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Can the combined use of an ensemble based modelling approach and the analysis of measured meteorological trends lead to increased confidence in climate change impact assessments?

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In anthropogenically heavily impacted river catchments, such as the Lusatian river catchments of Spree and Schwarze Elster (Germany), the robust assessment of possible impacts of climate change on the regional water resources is of high relevance for the development and implementation of suitable climate change adaptation strategies. Large uncertainties inherent in future climate projections may, however, reduce the willingness of regional stakeholder to develop and implement suitable adaptation strategies to climate change.

This study provides an overview of different possibilities to consider uncertainties in climate change impact assessments by means of (1) an ensemble based modelling approach and (2) the incorporation of measured and simulated meteorological trends.

The ensemble based modelling approach consists of the meteorological output of four climate downscaling approaches (DAs) (two dynamical and two statistical DAs (113 realisations in total)), which drive different model configurations of two conceptually different hydrological models (HBV-light and WaSiM-ETH). As study area serve three near natural subcatchments of the Spree and Schwarze Elster river catchments.

The objective of incorporating measured meteorological trends into the analysis was twofold: measured trends can (i) serve as a mean to validate the results of the DAs and (ii) be regarded as harbinger for the future direction of change. Moreover, regional stakeholders seem to have more trust in measurements than in modelling results. In order to evaluate the nature of the trends, both gradual (Mann-Kendall test) and step changes (Pettitt test) are considered as well as both temporal and spatial correlations in the data.

The results of the ensemble based modelling chain show that depending on the type (dynamical or statistical) of DA used, opposing trends in precipitation, actual evapotranspiration and discharge are simulated in the scenario period (2031-2060). While the statistical DAs simulate a strong decrease in future long term annual precipitation, the dynamical DAs simulate a tendency towards increasing precipitation. The trend analysis suggests that precipitation has not changed significantly during the period 1961-2006. Therefore, the decrease simulated by the statistical DAs should be interpreted as a rather dry future projection. Concerning air temperature, measured and simulated trends agree on a positive trend. Also the uncertainty related to the hydrological model within the climate change modelling chain is comparably low when long-term averages are considered but increases significantly during extreme events.

This proposed framework of combining an ensemble based modelling approach with measured trend analysis is a promising approach for regional stakeholders to gain more confidence into the final results of climate change impact assessments. However, climate change impact assessments will remain highly uncertain. Thus, flexible adaptation strategies need to be developed which should not only consider climate but also other aspects of global change.