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Hydrology and Earth System Sciences Discussions

Interactive comment on "Sustainability of water resources management in the Indus Basin under changing climatic and socio economic conditions" *by* D. R. Archer et al.

Anonymous Referee #1

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1 general comments

This is a nice and well written paper that reviews the state of the art of water resources management in the Indus basin in view of climate change. It should be noted that the paper does not present new results (apart from shortly mentioning the extension of the time series used for trend analysis) but I think it can well serve as a review paper, especially within the scope of the special issue. It is important to view climate change impacts in a wider context, even if quantification of the different impacts is difficult. In view of the data scarcity of the region, I see particular value in the critical discussion of the grey literature complemented with the authors' field experience.

However, in line with Berthiers comments, I think that in places the grey literature sources could have been used with more scrutiny and perhaps with a better complementation by peer reviewed literature. In some places, especially those where a lot of quantitative information is presented (see specific comments), it may be good to mention the sources more frequently, and give some meta-information such as the year or time-length over which the data were collected.

In terms of the hydrological discussion, I have one major comment, and that is the lack of thorough discussion of the factor temperature throughout the entire discussion. I think that the impact of temperature is essential, for several reasons:

- a temperature increase may have a considerable impact on evapotranspiration, and therefore on changes in both water supply (runoff) and demand (irrigation);
- changes in temperature may have an impact on the timing of snow melt in spring and accumulation in autumn, hence potentially increasing the length of droughts;
- changes in temperature will affect the behaviour of glaciers in the future;
- the global climate models are much more in agreement about temperature, at least the direction of the trend, hence the discussion will be less speculative than for precipitation.

This remark frames in a general concern that the hydrological discussion, largely based on correlation observations, can be improved in places (see also the specific comments I made below). This should not necessarily incur a lot of work. For instance, adding a graph on the seasonality of precipitation (including extremes) would be very useful to assess whether an earlier snow melt in spring may lead to water scarcity or whether it is complemented by spring and summer precipitation.

2 Specific comments

p1887/19 - 1888/18: can you provide more references: from which year are these sources / over which time period?

4.1. Are improved techniques for sediment removal (dredging) an option?

4.3. are there any references for this part from the study area?

1892/23-27: consider reformulating. I don't think that a better abstraction regulation and opposition to new dams are incompatible but I assume that lower river users have simply opposed new dams without suggesting potential solutions, such as abstraction regulation.

1894/15-17: Although there is surely some truth in it, the statement sounds a bit dramatic without background information on the farmer's budget for pumping fuel and the alternatives.

4.4. again, I presume this information may be based on limited sources and the experiences of the authors, but it would be good to give some more references particularly for the mentioned data (e.g., 1893/3)

1896/6: how big is this degradation? It may be worthwhile showing the graph, as it seems these are new (or updated) analyses.

1896/19: Spring and summer temperature may have the greatest impact on trends in runoff, but I would certainly not disregards other factors. Precipitation all year round has an impact on the glacier mass balance. However, it may not surprising that winter precipitation does not show a significant relation with summer discharge. Winter precipitation falls probably as snow, which will eventually be incorporated in the glacier ice mass. How much of this melts the next summer depends on the summer temperature, but the rest contributes to the long-term glacier mass balance. Hence, in the long term, a significant decrease in winter precipitation may eventually have an impact on the total

glacier mass and hence summer melt. But you would not be able to detect this with a simple regression.

1897/13: glacier surges are often linked to increasing melting of glaciers.

1896/10: does Hewitt (2005) provide any potential explanation of the reason for this increase? This would be very interesting. For instance, if the increase is mainly precipitation driven, then this may well persist in the future. However if it is a decrease in temperature (which would be compatible with your own observations in Fig 4), then this would be much more worrying, as (likely) future temperature increases may quickly reverse the trend!

1898/4-8: as discussed in my earlier remarks on winter precipitation and glacier mass balance, limiting the discussion to summer temperatures may be insufficient.

1900/9: maybe add satellite imagery that is used directly for precipitation estimations?

Fig. 1: Would it be possible to indicate the location of rain gauges on the map? I would also agree with the comment by Ethienne Berthier that a better glacier map is helpful, especially if data would be available in the public domain.

Fig. 2, 3, 5: improve the quality (although this may be due to the production process?)

3 Technical comments

1887/2 and onwards: suggest to use SI units

1901/26: irrigation systems

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 1883, 2010.