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Testing LISFLOOD model as a spatial management tool for catchment flood hazard assessment

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An increasing number of residents living on floodplains are being exposed to flood hazards due to climate change and city expansions. Meanwhile, land and water systems are constantly altered under the high pressure of water demand. There is an urgent need for the development of an integrated approach to evaluate the impact of climate change, land use change as well as river alteration on the occurrence of hydrological extreme events. LISFLOOD is a physically based rainfall-runoff model that simulates hydrological processes in a catchment at user-defined temporal and spatial resolution. In this study, the application of the LISFLOOD model was demonstrated in the Wei River Basin for the years 2000-2010. Seven sub-catchments were calibrated and validated, of which four are located on the South bank of the river, two are on the North and one is the main outlet on the floodplain. With DEM and land use maps built on ASTER GDEM datasets, soil maps modified from SoilGrids, LAI maps extracted from MODIS/Terra Leaf Area Index and local river channel and meteorological data, LISFLOOD uses existing locally or globally datasets as model inputs. It computes sub-catchment maps based on the gauge stations and uses the output of the upstream sub-catchments as input for downstream catchments and loops through the whole basin in an automated manner. The calibration and validation results suggest that the model is able to simulate the streamflow at the catchment outlet Huaxian station (Daily streamflow: NSE = 0.69, Pbias = 9%; Monthly streamflow: NSE = 0.79, Pbias = 9%) for flood analysis. The outlets of 17 tributaries that drain into the main river were then identified in order to assess the contribution of each tributary to the total runoff. Based on the result of the contribution analysis, four scenarios were created and evaluated: 1) Business as usual, 2) Additional reservoirs in 2a) the southern catchments, 2b) the northern catchments, 2c) on the main river and 2d) in all catchments and on the main river, 3) Land use as in 1980, 4) Water diversion plan with a pipeline injection from an adjacent catchment. The results of these scenario simulations show a change in flood frequency in three strategically important cities located on the floodplain. There is a decrease of 11.9% of the peak flow as a result of scenario 2d, a decrease of 12.6% in scenario 3, and an increase of 2.5% as a result of scenario 4 averaged for all three cities. Compared to the business as usual case, the minimum base flow at the above mentioned three cities increased by 54 times on average due to dam construction, 41 times by the pipeline injection scenario, and decreased by 0.8 times under the 1980 land use. In conclusion, LISFLOOD is a sophisticated model for land and water management planning at catchment scale which can be applied using existing regional and global scale data.