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Hydrology and Earth System Sciences Discussions

Interactive comment on "Basin-wide water accounting using remote sensing data: the case of transboundary Indus Basin" *by* P. Karimi et al.

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General comments

The authors apply the water accounting plus method of a companion paper to the Indus river basin. The paper demonstrates the value of water accounting in the context of a particular basin.

However, the authors are somewhat muddled in the basic aim of the paper, and as such do not quite do themselves justice. In several places, they write that the application is only a demonstration, and that the paper does not deal with solutions for the Indus (stated, for example, in the first paragraph of section 6). Nevertheless, in the dis-

cussion and conclusions, the authors write that "policy makers have to make a choice between these options" and "water and land productivity has to be improved". The final paragraph of the conclusions gives suggested solutions and states that "Policy makers and donor agencies should work out plans in that direction." These statements are not those of a demonstration of a method: they are recommendations about solutions. Some, such as a suggestion of providing micro-credit, are not based on anything in the water accounting method.

The authors should either stick to their stated intention of providing a demonstration of application of the water accounting plus method, or drop the pretence and declare that they are indeed suggesting solutions. At the moment, it is neither really a demonstration example, nor a full exploration of solutions. Solutions such as providing micro-credit should only be canvassed if they are backed up by reference to studies demonstrating that micro-credit does indeed work in the Indus Basin.

In the title, the Indus is described as transboundary, yet there is no reference to transboundary issues. Nor is there any hint in the analysis of the considerable difference in agricultural yields between the Indian Punjab and Pakistani Punjab (Sharma et al, 2010; Cai et al, 2010). In offering solutions (unless they choose to refrain from so doing), the authors should consider why there are such differences.

Specific comments

The authors state on page 12923 that "The fundamental data on water sources and flows in basins such as the Indus Basin are either missing or not accessible". Depending on what the authors define as fundamental data, this is arguably incorrect. Flow data over several decades for several gauges in the Indus and its tributaries can be sourced from dataset ds552.1, available on the internet (URL: http://rda.ucar.edu/datasets/ds552.1/#access). Not every tributary is represented in this database and, like all other data sources, there are likely to be errors, but the information is certainly helpful in understanding and constraining water balances in the

basin (e.g. Eastham et al, 2010). (Note: Eastham et al noted that the measured river discharge in parts of the upper basin exceeded the apparent total rainfall for those parts. Their report gives erroneous, and excessive, "corrected" rainfall figures to correct for this, and they do not consider glacier melting as a possible explanation.)

Furthermore, Section 3 on data makes no mention of flow data, even though in several places the outflow is mentioned, and later in the paper on page 12931 is given a value of 21 km3 "derived from discharge measurements". What is the source for the discharge measurements?

The authors write on p 12929 that "Despite heavy utilization of groundwater in the Indus, direct measurements on groundwater change remain limited. The WA+ offers the possibility to estimate total bulk groundwater storage change through mass conservation 5 of the water balance. This is only feasible if ET data is available, because ET is usually computed as the residual term in the water balance. Measured outflow is used to back calculate total groundwater storage change by closing the water balance. It appears that an amount of 29.8 km3 was extracted from groundwater storage during 2007". Given the statement on p. 12923 that data on flows are not available (see also comment above), it is not clear whether they have an outflow measurement to use in the water balance. In the abstract, the sum of ET plus outflows is 523 km3, which exceeds the precipitation plus groundwater depletion of 513 km3. The abstract should note also the surface water storage depletion of about 10 km3 to close this balance.

The glacier melt component is suggested as about 2 km3, whereas Immerzeel et al (2009) suggest that 22 km3 is plausible, though the figure was simply that required to close the water balance (given an estimated ET for the upper Indus basin that exceeded the measured discharge). Neither figure can be regarded as anything more than gross estimates, which points to the desirability of further work.

E and T in Table 2 generally do not add up to ET in the table. The discrepancy is sometimes large. The authors should check and correct their figures.

The first paragraph of section 4.2 refers to Figure 4 when Figure 3 is meant, and the second paragraph of the section refers to Figure 2c when Figure 1c is meant. Also in that paragraph, the authors state that, except for evaporation from natural lakes and industries, all evaporation is 100 % non-beneficial. I think that evaporation from much more than natural lakes would be considered beneficial or necessary in realising a benefit, and I would include rivers, wetlands, canals, artificial lakes and so on.

In Section 4.3 Productivity sheet, the authors describe biomass production sequestering carbon, and note that much carbon in cropping is removed from the field after harvest and hence (they imply) is not sequestered. They give no evidence, reference or even description of the method they use to determine how much carbon is assumed to be removed from the field. Furthermore, the removed carbon goes somewhere. Do the authors know that it is not sequestered?

On page 12934, the authors give domestic and industrial uses as 1.8 and 12.2 km3, whereas Figure 5 has the figures the other way round (domestic 12.2 and industrial 1.8 km3). The latter is consistent with Aquastat.

Keller and Keller (1999) is not in the reference list.

References: Cai, X.; Sharma, B. R.; Matin, M. A.; Sharma, D.; Gunasinghe, S. 2010. An assessment of crop water productivity in the Indus and Ganges river basins: Current status and scope for improvement. Colombo, Sri Lanka: International Water Management Institute. 30p. (IWMI Research Report 140). doi: 10.5337/2010.232.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 12921, 2012.