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Hydrology and Earth System Sciences Discussions

Interactive comment on "

Snow cover dynamics and hydrological regime of the Hunza River basin, Karakoram Range, Northern Pakistan" *by* A. A. Tahir et al.

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RC 1. The authors state the Hunza is not impacted by global warming because a large part of the basins, which also produces most runoff is at high elevation where temperatures remain negative. I challenge this statement because there is always equilibrium between the melting point and the extent of the snow cover in a catchment. If the temperature rises with a constant precipitation snow cover will always recede. It depends on the topography of the catchment how fast the snow cover will be reduced. Your data

shows that the temperatures in the basin do not show strong positive trends (0.0003 x 12 = 0.0036 degree / year compared to the global average of 0.021 degree / year over the last decade) and this is the reason why no large trends in runoff are observed. The reasons for this relatively constant temperature are multi-fold and should be compared to nearby stations before any conclusions can be drawn.

AR: The referee has challenged the statement by considering the rising temperature with a constant precipitation. But this is not the case in the Hunza River basin. The phenomenon of cryosphere area expansion is explained by constant temperature trend and increasing westerly circulations (winter precipitation) in the central Karakoram area. These results are found by the data analysis in this study and by Hewitt (2007) as given at page 2836. The correlation of valley temperature records to a nearby Gilgit station are presented in Table 3 and discussed at page 2831.

RC 2. In the abstract it is stated that snow cover is expanding in contrast to receding glaciers worldwide. Glaciers and seasonal snow are two very different things that respond very differently and the authors seem to suggest that climate change is not happening in the Hunza based on this statement. Evidence on the glacier extent and down wasting or thickening rates should be included to support this conclusion. Glacial melt is an important contributor stream flow, but the topic is completely ignored in the paper.

AR: The results obtained in this study for snow cover area change are based on the MODIS satellite images and it is difficult to differentiate between the glaciers and snow cover from these images. However, the references of the previous studies conducted on these glaciers are given in this study as Hewitt (1986; 1989; 2001; 2005; 2007), Immerzeel (2009), Wake (1989) and Young (1990) etc. We discussed the melt of the cryosphere (snow and ice) in the Hunza River basin in detail in a research paper titled "Modeling snowmelt runoff in the Hunza River basin", currently under the process of publication (resubmitted after moderate revisions to the Journal of Hydrology). However we will add some sentences to explain the glacial melt contribution in the Hunza

River basin.

RC 3. Although winter precipitation is significant in the Hunza I am not convinced it exceeds the monsoon peak. It would be good to show some proof of this statement.

AR: We did not claim that the winter precipitation is greater than the monsoon precipitation. But the Hunza does not receive as much summer (monsoon) precipitation as the other Himalayan catchments because of high Karakoram barrier.

RC 4. Runoff in these basins is obviously a function of temperature and precipitation. The authors state that their precipitation measurements are completely unreliable and the fact that average stream flow exceeds average precipitation by at least a factor 2 seems to indicate something strange is indeed occurring. The authors mention a severe under catch of precipitation at high altitude and a strong increase in precipitation at elevations higher than 5000 meter based on work of Hewitt and others. This seems plausible but extremely large. A possible other explanation could be increased glacial melt. It would be good to do a literature review on glaciers in the Hunza.

AR: The Hunza River runoff is influenced by the glacial melt during two months (July and August). However the main factors influencing the Hunza River discharge are the winter precipitations (snow fall) and the summer mean temperature. We will add the sentence to explain the glacial melt in Hunza basin.

RC 5. The authors mention an NDSI threshold of 0.82, while this is normally 0.40.

AR: The NDSI threshold value used for MODIS images is normally between 0.40-0.54. But this may not be the case in other satellite images. As a threshold value of 0.90 for ASTER images was found by Haritashya et al. (2009) in the region of Afghanistan. We calibrated this value on the 4 ASTER images and found a threshold value of 0.82.

Overall, the referee comments really helped us to improve the scientific quality of the manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 2821, 2011.