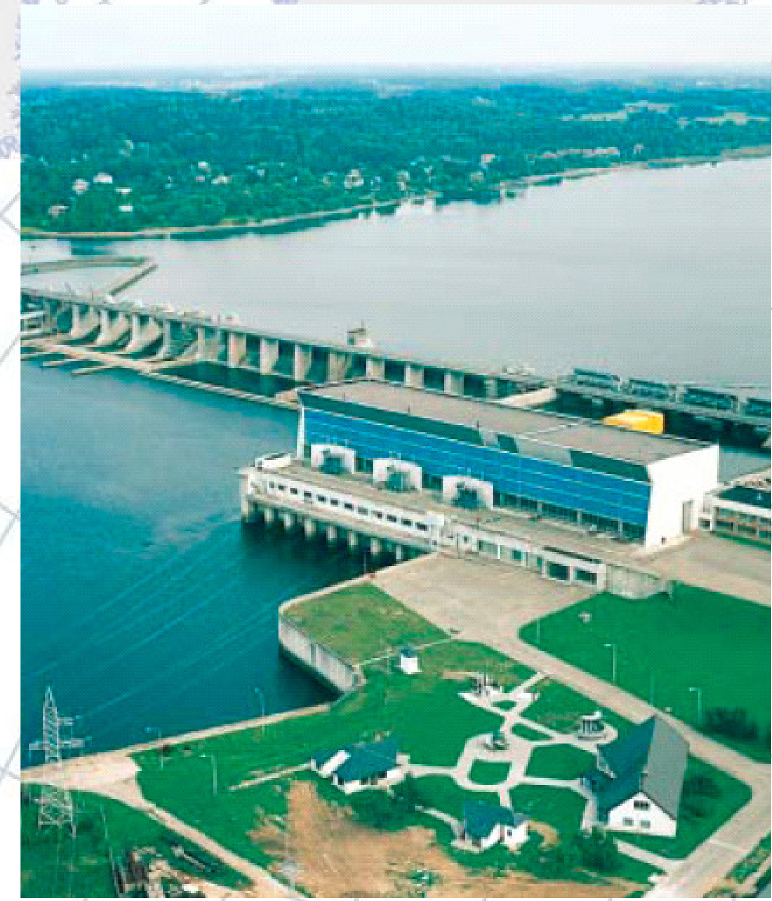
The aim of the study

Hydroenergy is the most important source of renewable energies actively used today. Climate change leads to the significant changes of the water resources and further effects the hydropower production.

- The biggest hydropower plants in Latvia produce approximately 50% of electricity consumed per year in the country. Climate change impacts on hydrological regime might have a significant effect on a hydropower production
- To study the climate change impact on hydrological regime in Latvia river basins for the period 2021-2050

Methods and study area

The Plavinas HPP on Daugava River and the Aiviekstes HPP on Aiviekste River were the objects of the case study



