Hydrol. Earth Syst. Sci. Discuss., 8, C553–C556, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C553/2011/

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.

B. Bookhagen (Referee)

bodo@eri.ucsb.edu

Received and published: 20 March 2011

The manuscript presents a study of remote-sensing and river-gauge data from Upper Indus Basin in the northwestern Himalaya. The authors use the 8-day MODIS snowcover product in conjunction with a with river discharge dataset at the Hunza River from 1966 to 2008. For some cases, the MODIS data were validated with higher-spatial resolution ASTER imagery. The manuscript provides a hydrologic description of a remote area that needs to receive more attention because of its significance of transient-water storage. The discharge from this area is crucial for a large population

living downstream in the Indus-catchment area. Overall, the presented data are robust and the conclusions are solid. See more detailed comments below.

The scientific significance in this paper is several folds: First, the authors show a decrease in discharge over the past 25 years of the Hunza River. This is explained with an increase in the cryospheric reservoirs as has been suggested by other studies (for example, see [Scherler et al., 2010]). Second, the manuscript highlights the complex interactions between climatic variables and the cryospheric reservoirs. The manuscript does not contain substantial new concepts, but supports the hypotheses and results with solid data.

The scientific quality of the manuscript is good, but can be improved in places: The validation of MODIS snow cover data with ASTER is an important step, but only a visual presentation and a table are presented. The results are robust and I have no doubts about this as the MODIS snowcover product has been validated with several other datasets worldwide. However, in this high-relief area with steep topography, I am wondering about the impact of deeply incised rivers on snow-cover distribution. Figure 6 clearly indicates that the MODIS data gridcells are dominated by snowcover even in snow-free valleys. This is really important, because snowmelt models depending on high-resolution topography and atmospheric lapse rates will overpredict snowmelt from these areas. As an additional (very interesting) analysis, the authors could separate the snowcover data into elevation slices and then compare the fit. My prediction is that low-elevation, high-relief areas have a larger mismatch than lower slope, higher elevations.

There have been recent reports that underline the importance of snowmelt processes in this part of the Himalaya [Bookhagen and Burbank, 2010] and indicate growing cryospheric reservoirs through advancing glaciers [Scherler et al., 2010].

I am somewhat uncertain about performing a trend analysis on a 9-year long precipitation record (Figure 8). There are several monsoonal oscillations and large-scale atmospheric circulation systems that have longer periodicities. If the authors want to retain this analysis, it should be justified with either published, longer records or other

arguments.
Overall, the presentation quality is good. There are several improvements on the figures that should be considered before resubmission. The figures are an integral part of the manuscript and help to convey the information – good figures ensure that the scientific message comes across.
Table 1: No need to mention ArcMap. If you mention a software package, the correct reference is ESRI ArcGIS (ArcMap is just a subset of ArcGIS). Please correct subsequent reference in tables and text, too.
Table 5: This contains a lot of information, but is not easy to read. It would be really instructive to have a figure showing these correlations in graph form (chose only the most important ones). This table can be retained.
Figure 5: It is hard to distinguish between the colors of Ziarat and Gilgit.
Figure 7: In the caption, you have to list the data source for the snowcover data (MODIS). It may be instructive to add it on the Y axis. Change label Lineaire and increase size and width of line.
Figure 8: Change label Lineaire (also in all other figures, too). In the caption, briefly indicate how snowmelt or snow-water-equivalents were included in precipitation records.
Figure 9: This graph contains too much information and needs to be simplified. First, add a moving average line for all years. Second, choose the max and min snowcover years and show their moving average to give a sense of the inter-annual variability.
Figure 11: Show uncertainties for fit. Is this a weighted fit line? It is likely that large snow cover difference has a larger impact on discharges, because larger snowcover may also results in higher snowdepths (at least in low-slope areas).
Figure 12: Again, what is the uncertainty of the Runoff trend? There appears to be a decreasing trend, but how certain can you be? Change label rain to precipitation, as I assume you are merging rainfall and snowfall, right?

References

Bookhagen, B., and D. W. Burbank Toward a complete Himalayan hydrological budget: Spatiotemporal distribution of snowmelt and rainfall and their impact on river discharge, J. Geophys. Res., 115(F3), F03019.
Scherler, D., B. Bookhagen and M.R. Strecker (2011), Spatially variable response of Himalayan glaciers to climate change affected by debris cover, Nature Geosci, 4(3), 156-159.

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