IWRM2018-74
8th International Water Resources Management Conference of ICWRS
© Author(s) 2017. CC Attribution 4.0 License.

Impact of possible climate changes on river runoff under different natural conditions

Yeugeniy Gusev, Olga Nasonova , Evgeny Kovalev , and Georgii Ayzel
Institute of Water Problems, Russian Academy of Sciences, Moscow, Russian Federation (sowaso@yandex.ru)

The present study was carried out within the framework of the International Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) launched in 2013. The aim of the study was to investigate possible changes in river runoff up to 2100 for 11 large river basins located on different continents of the globe under a wide variety of natural conditions and including the Rhine and Tagus in Europe; the Ganges, Lena, Upper Yellow River and Upper Yangtze in Asia; the Niger in Africa; the Mackenzie and Upper Mississippi in North America, the Upper Amazon in South America and the Darling in Australia. The basins were schematized as a set of regular grid cells (with a one-degree spatial resolution in latitude and longitude) connected by a river network.
The Land Surface Model (LSM) SWAP (Soil Water - Atmosphere - Plants), previously developed by the authors, was used as the main tool for calculating river runoff. The data needed for model simulations include (1) near-surface meteorological forcing data to drive the model, (2) land surface parameters and (3) river runoff for model calibration and validation. For the calibration and validation of the model, daily values of meteorological characteristics for the base period (1969-2005) were taken from the global Water and Global Change (WATCH) data set created by means of hybridization the ERA-40 reanalysis product with monthly ground-based measurements (including air temperature, number of days with precipitation, cloudiness, and precipitation) from the Global Precipitation Climatology Center (GPCC) and the Climatic Research Unit (CRU of the University of East England) data sets. For hydrological projections, daily meteorological forcing data simulated by five General Circulation Models (GCMs: HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, GFDL-ESM2M and NorESM1-M) for the period from 2006 to 2099 and for the four RCP (Representative Concentration Pathways) scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) were used. The obtained results were generalized in terms of the so-called climatic "elasticity" of river runoff. In addition, the dynamics of the natural variability of river runoff (due to weather noise) was investigated.
The following results were obtained. The possibility of estimating changes in various characteristics of river runoff (annual and monthly values averaged over 30-year periods and their standard deviations) for the selected large river basins up to 2100 on the basis of application of the LSM SWAP and meteorological projections simulated by different GCMs according to four RCP scenarios was demonstrated. It was also shown that the obtained values of the climatic elasticities of river runoff to changes in air temperature and precipitation make it possible, as the first approximation, to project changes in climatic values of annual runoff, using the projected changes in mean annual air temperature and annual precipitation for a river basin. It was found that changes (in absolute value) in runoff of the rivers under study due to climate change by the end of the 21st century, as a rule (with the exception of the runoff of the northern rivers), are less than natural interannual variability of the runoff due to weather noise.