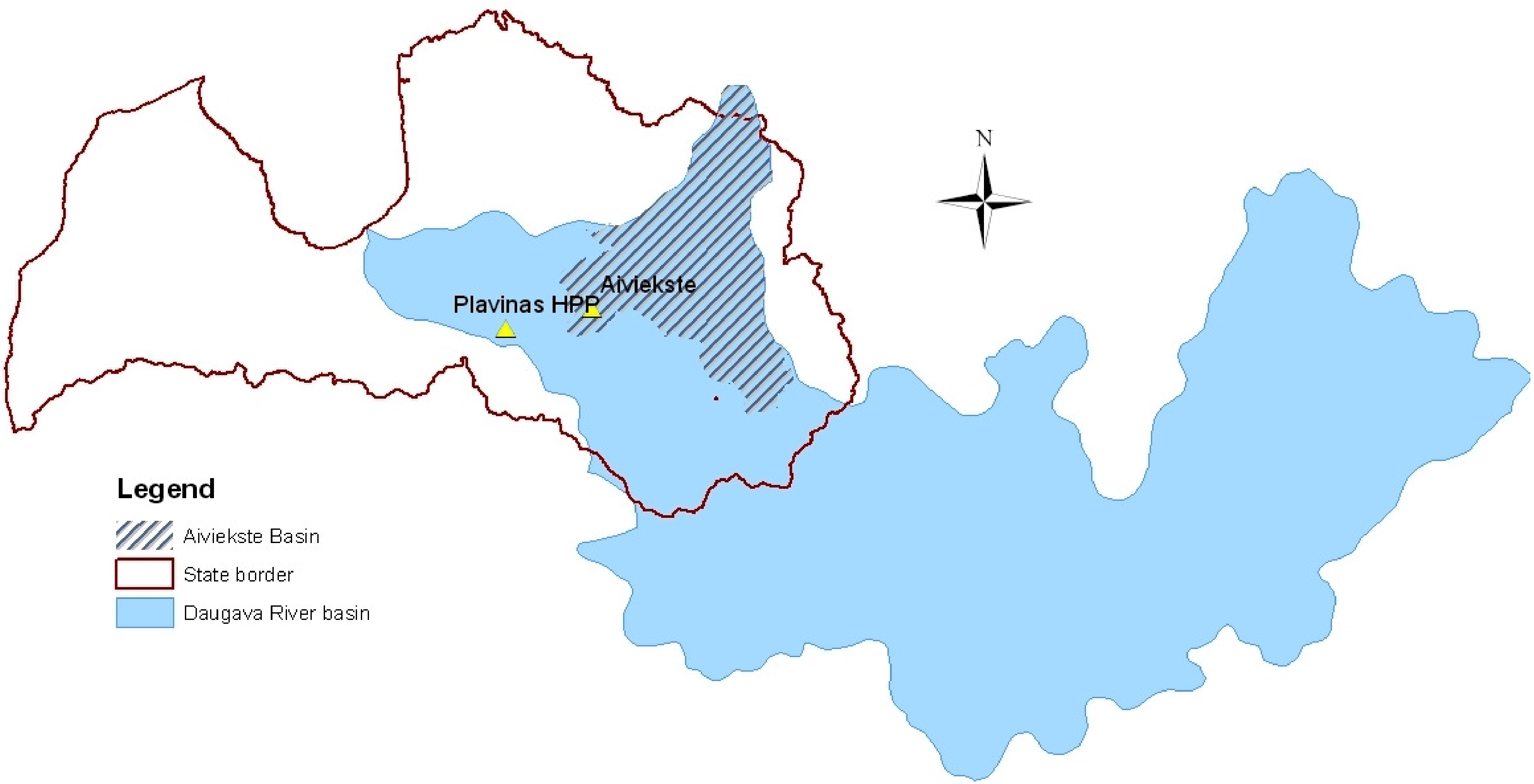
The total capacity of Plavinas HPP – 868.5 MW. Aiviekste HPP generates electricity with the capacity of 0.8 MW.

Plavinas HPP with its ten hydroelectric sets is the largest hydropower plant in the Baltic States and the second largest in the European Union in terms of installed capacity.

