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an evaluation of the impact of climate change on the water balance of a mesoscale catchment in northeastern germany – a case study

M. Wegehenkel (1), K.C. Kersebaum(1)

(1) Centre of Agricultural Landscape Research, ZALF e.V.„Institute of Landscape Systems Analysis, D-15374 Müncheberg, Eberswalder Strasse 84 (mwegehenkel@zalf.de / Fax: +49 33432 82334/Phone: +49 33432 82275)

Expected future climate changes such as an increase in temperature might decrease water availability especially in spring and summer months in many countries in Europe. Furthermore, this may also result in longer drought periods. Therefore, an estimation of these impacts of climate change on water availability is essential e.g. for the developing of adaption strategies in the actual and future management of agricultural and forested areas.

For such an estimation, a case study was carried out in the Ucker catchment with an area 2415 km^2 located in the northeastern german lowlands. In that case study, we applied a hydrological catchment model to evaluate the impact of climate change on e.g. spatial and temporal dynamics of e.g. evapotranspiration, soil water storage, ground water recharge and discharge. For the application of this model, we used different meteorological time series obtained from 10 meteorological stations located inside and near by the catchment with daily rates of precipitation, minimum and maximum temperature of air, saturation deficit of air, wind speed and global radiation for the time period from 1951-2100. One set of these time series was generated by the Potsdam Institute of Climate Research. The other one, the so called WETTREG-data set, was generated by the Federal Environmental Agency of Germany, Berlin. Both generation procedures were based on the A1B-Scenario with an increase of 1.4 ˚C of the mean annual temperature in Europe.

For the model calculations, we used a landuse cover obtained from multitemporal classifications of Landsat-TM scenes. The soil map used for our model application indicated, that the northern parts of the Ucker catchment are covered with sandy soils with high infiltration rates and low soil water storage capacities. In the southern parts and at the end moraines at higher elevations in the western part of the catchment, soils with a more loamy texture are located. In the flat rivers plains, wetlands and peat soils with high ground water tables dominate. Additional data are a river net map, a digital elevation model with a grid size of 50 m x 50 m and a subbasins map. The highest elevation of the catchment was at 145 m a.s.l. and the lowest one with 0 m a.s.l. at the mouth of the Ucker.

For the calibration of the model, time series of daily discharge rates measured at two gauges in the catchment for the time period from 1989-2005 were compared with the corresponding simulated rates. This comparison was analysed using using the Nash-Sutcliffe-Index NS (Nash and Sutcliffe 1972) and the Index of Agreement IA according to Willmott (1982). The values of IA=0.85 and NS=0.41 indicated a sufficient simulation quality of the calibrated model. The results of this simulation study for the time period 1951-2100 indicated also, that the future water availability especially on the areas with poor sandy soils without groundwater tables showed a stronge decrease in spring and also longer drought periods in summer in comparison with the actual conditions. This decrease will also cause a stronger limitation for crop production on these areas in future.