

## ***Interactive comment on “Land-use change may exacerbate climate change impacts on water resources in the Ganges basin” by Gina Tsarouchi and Wouter Buytaert***

**Anonymous Referee #1**

Received and published: 4 September 2017

General comments: This is a well-presented and interesting paper that makes a useful contribution to the projection of water resource availability in the Ganges basin and elsewhere. The use of a range of outputs from models of climate, water demands and land use is novel and allows for particularly valuable exploration of relative impacts and uncertainties. However, while the climatic projections come from well-developed models, the land use and water demands are fairly crude, not very well justified, and may be internally inconsistent. Revisions focusing on improvements in this area could improve the paper substantially and make it an excellent exemplar of a widely-applicable methodological approach. In the absence of such improvements the conclusions of the study are not fully supported and would have to be significantly qualified.

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Specific comments:

Introduction: The first (long) paragraph doesn't really need so many population statistics; they would be better grouped and trimmed.

Research hypothesis, lines 112-114: This hypothesis is not fully tested as currently worded, because the land use impacts are not assessed individually. Doing so, especially if more advanced/diverse land use 'scenarios' were used, would be very useful.

Land use 'scenarios', Section 2.4: These 15 projections of land use change are not wholly convincing, and certainly not as useful as they could be, for a number of reasons. 1) 2000-2010 is a very short time-period, during which highly specific factors may have driven land use transitions. Is there any reason to think this particular period will be representative of future change? 2) They are not really 'scenarios', in the sense that they don't represent coherent and alternative futures, but simply extrapolations of arbitrary (and overlapping) time periods. 3) There's an inconsistency in assuming, on the one hand, that future change will follow the same trends as observed in the past but acknowledging that, on the other hand, past trends depend on the time period you consider. Why should these 15 projections differ, and what does that mean for future change? And why use all 15 possible combinations? 4) There's also a risk of inconsistency with the other (climatic and water demand) model inputs, though this is obviously lessened by the fact that the study only runs until 2035. Still, are the same land use changes really consistent with both (contrasting) climate scenarios, and with a single water demand scenario? This issue seems to require substantially more thought and explanation, preferably with respect to the underlying processes of land use change, to develop and justify scenarios that account for past change in a coherent way and that are consistent with other assumptions about the future.

Water demand data: As above, the use of this data is not really consistent with the other (RCP and land use) scenarios, since water demand is so strongly dependent on both land use and climate, and so should vary depending on those scenarios. At the

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very least, the extrapolation of past land use is unlikely to be fully consistent with either climate scenario, and the extrapolation of past water demand cannot be consistent with all 15 land use scenarios. I'm not sure that fully consistent water demands can be derived here, but some clear acknowledgement of these issues is certainly needed, especially when it comes to interpreting the results.

Figure 4: This type of plot is not very suitable here as the scenario-based changes are not measurements of the same things. It would be better to simply plot all the values. Also, could an explanation for the projected increase in snow cover be provided? This seems to contradict the climate scenario results.

Discussion: Depending on the revisions made to the scenarios, the discussion section needs to do more to explain and interpret the effects of those scenarios. The results are clearly highly conditional on scenario definitions, and with such a limited range as there are at present it's hard to draw any strong or general conclusions. A couple of additional specific points below:

Lines 363-369: This is an almost verbatim repetition of section 2.5. Since it's in the Discussion, perhaps add some justification of assuming that water demand in contrasting futures will follow the trend from one period of the past? And some discussion of what this means for interpretation of the results?

Line 383: 'the main driver of future change. ...is not land use change' is far too general a statement, given the highly limited nature of the 'scenarios' used. In fact I would suggest deleting this and going straight into the next sentence. Further, the point here (repeated in the conclusion) that land management is more important than land use is not derived from this work, and should be referenced.

Figures and Tables: These could be trimmed, with some moving to the supporting information. Specifically, Figures 2 and 3 could be combined, and Table 1, Table 2, Figure 5, Figure 7 and Figure 8 removed from main text without losing any essential information.

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Technical comments:

General: There are too many abbreviations, which make the paper hard to read in places. Those that seem particularly unnecessary include 'UG' for Upper Ganges, 'DJF' etc. for seasons (e.g. December-February / dry period), 'ET' for evapotranspiration, 'SM' for soil moisture.

Abstract, line 7: Future projections aren't themselves affecting the hydrological response – better as 'might affect'?

Abstract, line 16 and elsewhere: Calling the land use projections 'scenarios' is not really accurate, as mentioned above.

Line 41: 'expects' rather than 'eyes'?

Lines 88-89: comma needed after 'concentrations'

Line 117: Please reference (some of) these 'few studies'

Line 182: comma after '5 & 6' isn't necessary.

Table 1: The 'Country' column doesn't seem particularly relevant?

Line 329: Clearer if 'results are presented' is deleted?

Line 335: 'calculated' rather than 'presented'?

Line 346: 'compared to historic values' seems unnecessary

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2017-468>, 2017.

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