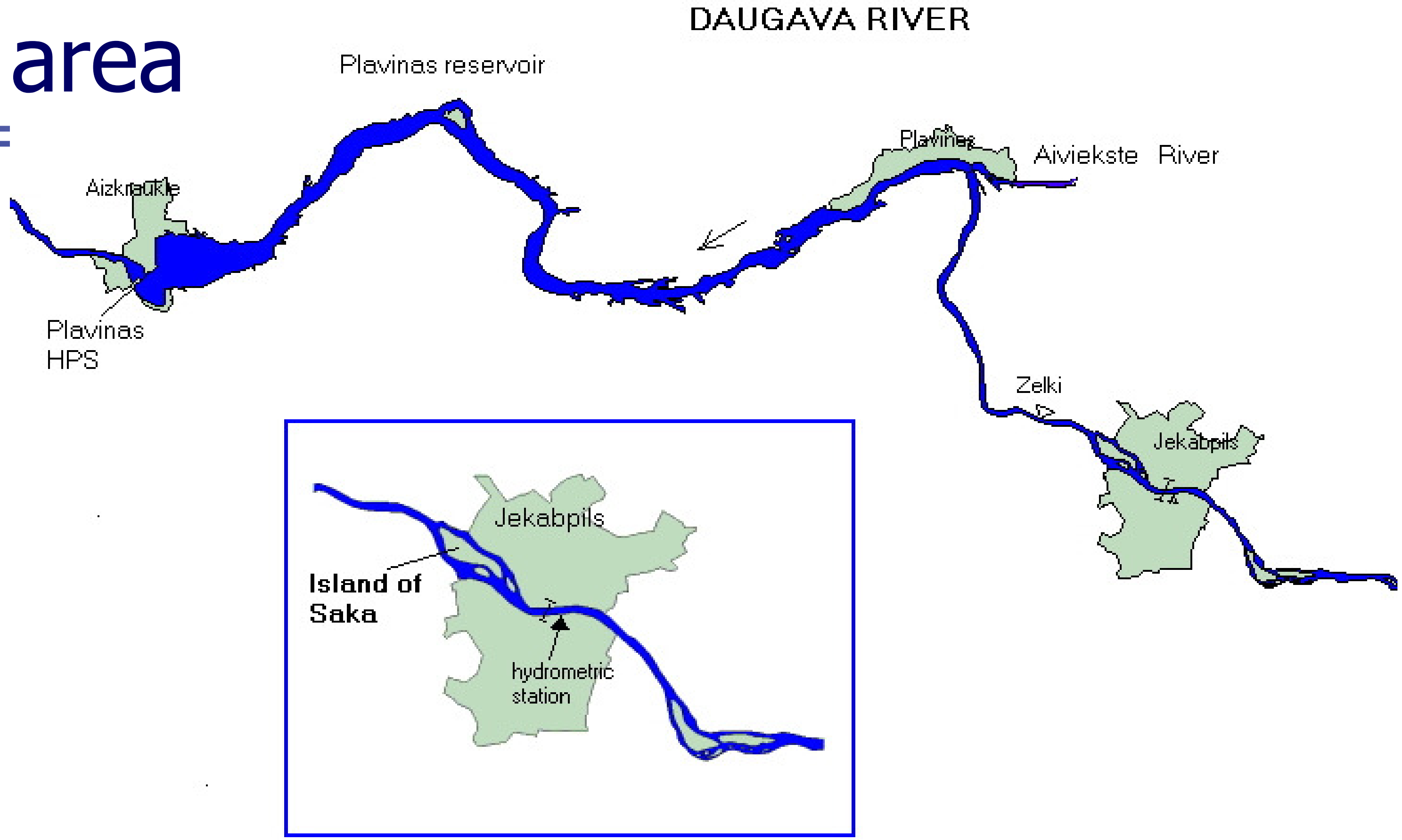
From 1925 to 1938, Aiviekste HPP was the largest in Latvia.

Plavinas hydropower station on Daugava River

Daugava and Aiviekste Basins



Study area



After Plavinas HPP was constructed in 1967, territories near Plavinas city and above river to Jekabpils city almost every spring are endangered by floods caused mostly by ice jams.

Hydrological model

- since year 1994, HBV model is used at LVGMC
- HBV 96 model (version 4.5) was used to simulate runoff in future climate conditions for this project purposes
- Large area of Daugava River Basin is situated outside Latvia
- Model consists from 8 connected subbasins, only 5 of them are situated inside Latvia teritory.
- Data from 13 meteorological stations were used to create a model, 6 of them belongs to Russian or Belorussian meteorological network

Calibration and validation results

The model was calibrated and validated for both river basins.

The calibration period 1961 to 1990, but validation of model was done for the 5-years period from 2005 to 2009.

