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Comment

Interactive comment on “Modelling multiple threats to water security in the Peruvian Amazon using the WaterWorld Policy Support System” by A. J. J. van Soesbergen and M. Mulligan

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General comments

This is an ambitious paper that seeks to integrate biophysical and human impacts on hydrological processes in the Peruvian Amazon and link these to a two-part (quantity and quality) definition of water security. It does so through application of WaterWorld, a tool that has been developed it seems largely by co-author Mulligan. The challenges identified and addressed by the paper are real, and in general terms, the methods used allow for successful development of the model runs.

The manuscript makes some clear contributions to the field of modeling in data-poor

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environments. However, I find there are some conceptual and methodological challenges in using the model for water security assessments. The water balance and supply-demand analyses appear not to account for groundwater. And the analyses of water-quality threats to water security are based on assumptions that are not verifiable (e.g., area of extractive concessions that are actually exploited, differences in downstream water-quality impacts that result from mining compared to land conversion for agriculture, etc.). This limitation in itself might be remedied with a sensitivity analysis, e.g., varying concession exploitation percentages, instead of the arbitrary definition of $HF > 50\%$. However, 1) the local-scale (point discharge) to medium-scale (subcatchment accumulation) processes of water-quality impacts of land disturbance, and 2) differences in impact caused by various land uses raise questions about the validity and utility for decision-making of the water quality component.

Finally, given that exploration of scenarios, their implications, adaptive actions, etc. is at least part of the authors' stated objectives (in the abstract and conclusions), I am struck by the apparent lack of any engagement with users, decision-makers, or other stakeholders. My sense is that this may be a stated intent for future work; however, if this is the case, then a process by which users engage with the model and its outputs should be outlined.

In sum, my evaluation is that this manuscript should be reconsidered after major revisions.

See further comments on these observations below.

Specific comments

Refer to page/line numbers.

Last parts of Introduction read too closely to the Abstract.

569/25 – the following is not clear: “10 deg square tiles at 1 km² resolution or 1 deg square tiles at 1 ha resolution”. This refers to the maximum grid size; simply state

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WaterWorld accepts a YxY grid.

573/8-10 – trend in temperature is per year? Increase of 2 degC over what time period?

573/19 – per year?

574/5-9 – not clear: “modelled wind driven precipitation, actual evapotranspiration and its cumulation downstream as runoff” – you are modeling ET land-atmosphere flux, cloud formation, and subsequent precipitation? Additionally: “output generated by the wash soil erosion model . . . and snowfall and melt water production” – I assume the output of the erosion model is sediment transport but is this also runoff to be combined with melt water?

574/15 – clarify how you separate irrigated from rainfed agricultural ET – blue from green water if you will – because your water security definition appears to be based on blue water. Alternately if you combine them, the green water is likely to very substantially dominate the water balance (sufficiency-based water security definition) in volume terms

574/23 – there have been water security assessments that consider groundwater

575 - The human footprint assessment of water quality (percentage of runoff generated on land upstream that has some human activity) is a very crude indicator, understandable given the lack of information available. However, the point-source impacts of mines, oil/gas development, and urban wastewater (is any of it treated, even for urban centers?) indicates that this is a major methodological limitation of WaterWorld.

I have no ability whatsoever to comment on the assumption of 10% mining conversion and 1% oil/gas conversion of concessioned area to actual exploitation. This raises further questions about the water quality component of the analyses.

577/13-14 – should be denoted SRES A2a scenario; warming by 2100 is relative to 2000. 577/19-20 – mean *annual* increases of 61mmyr⁻¹ and 180mmyr⁻¹ are impossible; you mean 21st Century projected increases of X and Y in annual precip

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578/6-10 – “nearly 45%” ... “nearly doubling” - which one do you mean? Sustained 5%/yr population growth for 60 years (1990-2050) would increase population by over 18 times; for 40 years (2010-2050) by over 7 times. Obviously sustained 7%/yr growth would increase numbers far more. Have you looked at other projections? I don't know Peru well, but many countries in the LAC region have populations that are projected to plateau within a few decades from now.

578/20 – what water storage and transfer currently exist? Your comments on 582/23 don't clarify which sub-basins are slated for infrastructure development, compared to those you are projecting will face water deficits. From a policy perspective, are you indicating that water storage and transfer should be expanded, or that lack of infrastructure will limit growth (or per capita water demand, ie, through different livelihood futures)?

581/5 – I assume you mean changes in the *intra-annual/seasonal* distribution of precip?

581/14-17 – what is important is how well individual GCMs within the ensemble reproduce the climatology. Additionally, I don't know how well CIAT's downscaling accounts for Andean topography (I think this is the point you're trying to make by citing Wouter Buytaert)

581/27 – not clear “brown and grey water” (mining and wastewater?)

582/20 – 583/2 – this paragraph needs to be rewritten to better capture what I believe you are trying to say, i.e., that dams provide storage until filled with sediment; that construction of dams, road, power lines, etc. disturbs the land and generates erosion (HF impacts). “major infrastructural threats” = threats of major infrastructure? What is it about “managed flow regulation and changes in sediment loads” (or is it sedimentation from a previous sentence?) that “could have serious implications for water quantity and water quality”?

583/7 – you have made some major assumptions along the way to claim “the model

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includes all necessary data”. And I’m not clear what “interactively” in the final sentence of the paragraph actually refers to, interactive modeling with users? What would be particularly interesting here would be to actually have “non-technical users” look at WorldWater or review/discuss your outputs. I assume this hasn’t been done or at least not yet in a planned fashion. You may find it useful to look at the large and expanding literature on science-policy dialogues, the use of (modeling-supported) Scenario Planning to identify critical uncertainties, etc.

Technical corrections

None – this is written very clearly.

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