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Climate Change Impacts on Flood Related Hydrological Processes: Further Development and Application of a Global Scale Hydrological Model

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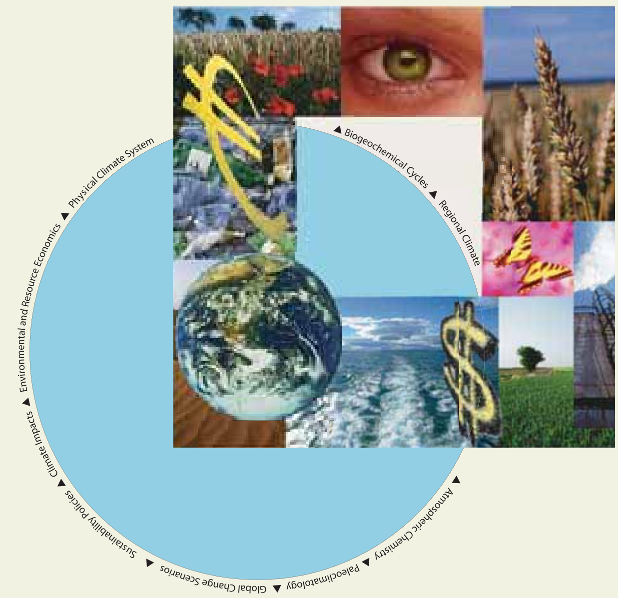

Abstract

Floods are one of the most frequent and most costly natural catastrophes. Major floods worldwide generated costs over US$ 200Billion in the 1990s alone, whereas the summer flood in Europe in 2002 caused economic losses exceeding 20 Billion Euro. Available research suggests that the expected future increase in heavy rainfall and the decrease of the snow cover in many regions worldwide alters future flood risk. Numerous hydrological studies dealing with flood risks have been performed on catchment scale. To date, only two studies investigated climate change effects on floods risks on European scale and there is a lack of models that are able to perform worldwide calculations of flood risks. This gap is bridged by the central theme of this dissertation: The (further) development of a global scale hydrological model to assess climate change effects on flood hazards worldwide. The model should be suitable to define regions on large scale, in which considerable changes in floods might be expected based on different climate change scenarios. The global hydrological model WaterGAP has been improved to comply with the objective of this dissertation. The spatial resolution of WaterGAP has been increased to enhance the information density of the model input, which leads among other things to a more realistic representation of the river network. Further the model results can be assessed with a higher level on detail. But it is also important to look into the model to examine whether the flood related hydrological processes are represented well. Therefore the representation of the snow dynamics as well as the river flow velocity within WaterGAP have been assessed in detail. This included the validation of the model results as well as the investigation of climate change impacts on snow cover and river flow velocity. It has been found that WaterGAP is able to reproduce the snow related hydrological processes well and calculates flow velocities satisfyingly. It is expected that climate change causes a significant decrease of the snow cover magnitude and extent in most regions of the world until the end of the 21st century. Changes in either direction are expected from the climate change impact on river flow velocity in Europe. The improved model version has been applied to investigate the climate change impact on floods in Europe. It has been found that an increasing flood risk can be expected in parts of the Mediterranean, north and south Scandinavia and in different regions of central Europe with varying extent and location. The flood risk is predicted to decrease most pronounced in parts of the Mediterranean as well as in eastern Europe. However, the results vary between different flood indicators, different scenarios, calculated by different GCMs and between the method that is chosen to derive the time series of the forcing climate. Further research should be carried out on the selection or development of flood indicators and on the choice and preparation of the forcing climate.