	Aiviekste HPP R^2	Plavinas HPP R^2
1961-1990	0.83	0.83
2005-2009	0.74	0.92

Climate change scenarious

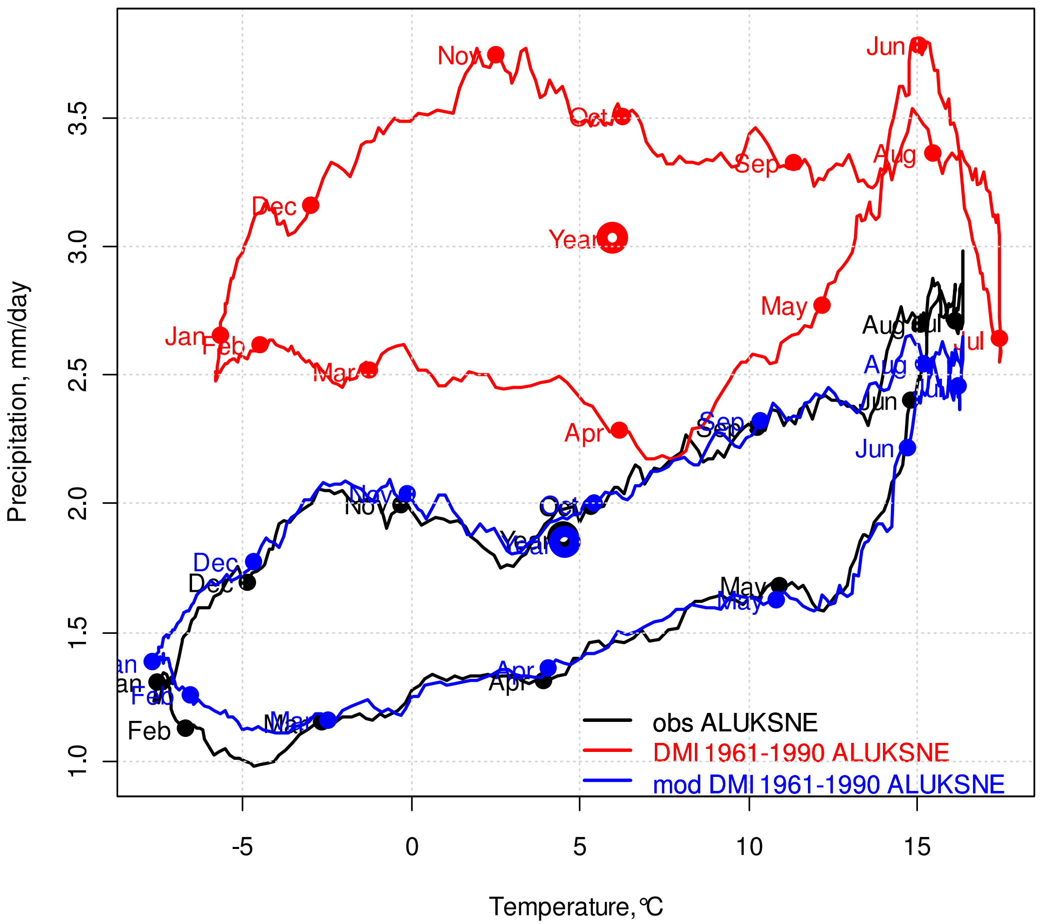
The assumption of future (2021-2050) climate conditions was based on results of the three climate models

- DMI-HIRLAM-ECHAM5,
- MetNo-HIRLAM-HadCM3,
- SMHI-RCA3-BMC with the SRES A1B.

The climate model results were downscaled using statistical downscaling method:

Sennikovs, J. and Bethers, U. 2009. *Statistical downscaling method of regional climate model results for hydrological modeling.* 18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009 http://mssanz.org.au/modsim09

