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Earth System Dynamics
Discussions

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

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Reviewer Comment = RC Author Comment = AC

RC Major comments
The authors investigated terrestrial moisture recycling in three inland countries, namely, Mongolia, Niger, and Bolivia, by focusing on land-use change in moisture-source regions. By investigating land-use change policy of the countries in question and surrounding countries, the authors tried to explore the social dynamics of moisture recycling. Although I found the attempt quite interesting and novel, the manuscript in present form lacks clarity and quantitative evaluations in many parts. Hope the comments below are useful for further improvements.

AC. We appreciate the time that the Reviewer took to respond to the manuscript. We have made many improvements to the manuscript in response to all of the Reviewers, and hope that the updated manuscript meets the expectations of this Reviewer.
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RC Specific comments
RC1. Page 1 line 8 "We find that the sources and sinks of moisture can experience very different levels of human well-being, suggesting that power discontinuities must be included in the description of MRSES dynamics": How moisture "can experience different levels of human well-being"? What are "power discontinuities"?

AC1. Thank you for pointing out these issues, which were indicative of broader problems related to jargon and lack of clarity in our text. We have made major changes throughout the text to define terms and remove jargon.

RC2. Page 1 line 11 "This exploration of the social dimensions of moisture recycling": It seems an important precondition of this work that the "social dimension" plays an important role in terrestrial moisture recycling, but this is hardly proved (quantified) in text. I suppose the direct impacts of land-use change on the terrestrial hydrological cycle would be marginal. Exceptions are the cases for quite intensive irrigation (e.g. DeAngelis et al. 2010; Puma and Cook, 2010) and land-use change at continental and century-scale (e.g. Takata et al. 2009).

AC2. Thank you for this comment. In the original Introduction we stated "That the land-surface can and does influence the atmosphere is well-known (Dirmeyer and Brubaker, 1999; Domenguez et al., 2006; Tuinenburg et al., 2011; Bagley et al., 2012; Keys et al., 2016)."

It is apparent from the Reviewer's comment, however, that this sentence is insufficient to provide a convincing basis for proceeding toward the discussion of how social drivers of land-use change are a reasonable topic of discussion. As such, we have added a brief paragraph to clarify how land-use change modifies atmospheric moisture recycling, and then clearly state that a land-use change analysis is not the point of the present study, and that the interested reader should seek the original works that explore this topic. This updated text appears in the Introduction
"That land-use change can and does influence the atmospheric water cycle is well-supported (e.g. Lo and Famiglietti, 2013; Wei et al., 2013; Halder et al., 2016; de Vrese et al., 2016). Impacts can include modifications of the energy budget (e.g. Swann et al., 2015), impacts to local or regional circulation (e.g. Tuinenburg et al., 2013), and impacts to the atmospheric water cycle (e.g. Spracklen et al., 2015; Badger and Dirmeyer, 2015)."

RC3. Page 4 line 3 "2.2 Tracking the sources of moisture": The authors applied the WAM2layers model to estimate the evaporation and precipitation of their study domain. First, I would suggest providing more detailed information on the boundary condition (i.e. simulation period, land-use assumption, validation data). Second, I would suggest conducting some additional simulations under counterfactual land-use which implies historical land-use change mentioned in Section 3.4. Such simulations would be highly effective to convince readers how significantly "social dynamics" would change precipitation or evaporation.

AC3. We appreciate the reviewers comments regarding the WAM-2layers and additional simulations. Evidently, our explanation of the WAM-2layers was insufficient, since the WAM-2layers does not in fact simulate anything. Rather, it is a moisture tracking scheme, that keeps track of the atmospheric water budget. In section 2.3, we explain how the WAM-2layers tracks moisture, and that we employ the ERA-Interim

Reanalysis data. Given that this Reviewer, and Reviewer 1, both thought we were simulating something, we have improved and clarified our explanation of the WAM-2layers to ensure there is no confusion of what the WAM-2layers does and does not do. This text may be found in section 2.3:
"We emphasize that the WAM-2layers is a moisture tracking scheme, and not a simulation. It is possible to couple the WAM-2layers with dynamic simulations of land-surface hydrology, including vegetation (e.g. Wang-Erlandsson et al., 2014; Keys et al., 2016), but that is not what we have done in this research. Thus, the results that we present are purely based on the implicit hydrological information contained within the ERA-Interim Reanalysis data."
While it would be very interesting to conduct counterfactual land-use changes to explore how various land covers influence the moisture recycling patterns, this is outside the scope of what we are writing about in this research.
Additionally, we recognize that the Reviewer would like to see additional evidence for how land-use change can significantly change precipitation and evaporation. However, we highlight (as noted in the previous comment) that the evidence for land-use change impacts on moisture recycling are well-established, and are thus not necessary to establish in this paper.

