The assessment of hydrological impacts of climate change and their implications for water management across scales: from the local to European scale

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Summary

The impacts of climate change can become a trigger for critical changes in the spatial and temporal distribution of water resources in many regions in Europe. This will lead from obviously negative effects in some regions to creation of opportunities in others. In the face of future changes: economic, social and environmental, both natural and triggered by anthropogenic activities, the effective water resources management is becoming a very intricate matter and a serious challenge for the practitioners and scientists. In order to ensure sustainability and robustness of the water management strategies, the impacts of climate change and associated risks have to be quantified and included in the water management plans.

In this Thesis an assessment of impacts of the high-end and moderate climate change scenarios on water resources in Europe was performed by means of application of the process-based eco-hydrological catchment-scale model SWIM (Soil and Water Integrated Model) coupled with the reservoir and water allocation modules. The assessment was conducted at three scales. Firstly, it was performed at the scale of Europe, considering eight representative river basins with varying climatic conditions and anthropogenic services. Then, the scale was narrowed down to a single, highly-regulated river basin in the semi-arid region, and the impacts of climate change on the reservoirs functioning were assessed. Third, a possibility to harmonize the inter-sectoral water allocation scheme within a highly altered human-hydrological system in the headwaters of the Tagus river basin in the semi-arid region under reduction in water availability triggered by the projected climate change was evaluated applying a scenario-based approach.

The extrapolation of results allows concluding that the moderate and high-end climate change scenarios of global warming across Europe would lead to robust decreasing trends in water availability in the southern river basins, an overall increase in discharge of the northern river basins, and increase in winter discharge and decrease in summer water flows in the central European catchments. Besides, a shift in seasonality (due to earlier snow melt) was projected in basins of central and northern Europe. The difference between the high-end and moderate global warming scenarios becomes evident after the mid-century. These findings support the previously reported

results of the other studies, mostly conducted with the global-scale models, confirming the robustness of the trends found.

Further, the scaled down assessment of the water scarce catchment in southern Europe, the Tagus river basin, offers a glance on the effects of projected climate change on water resources availability and influence of potential changes on hydropower generation of the three important reservoirs in the basin. The results indicate a substantial decrease of discharge and, consequently, a strong decrease in hydropower production under both future climate scenarios. The findings also show that the vulnerability and adaptive capacity of the reservoirs depend on their size.

Further, on the example of a single water management unit in the headwaters of the same semi-arid southern catchment of the Tagus River it was shown that a shift to sustainable water management strategy and river restoration is possible even under reduced water availability in future. The results suggest that adaptation of the complex water management system to climate change and a shift to a more sustainable management of those could be parts of one joint strategy to cope with climate change impacts.

Though it is impossible to give precise quantitative assessment of all future changes triggered by climate warming, the accounting for climate change impacts may help to take right decisions in the water resources allocation and water management, to assure good environmental conditions and avoid potential socio-economic conflicts in river basins. Even in the face of significant uncertainties, associated with climate projections, managers can pursue an adaptation strategy, based on the win-win or no-regret solutions to minimize the worst potential consequences.

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