Observed, modeled and corrected data

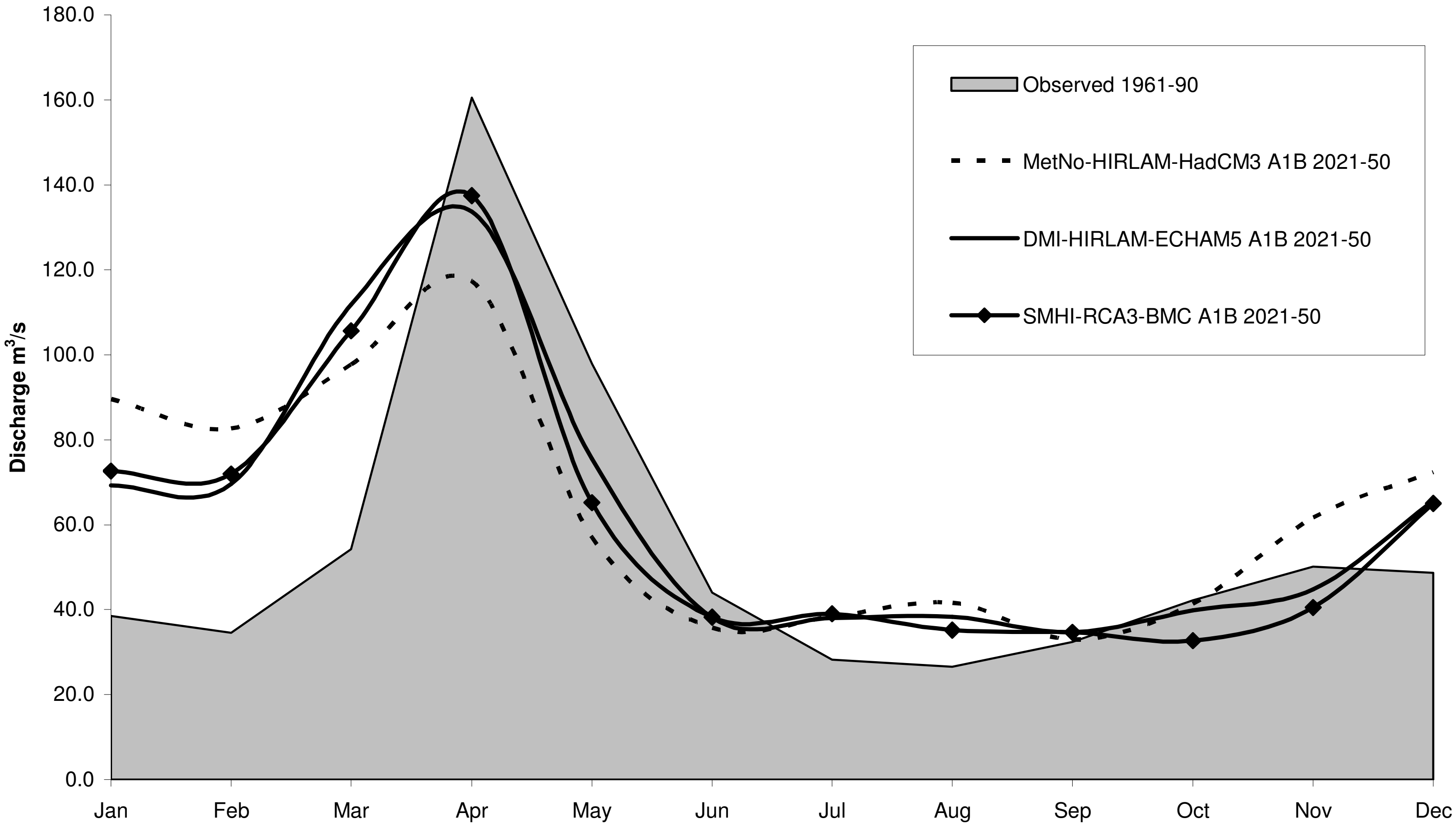


After the correction all 3 climate models agree with observed data

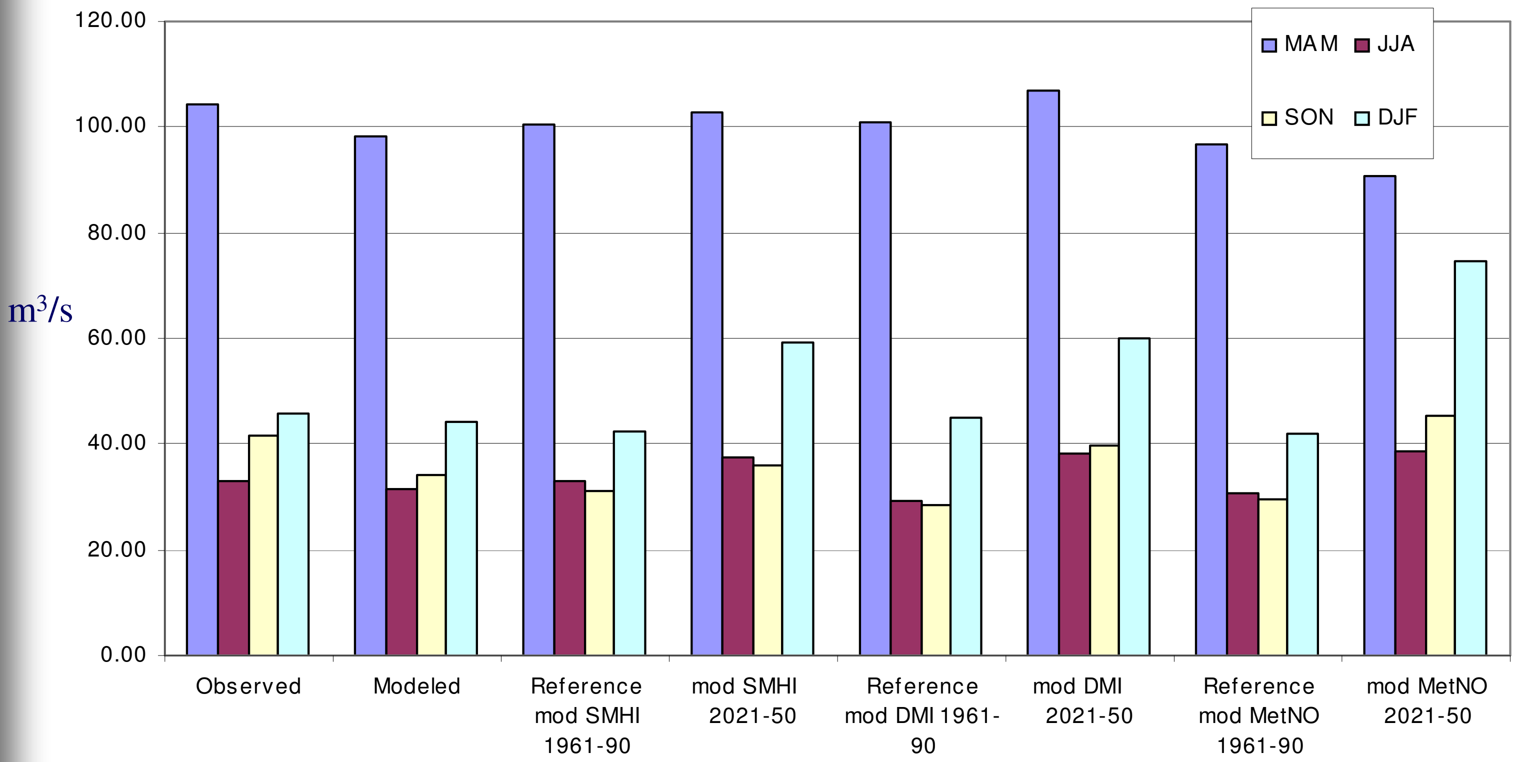
Results

The comparison of mean annual runoff, seasonal runoff, and winter-spring and summer-autumn flood maximum has been done between simulations for control period 1961-1990 and scenarios period 2021 - 2050.