RC4. Page 8 line 26 "in general evaporation arising from relatively wealthier, less hungry areas falling out as precipitation in poorer hungrier areas": This part sounds very subjective. Add figures and tables to make this part quantitative and concrete.

AC4. Thank you for the comment, and we agree that this is unclear. Throughout Section 3.2 (in the original manuscript), we are referring to the results in Fig 3. However, this comment along with the feedback from the other Reviewers, suggests that we need to improve both the clarity of the text of Section 3.2 as well as the clarity

of Fig 3.
So, we have significantly modified Fig 3 to be much simpler and convey the information of evaporation source and precipitation sink characteristics much more robustly and clearly. Also, given that we now present each case study in its entirety, Fig 3 has been divided among the three case studies.

RC5. Page 10 line 3 “However there is a flow of moisture from wealthier areas to poor areas (relative)”: Same comment as above.

AC5. Thank you for the comment, and we agree. Please see above comment for full details of the changes we made.

RC6. Page 10 line 7 “Within Bolivia itself, there is a cluster of wealthier rangelands and populated woodlands, and a cluster of much poorer remote and wild forest systems” Same comment as above. What is a cluster?

AC6. Thanks, and please see the comment above. We used cluster to refer to general grouping of the circles in the figure. However, since we have replaced Fig 3, with a much simpler figure, we have removed all text that refers to clusters (or the distribution of circles generally).

RC7. Page 10 line 8 “Surprisingly”: Explain what is surprising. The authors tend to connect factor and factor subjectively. What are the solid knowledge based on established evidence here? In what sense surprising?

AC7. Excellent point, and we have removed this text. We agree that we should

not be injecting phrases like ‘surprisingly’ or ‘interestingly’ into the text.

RC8. Page 11 line 10 “affect moisture recycling policy”: What is moisture recycling policy? In my view, the impact on moisture recycling is one of many (often unintended) secondary-impacts of land-use/industrial policy.

AC8. Moisture recycling policy (as far as I know) does not yet exist. The Reviewer is correct that changes to moisture recycling are going to be secondary impacts of land-use/industrial policy. Some work has been done to identify potential policies for direct governance of moisture recycling as well as for integrating moisture recycling into existing policy (e.g. Keys et al., 2017). However, no policies exist yet. We removed this sentence since it was confusing and unnecessary.

RC9. Page 14 line 29 “Construction of archetypes”: Although it is an interesting idea that inland moisture recycling could be subdivided into three categories, I’m wondering how to find thresholds among them. Any region is neither fully isolated nor fully teleconnected. What to do with regions in between?

AC9. This is an excellent point and we agree with the Reviewer. Undoubtedly some regions may fall in between these archetypes, if not manifesting additional (as yet uncharacterized) dynamics that may yield entirely new archetypes.
Nonetheless, in the updated Section 3.4 and Section 4.2, we discuss the process of classification and how MRSES are likely to move from isolate toward regional toward tele-coupled, and that once they have become tele-coupled they are unlikely to reverse that trajectory.

RC10. Page 18 line 15 “in isolated systems (e.g. Mongolia) there can still be a wide range of well-being (e.g. wide range in poverty and malnutrition)”: I couldn’t follow the authors’ logic. In every isolated systems the authors’ claim holds true? Which figures/tables/sub-sections clearly do clearly support this claim?

AC10. This is a good point, and we have removed this text since it is unclear.

RC11. Figure 3: Very hard to understand. What does each plot represent (grid cells of each nation or those for each precipitationshed)? Also clearly indicate in text what we should focus on. These panels look random scatter without meaningful information at first glance.

AC11. Thank you, and your comment echoes the comments from all the Reviewers. We have re-made Fig 3 to be much clearer and communicate the intended information more simply. Likewise, given the restructuring of the cases (based on Reviewer 2 feedback), we present each panel of Fig 3 with its corresponding case study.

References

DeAngelis, A., Dominguez, F., Fan, Y., Robock, A., Kustu, M. D., and Robinson, D.: Evidence of enhanced precipitation due to irrigation over the Great Plains of the United States, J. Geophys. Res., 115, D15115, 2010.

Puma, M. J., and Cook, B. I.: Effects of irrigation on global climate during the 20th century, J. Geophys. Res., 115, D16120, 2010.

Takata, K., Saito, K., and Yasunari, T.: Changes in the Asian monsoon climate during 1700-1850 induced by preindustrial cultivation, P. Natl. Acad. Sci. USA, 106,

9586-9589, 10.1073/pnas.0807346106, 2009

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