Geophysical Research Abstracts
Vol. 15, EGU2013-8180, 2013
EGU General Assembly 2013

Future hydrological regimes of the upper Indus basin: results from the PAPRIKA project.

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The mountain regions of the Hindu Kush, Karakoram and Himalaya (HKKH) are the “third pole” of our planet, and the glaciers in this area play the role of “water towers”, delivering significant amounts of melt water, especially in the dry season, essential for agriculture, drinking purposes, and hydropower production. The recent dynamics of glaciers in the Karakoram area is also called the “Karakoram anomaly”, characterized by substantially unchanged ice cover during the last decade, against noticeable area loss worldwide, possibly leading to slightly decreasing stream fluxes. Yet, recent major floods occurring in Pakistan and the Karakoram area, may represent an effect of modified climate in the area, carrying heavier precipitation in the Monsoon season. Therefore, and notwithstanding the uncertainty embedded in measuring and modelling the hydrological behaviour of this area, there is a great need for assessment of future water resources and hydrological variability in this area. We present here results obtained at year two of the SHARE-Paprika project of the EvK2CNR Committee of Italy, aiming at evaluating the impact of recent and prospective climate change on the hydrology of the upper Indus river. We focus here on a particular watershed, the Shigar river close to Shigar, with an area of about 7000 km2, nested within the upper Indus basin, and fed by seasonal melt from two major glaciers (Baltoro and Biafo), at the toe of the K2 peak. We illustrate data gathered during three field campaigns during 2011-2012, aimed at investigating ice ablation dynamics, seasonal accumulation, and hydrological fluxes from the Baltoro-Biafo glaciers area and Shigar river. Based upon these data, topographic information, historical climate data and remote sensing data of ice and snow cover, we set up a semi-distributed, altitude belt based hydrological model, providing acceptable depiction of in stream flows, and snow and ice cover dynamics. We then project the future (until 2050) hydrological cycle in the area by feeding the hydrological model with future precipitation and temperature (plus downscaling, whenever necessary) from two climate models, one global (EC-Earth), and one regional (RegCM), the latter specifically set up for SHARE-Paprika project. The projected flow duration curves, some selected flow descriptors, and the significance of modified flow regimes in the Shigar river are then evaluated. We comment upon modified snow cover, ice ablation regime and implications for future water resources and flood regime in the area. The uncertainty of the results is addressed, and future research questions are discussed.

Keywords: Upper Indus basin; hydrological models; climate models; future water resources.