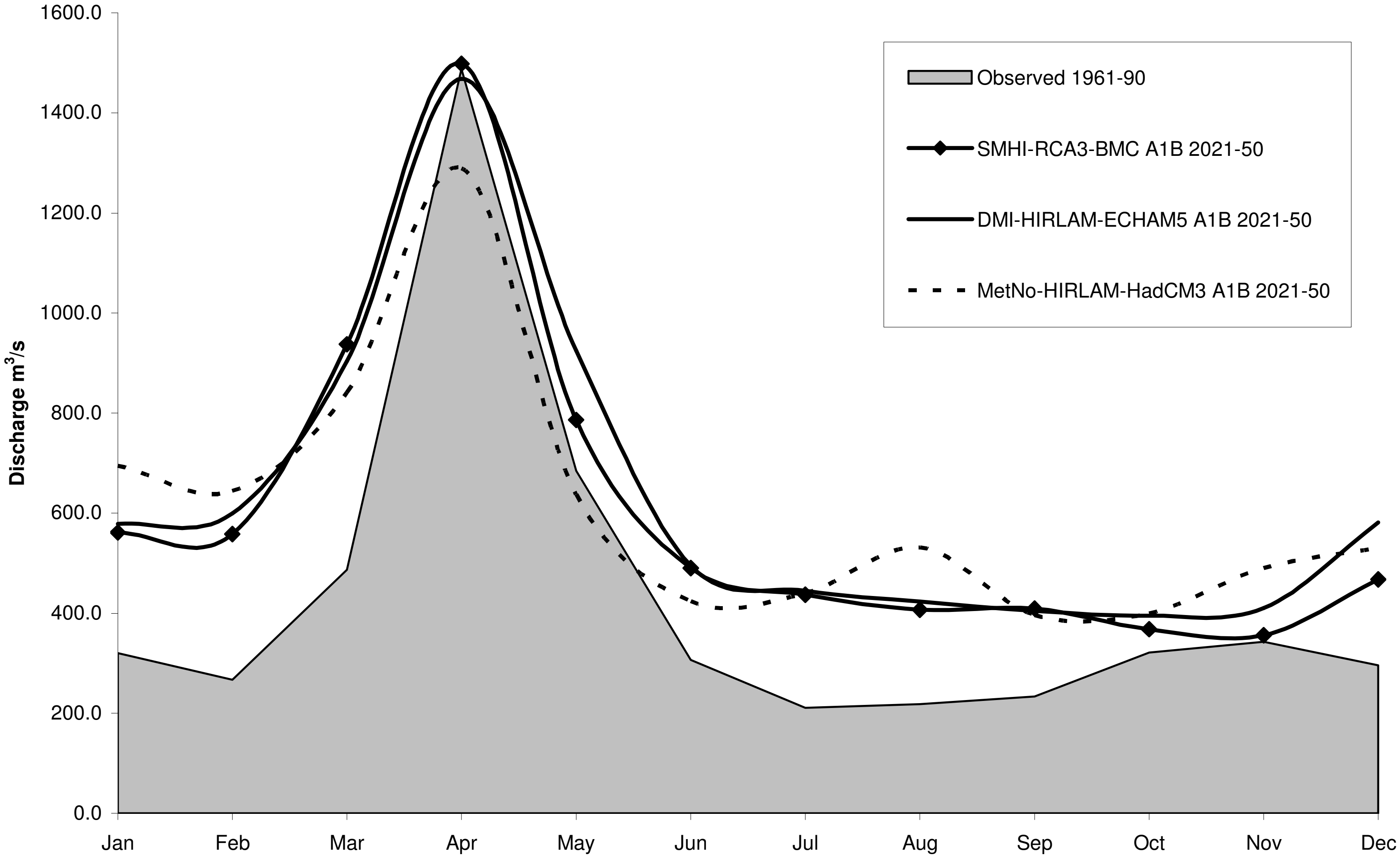
Monthly distribution of runoff under present and future conditions, Aiviekste HPP



