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Application of the response surface method to hydrological impact studies

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The new trend towards ensemble climate modelling systems and multi-model simulations for generating future climate projections leaves the impact modeller having to deal with a large number of future climate realizations. If analysed in the conventional way, this could lead to a great number of impact model simulations. Therefore, a systematic approach is required that enables a fast, consistent and objective assessment of potential future impacts. One approach is the response surface method. In this study, it is analysed in respect to its applicability to hydrological modelling. Explicitly, this study aims at assessing the impacts of climate change on water availability in several European catchments. The global hydrology model WaterGAP (Alcamo et al., 2003) is applied to generate response surfaces of average long-term standardized water availability to simultaneous changes in the key climate parameters temperature and precipitation. Temperature and precipitation cycles are hereby adjusted to follow a future average annual cycle as projected by 5 different RCMs for 2050. The risk of reaching an unacceptable state in 2050 under the IPCC A1B scenario is examined with different indicators relating to discharge, e.g. high flow, low flow and water quality indicators. Superimposing multi-model climate projections enables a water stress classification of the analysed basins. The results of this analysis provide a good overview of the sensitivity of European river basins towards climate change and allow assigning the basins to categories of different response surfaces. Overall, the degree of response differs between basins in the cold climates of Northern Europe and basins located in the rest of Europe. The degree of future water stress is highly influenced by the intensity of anthropogenic interference with the hydrological system as well as with the amplitude of projected climate changes.

References: Alcamo, J., Döll, P., Henrichs, T., Kaspar, F., Lehner, B., Rösch, T., and Siebert, S. (2003) Development and testing of the WaterGAP 2 global model of water use and availability. Hydrological Sciences, 48, 317-337.