

Interactive comment on “On the social dynamics of moisture recycling” by Patrick W. Keys and Lan Wang-Erlandsson

Patrick W. Keys and Lan Wang-Erlandsson

patrick.keys@colostate.edu

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Reviewer Comment = RC Author Comment = AC

RC Overview: The paper by Keys et al presents three case studies of links between the social and terrestrial moisture recycling system. This study combines quantitative modeling of terrestrial moisture recycling with metrics and a literature review of social factors. In this way, the study estimates the major sources of precipitation (i.e. precipitationsheds) for three case study countries. Gridded social variables are then evaluated for the source and sink nodes in each case study. Finally, a literature review is performed to reveal additional context for each case study and enable the development of moisture recycling social ecological systems archetypes.

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Overall, I think this is an innovative, well-executed, and (reasonably) well-written paper that would make a unique contribution to the literature. I recommend publication after consideration of my comments below.

AC. We are pleased that the Reviewer has considered this work carefully. We hope the responses below address the Reviewers' concerns.

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Major comments:

RC1. Human well-being/welfare has a precise definition in the social sciences literature. The term(s) "well-being" and "welfare" are used several times in the paper. I don't think these is the best term to use, since they mean something precise in the economics literature that is distinct to the meaning here. I think it would be better to refer to "social" aspects/variables/indicators of source and sink nodes. Then, the precise metric references should be specified whenever possible.

AC1. Thank you for the comment. We note that the phrase human well-being and welfare have specific definitions. As suggested by the reviewer, we use the specific phrases that describe the variable /indicator/ etc. and we make clear when using a general phrase that it is not already laden with pre-existing meaning.

RC2. Why not perform a global scale analysis? The literature review would be too difficult to perform for all countries in the world. However, a global scale analysis of precipitation-sheds and receiving countries would be relatively straightforward to perform. It appears the authors have all the information they need for this. They have WAM-2 pixels, social variables at the pixel scale. So, couldn't this be a global scale analysis for most aspects? Then, the 3 case study countries could be used for the literature review portion of the paper. If a global scale analysis is performed, then the authors will have more data to run some interesting regressions. For example, they

can calculate “precipitation-sheds” and “sink” nodes for all countries. Then, they can obtain average values of social variables in each source/sink. In this way, they will have enough statistical power to run multivariate regressions of the driving factors of the terrestrial moisture recycling system.

AC2. Thank you for the suggestion, but this level of analysis is beyond the scope of this present work of understanding the social aspects of a moisture recycling system. In terms of practical usefulness for stakeholders and the construction of MRSES, we think it is necessary to go deeper in understanding each moisture recycling system. Running the WAM-2layers for all countries globally, would be a considerable computational undertaking that, while compelling, addresses a somewhat different research question and target audience than at present. We also removed Fig 4 in order to streamline the paper. Thus, we suggest that a global scale analysis could be set aside for future work.

RC3. Fig 3 is confusing and could be simplified. There is a lot of information in Fig 3. I don't think most of it is necessary. For example, does the biome information convey anything interesting? There does not appear to be any trend between malnourished children (y-axis) and GDP/capita (x-axis), so this information could be made easier to read. I think this figure would be better if it presented the average value of malnourishment and GDP/capita explicitly for the source and sink region of each country. This might be able to be accomplished with a simple bar graph or box-whisker plot for each variable for each source/sink node. A table might even best illustrate upstream/downstream differences. This simplicity would better illustrate the main points made in sections 3.2.1-3.2.3.

AC3. We appreciate this suggestion for a revised Fig 3, and much of this is consistent with Reviewer 2. We have updated this figure to be a much simpler plot

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showing sources and sinks, with corresponding mean and standard deviation. Also, the figures have been re-combined so that each case studies figures appear all together. This hopefully simplifies the information and assists interpretation.

RC4. The section on power dynamics could be improved. There seem to be many similarities between upstream/downstream power dynamics in precipitation-sheds and watersheds. I think this section would benefit from drawing from the power dynamics concepts in the transboundary watershed literature. A lot of work has been done on power/politics in international river basins that section 3.8 would benefit from referencing. Generally, section 3.8 could use a bit of a rewrite for clarity. Have any papers quantified the impact of upstream precipitation-sheds on downstream droughts? This seems like it would be the most clear example of upstream-downstream conflict/power issues. Also, can you expand on the Daw et al (2011) Reference? Does this paper specifically focus on power dynamics in teleconnected systems?

AC4. Thank you for this comment, and this is a very interesting suggestion. We have added several new sentences reflecting on the upstream/downstream power dynamics in watersheds, and how they are potentially similar or different to precipitation-sheds. The Daw paper focuses specifically on how there are trade-offs in ecosystem service benefits, and that a winner is often associated with a loser elsewhere. However, this is tangential to the core message of the research, and so we have removed this citation.

RC5. A bit more connection with the SES and socio-hydrology literature would be helpful. How does this work relate to socio-ecological systems (SES) work? Have similar archetypes (Fig 5) been presented in SES literature? Or socio-hydrology? What outcome variables are primarily of interest in the SES literature?

AC5. This is a great suggestion, and we have looked into similar discussions in the SES and socio-hydrology literature. The new section 4.3 “Advancing human-water systems understanding” and corresponding figure are included in the revised manuscript to address these considerations.

Minor comments:

RC6. The term “average market influence” is not clear and confusing. Please just call it what it is, i.e. GDP per capita.

AC6. The variable “average market influence” is actually a specific variable calculated in Verburg et al., (2011), that is a combination of (a) access to markets (calculated using proxies transport infrastructure, travel distance, and travel costs to major cities), and (b) per capita GDP. Thus, GDP per capita is not actually what the value is. However, other Reviewers have also pointed out that this variable is unclear, so we added a table that (among other things) provides clearer definitions of all variables throughout the text.

RC7. . Figure 4 doesn’t seem to show much. What happens if you just plot national international moisture recycling (y-axis) against GDP per capita (x-axis)?

AC7. Thank you for the comment, and this feedback echoes the concerns of other reviewers. However, Fig 4 was considered no longer useful and has been removed from the manuscript.

RC8. P 18 line 14: “Though the analysis of environmental justice flows has

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been simplified (Fig 3). . .”. Environmental justice flows are not quantified or presented in Fig 3. This statement is not warranted.

AC8. We agree with the Reviewer, and have removed the language of environmental justice, and refer more plainly to the specific variables we examine.

RC9. P 19 line 5: This sentence is a bit ironic. It seems to be a call for interdisciplinary scientists to engage and communicate with one another. However, this sentence is laced with jargon that is not widely understood (i.e. “positivism”, “normative terminology”)

AC9. This is ironic. We have defined these terms clearly now. Likewise, this feedback is generally consistent with other Reviewers, so we have read the text carefully and replaced or defined any remaining jargon.

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