Geophysical Research Abstracts
Vol. 15, EGU2013-11837, 2013
EGU General Assembly 2013

Climate change impact on the discharge in meso-scale catchments and consequences for the hydropower-production in Switzerland

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The potential effect of climate change on hydrology is the acceleration of the hydrological cycle that in turn will likely cause changes in the discharge regime. As a result, socio-economic systems (e.g., tourism, hydropower industry) may be drastically affected. In this study, we comprehensively analyzed the effect of climate change on different hydrological components like mean and low-flow levels, and drought stress in mesoscale catchments of Switzerland. In terms of mean flows approx. 200 catchments in Switzerland were simulated for the reference period 1984-2005 using the hydrological model PREVAH and projection for near (2025-2046) and far future (2074-2095) are based on delta-change values of 10 ENSEMBLES regional climate models assuming A1B emission scenario (CH2011 climate scenario data sets). We found seven distinct response types of catchments, each exhibiting a characteristic annual cycle of hydrologic change. A general pattern observed for all catchments, is the clearly decreasing summer runoff. Hence, within a second analysis of future discharge a special focus was set on summer low flow in a selection of 29 catchments in the Swiss Midlands. Low flows are critical as they have great implications on water usage and biodiversity. We re-calibrated the hydrological model PREVAH with a focus on base-flow and gauged discharge and used the aforementioned climate data sets and simulation time periods. We found low flow situations to be very likely to increase in both, magnitude and duration, especially in central and western Switzerland plateau. At third, the drought stress potential was analyzed by simulating the soil moisture level under climate change conditions in a high mountain catchment. We used the distributed hydrological model WaSiM-ETH for this aspect as soil characteristics are much better represented in this model. Soil moisture in forests below 2000 m a.s.l. were found to be affected at most, which might have implication to their function as avalanche protection forests. However, we found high uncertainties related to the downscaling method applied. Finally, we analyzed the effect of changed discharge characteristics on the hydropower production by coupling the hydrological model BERNHYDRO with a hydropower management model. For the near future (until 2050), the results indicate that losses in the hydropower production during the summer can be compensated by benefit during winter. These different aspects of climate change impacts on the hydrosphere reveal a differentiated picture involving potentially threatened and widely unaffected catchments, hydrologic parameters and hydrologic constraints to the society.