Geophysical Research Abstracts
Vol. 16, EGU2014-6516-1, 2014
EGU General Assembly 2014

Runoff scenarios of the Ötz catchment (Tyrol, Austria) considering climate change driven changes of the cryosphere

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The seasonal distribution of runoff in alpine catchments is markedly influenced by the cryospheric contribution (snow and ice). Long-term climate change will alter these reservoirs and consequently have an impact on the water balance. Glacierized catchments like the Ötztal (Tyrol, Austria) are particularly sensitive to changes in the cryosphere and the hydrological changes related to them. The Ötztal possesses an outstanding role in Austrian and international cryospheric research and reacts sensitive to changes in hydrology due to its socio-economic structure (e.g. importance of tourism, hydro-power).
In this study future glacier scenarios for the runoff calculations in the Ötztal catchment are developed. In addition to climatological scenario data, glacier scenarios were established for the hydrological simulation of future runoff. Glacier outlines and glacier surface elevation changes of the Austrian Glacier Inventory were used to derive present ice thickness distribution and scenarios of glacier area distribution. Direct effects of climate change (i.e. temperature and precipitation change) and indirect effects in terms of variations in the cryosphere were considered for the analysis of the mean runoff and particularly flood frequencies.
Runoff was modelled with the hydrological model HQSim, which was calibrated for the runoff gauges at Brunau, Obergurgl and Vent. For a sensitivity study, the model was driven by separate glacier scenarios. Keeping glacier area constant, variable climate input was used to separate the effect of climate sensitivity. Results of the combination of changed glacier areas and changed climate input were subsequently analysed.
Glacier scenarios show first a decrease in volume, before glacier area shrinks. The applied method indicates a 50% ice volume loss by 2050 relative to today. Further, model results show a reduction in glacier volume and area to less than 20% of the current ice cover towards the end of the 21st century.
The effect of reduced glacier areas can be seen in a reduction of runoff particularly in summer. Maintaining the glacier areas constant, runoff would increase in summer month caused by higher ice melt under climate change conditions. Also runoff increases in spring and fall is expected due to a shift from solid to liquid precipitation in the mountain catchments. The simulation of the combination of glacier change and climate change scenarios results in an increase in runoff in spring due to a shift in the snowline and a decrease in runoff in summer caused by reduced glacier area.