Geophysical Research Abstracts,
Vol. 11, EGU2009-12033, 2009
EGU General Assembly 2009

The water balance as a confirmation of glacial melt in the upper Indus basin

W.W. Immerzeel (1,2), P. Droogers (1), S.M. de Jong (2), and M.F.P. Bierkens (2)

(1) FutureWater, Wageningen, Netherlands (w.immerzeel@futurewater.nl), (2) Utrecht Univeristy, Utrecht, Netherlands

The spatial variation in observed and projected climate change is large and mountain ranges and their downstream areas are particularly vulnerable for several reasons. Firstly, the rate of warming in the lower troposphere increases with altitude, i.e. temperatures will increase more in high mountains than at low altitudes. Secondly, mountain areas exhibit a large spatial variation in climate zones due to large differences in altitude over small horizontal distances. These conditions make mountain areas more vulnerable to climate change. Finally, mountains play an important role in the water supply of downstream areas. More than one sixth of the global population depends on water supplied by mountains and changes in hydrology and water availability are expected to be large in mountain basins. Especially the diminishing role of snow and ice as a natural store for water supply will have a tremendous impact.

For all of these reasons knowledge on snow cover and ice dynamics and how it influences water availability is of great importance and surprisingly regional studies on this topic are largely lacking. The focus of this study is on the upper Indus basin, where snow and ice melt from the Himalayan and Karakoram ranges constitute the most dominant part of river discharge in comparison with other large Asian rivers. Similar to other glaciated areas global warming also has its effect here. However the effects of climate change on the cryosphere and subsequently on the basin hydrology remain largely unknown.

In this study various remote sensing products are used to identify spatial-temporal trends in snow cover in the upper Indus basin from 1999 to 2008. It is shown that remote sensing allows detection of spatial-temporal patterns of snow cover across large areas in inaccessible terrain, providing useful information on a critical component of the hydrological cycle. The upper Indus basin is, for its water resources, most dependent on snow and ice melt and large parts are snow covered for prolonged periods of the year. A significant negative winter snow cover trend was identified for the upper Indus basin. A hydrological model is used and forced with remotely sensed derived precipitation and snow cover. The model is calibrated using daily discharges from 2000 to 2005 and stream flow in the upper Indus basin can be predicted with a high degree of accuracy. From the analysis it is concluded that there are clear indications that climate change is significantly affecting the hydrology of the upper Indus basin due to accelerated glacial melting. This conclusion is primarily based on the observation that the average annual precipitation over a five year period is less than the observed stream flow and the unexplained source of water is proxy for the cryospheric changes in the basin. We conservatively estimate the annual loss of ice to be 1% of the total ice reserve. Using the calibrated model and results of the PRECIS climate model several climate change scenarios are then simulated to assess the effects of the hydrograph. All scenarios show a shift in discharge from summer to spring due to accelerated melt and a shift from snow to rain precipitation.