Geophysical Research Abstracts
Vol. 19, EGU2017-17052, 2017
EGU General Assembly 2017

Investigating the Capacity of Hydrological Models to Project Impacts of Climate Change in the Context of Water Allocation

Carlos Velez (1), Edith Maroy (1), Ivan Rocabado (1), and Fernando Pereira (2)

(1) Antea Group, Water Unit, Antwerpen, Belgium (carlos.velez@anteagroup.com), (2) Flanders Hydraulics Research, Berchemlei 115 - 2140 Antwerpen

To analyse the impacts of climate changes, hydrological models are used to project the hydrology responds under future conditions that normally differ from those for which they were calibrated. The challenge is to assess the validity of the projected effects when there is not data to validate it.

A framework for testing the ability of models to project climate change was proposed by Refsgaard et al., (2014). The authors recommend the use of the differential-split sample test (DSST) in order to build confidence in the model projections. The method follow three steps: 1. A small number of sub-periods are selected according to one climate characteristics, 2. The calibration – validation test is applied on these periods, 3. The validation performances are compered to evaluate whether they vary significantly when climatic characteristics differ between calibration and validation. DSST rely on the existing records of climate and hydrological variables; and performances are estimated based on indicators of error between observed and simulated variables.

Other authors suggest that, since climate models are not able to reproduce single events but rather statistical properties describing the climate, this should be reflected when testing hydrological models. Thus, performance criteria such as RMSE should be replaced by for instance flow duration curves or other distribution functions. Using this type of performance criteria, Van Steenbergen and Willems, (2012) proposed a method to test the validity of hydrological models in a climate changing context. The method is based on the evaluation of peak flow increases due to different levels of rainfall increases. In contrast to DSST, this method use the projected climate variability and it is especially useful to compare different modelling tools.

In the framework of a water allocation project for the region of Flanders (Belgium) we calibrated three hydrological models: NAM, PDM and VHM; for 67 gauged sub-catchments with approx. 40 years of records. This paper investigates the capacity of the three hydrological models to project the impacts of climate change scenarios. It is proposed a general testing framework which combine the use of the existing information through an adapted form of DSST with the approach proposed by Van Steenbergen and Willems, (2012) adapted to assess statistical properties of flows useful in the context of water allocation. To assess the model we use robustness criteria based on a Log Nash-Sutcliffe, BIAS on cummulative volumes and relative changes based on Q50/Q90 estimated from the duration curve.

The three conceptual rainfall-runoff models yielded different results per sub-catchments. A relation was found between robustness criteria and changes in mean rainfall and changes in mean potential evapotranspiration. Biases are greatly affected by changes in precipitation, especially when the climate scenarios involve changes in precipitation volume beyond the range used for calibration. Using the combine approach we were able to classify the modelling tools per sub-catchments and create an ensemble of best models to project the impacts of climate variability for the catchments of 10 main rivers in Flanders. Thus, managers could understand better the usability of the modelling tools and the credibility of its outputs for water allocation applications.

References

Refsgaard, J.C., Madsen, H., Andréassian, V., Arnbjerg-Nielsen, K., Davidson, T.A., Drews, M., Hamilton, D.P., Jeppesen, E., Kjellström, E., Olesen, J.E., Sonnenborg, T.O., Trolle, D., Willems, P., Christensen, J.H., 2014. A framework for testing the ability of models to project climate change and its impacts. Clim. Change.

Van Steenbergen, N., Willems, P., 2012. Method for testing the accuracy of rainfall – runoff models in predicting peak flow changes due to rainfall changes , in a climate changing context. J. Hydrol. 415, 425–434.