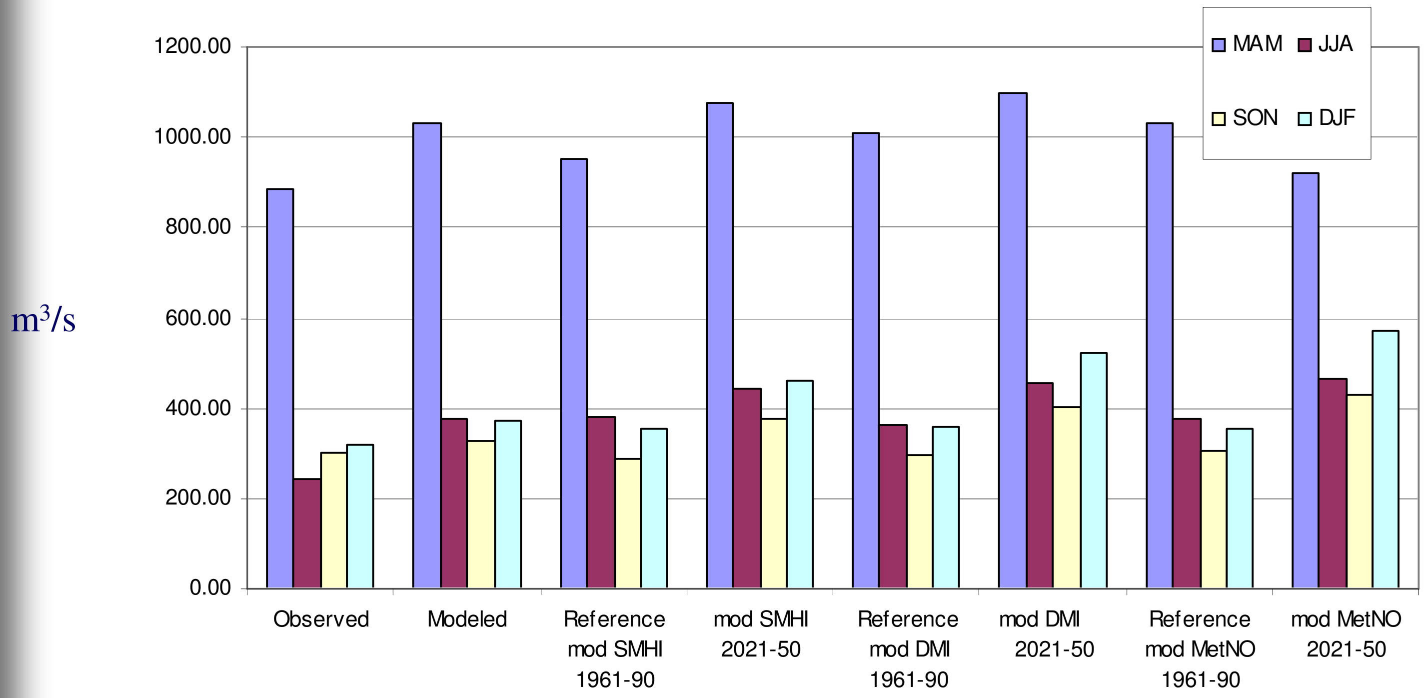
Observed and modeled runoff , Aiviekste



Monthly distribution of runoff under present and future conditions, Plavinas HPP



Observed and modeled runoff , Plavinas



Absolute maximal discharge, observed and modeled

	1961-1990 (m^3/s) (YEAR)	**mod SMHI** 2021-2050 (m^3/s)	**mod DMI** 2021-2050 (m^3/s)	**mod MetNO** 2021-2050 (m^3/s)
Aiviekste HPP	373 (1962)	419	530	355
Plavinas HPP	6480 (1983)	4616	3955	4648

Mean annual runoff changes

	mod SMHI 2021-50	mod DMI 2021-50	mod MetNO 2021-50
Aiviekste HPP	+ 19 %	+ 21 %	+ 27 %
Plavinas HPP	+ 22 %	+ 26 %	+ 19 %

Conclusions:

- According to all scenarios the annual runoff is going to increase by 19-27%.
- The most remarkable increase of runoff was found for winter (DJF) season (by 30-77%). All scenarios showed the decrease of runoff for the period April-May (by 6-39%), except SMHI-RCA3-BMC scenario showed small increase of runoff for Plavinu HPP in April
- The analysis of shows that under all three scenarios for Aiviekste HPP the winter-spring flood will be reduced by 6 to 20 % whereas for Plavinas HPP scenarios will cause insignificant changes in range of increasing by 2% to decreasing by 10%.
- The summer-autumn flood will generally decrease for Aiviekste HPP and increase for Plavinas HPP.
- Increasing of winter and summer flows is obvious in both basins. Stream flow changes in winter are strongly linked to changes in snow regime.
- Positive runoff tendency in summer season will lead to a positive effect on the work of the HPP and energy production as a whole. The negative trends of maximum discharge in spring are conductive to a safe work of the HPP during extreme floods.

THANK YOU FOR ATTENTION!