Biogeosciences Discuss., 8, C4781–C4787, 2011
www.biogeosciences-discuss.net/8/C4781/2011/

Biogeosciences Discussions

Interactive comment on "Analyzing precipitationsheds to understand the vulnerability of rainfall dependent regions" *by* P. W. Keys et al.

P. W. Keys et al.

patrick@keysconsultinginc.com

Received and published: 9 December 2011

We would like to thank the Reviewer for the positive comment stating that the paper is well written and fascinating. Below we reply in detail to the Reviewer's other comments.

1. Comment: "My first comment is on the use of the term 'precipitationshed'. I think this is very interesting but it needs a section of its own for elaboration. As the authors state, the term is coined as an analogy of the watershed and surface water processes. However, more definition and quantification are desired, assuming that most readers will be thinking from the biased mindset of having prior knowledge of a watershed. It seems the precipitationshed is basically to define the 'divide' or boundary within which most of the recycling of precip takes place. The whole earth could be considered one universal precipitation shed with a recycling ratio of 1 (or 100%). So what exactly is the

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

authors' quantitative definition here? "

Response: The 'precipitationshed' is defined on page 10488, line 26: "the upwind atmosphere and surface that contributes evaporation to a specific location's precipitation (e.g. rainfall)." We agree with the Reviewer (on p. 10495, line 21) that the Earth could indeed be considered the 100% precipitationshed. The Reviewer's feedback, however, is consistent with several other of the referees, and we plan to expand the precipitationshed section to properly elaborate the concept. The Reviewer also mentions ENSO and other teleconnections, which could play a role. The precipitationshed however deals only with the 'direct' influence on the sink region's precipitation. We fully acknowledge that if a source region within the precipitationshed is affected by any change, than this will indeed 'propagate' to a change in the sink region. We will mention the example suggested by the reviewer in Section 4.3. A full-scale analysis of how these teleconnections interact with our precipitationsheds is outside the scope of this analysis, but does warrant more investigation in future research.

2. Comment: "In figure 3 authors use both 'absolute' and 70% contribution to define boundaries. I think both could be very dangerous if not associated with qualifiers. What is really absolute without stated assumptions? "

Response: The 'absolute' and 'relative' types of precipitationsheds are described in detail in section 4.2 and 4.3. 'Absolute' in this sense does not mean the 100% precipitationshed, but refers to absolute contributions of evaporation, Fig. 3a (top scale bar), as opposed to relative contributions, Fig. 3b (top scale bar). An x% precipitationshed can be obtained from the bottom scale bars. Here, we also stress that it is up to the users to decide what should be the appropriate threshold for the precipitationshed and for the land-use vulnerability assessment here we chose the 70%-relative precipitationshed.

3. Comment: "On the same comment of precipitationshed – I think it's important to highlight the 'dynamic' nature of the 'shed' or boundary unlike watersheds where the

BGD

8, C4781–C4787, 2011

topographic boundaries are very static even at climate timescales (unless one wants to go to geologic/ paleoclimate timescales and incorporate erosion/subsidence etc.). ”

Response: We agree with the Reviewer that the ‘dynamic’ nature of the precipitationshed should be more clearly acknowledged. Following line 27 on page 10495, we will add the following text to clarify the ‘dynamic’ nature: “The precipitationshed is more dynamic than the relatively static boundary of a surface watershed, given that the boundary is dependent on climatological phenomena that fluctuate both intra- and inter-annually. Furthermore, the precipitationshed boundaries depicted in Figure 4 reflect the mean boundary for the years 1998-2008, which is the range for which reanalysis data were available. It is beyond the scope of this paper whether and how these boundaries might change with climate data from before or after this period. Additionally, the authors acknowledge that the El Nino Southern Oscillation (ENSO) or similar events could indeed alter the precipitationshed boundaries.”

4. Comment: “Lastly, I think some in-situ ‘match-up’ would be preferable to show that the authors analysis agrees somewhat with observations. I don’t know how exactly to do this and there may not be a clear way – but perhaps greater use of MODIS vapor products, tracking them and using in-situ pan evaporation/weather station data, modeling etc. might help.”

Response: The request for ‘in situ’ match-up is acknowledged, but we consider the reanalysis data, which is derived in part from observations, to be sufficient for this paper. ‘In situ’ match-up would likely be very useful, however, for future research, which incorporates fully simulated data (e.g. from an AOGCM). The Reviewer suggests following an approach similar to Gangoiti et al. (2011a; 2011b) to accomplish this. These are two interesting papers and they perform a very similar type of analysis compared to our paper, albeit over an extraordinarily shorter time scale, and for a specific storm. It should be noted that we present global analysis; relatively speaking, we feel that the amount of ‘observed’ data is similar (given the differences in spatial and temporal scale) to the Gangoiti et al. research.

BGD

8, C4781–C4787, 2011

5. Comment: “The authors refer to a work of Millan (who is a co author above) and also of Knutsmann who has recently tied some vapor tracking work for the Volta basin to find out the contribution of lake volta evaporation to downwind precipitation (which is in the range of 7-10%). I suggest the authors read and then cite these papers as well.”

Response: We are aware of the interesting work of Harald Kunstmann’s group (Kunstmann and Knoche) and we have been in touch with them. However that specific work has not yet been published. In the revised version we will give credit to Kunstmann’s (if published) as well as Gangoiti et al,’s work. We do want to note that this latter work was published after our discussion paper was accepted and thus could not be referred to in this discussion paper. In the revised version we will also make it more clear that in places where we cite several papers, these are often a selection of available literature. We will add “e.g.” whenever appropriate (notably at p. 10490, line 2; p. 10490, line 5; p. 10490, line 13; p. 10490, line 21; 10500, line 3, and 10500, line 8).

6. Comment: “It seems the focus of the study is mostly on the pure rain-fed ecosystems. I doubt if there is such pure rain-fed ecosystems of the scale of the West Sahel given how connected everything is.”

Response: We are not suggesting that the sink regions are “pure rainfed ecosystems” but rather that they are particularly reliant on rainfall. We agree with the Reviewer that there are many other local hydrological interactions that are outside the scope of this paper, and therefore not discussed. We have drafted the following text to go after line 12, on page 10495: “We chose to focus on sink regions that are strongly rainfall dependent. However, water supplies can enter these regions from other sources (e.g. surface runoff, groundwater) and there could be local hydrological interactions that are unaccounted for in our analysis. Any analysis of local hydrological interactions is both outside the scope of this work, as well as beyond the resolution of the data and models employed in the analysis.”

7. Comment: “The vulnerability discussion and analysis is really useful. It makes

BGD

8, C4781–C4787, 2011

sense for 'pure' rainfed systems to do such an analysis. But as the authors state, perhaps it is better to call the assessment a sensitivity analysis rather than a vulnerability assessment. "

Response: We use the term 'vulnerability' to refer to both sensitivity (i.e. the extent to which something can be affected) and susceptibility (i.e. the level of exposure to a hazard or risk) on p. 10498, line 20-22. Therefore, the use of 'sensitivity' only is not comprehensive enough, given that we acknowledge 'susceptibility' as well.

8. Comment: "Just like transboundary water management, it makes more sense for more (far away but within the shed) nations to know what their precipitation sheds are and get together for a wiser and scientific utilization of the water resources. It might be wishful thinking, but it won't hurt for the authors to elaborate extensively on this point."

Response: We agree with the Reviewer that there is a large potential for new transboundary management organizations, especially for more informed planning of land-use changes and for understanding how consequences of land-use change can occur far beyond the area of where it takes place. We have not explored this point extensively, because we considered the likelihood of this type of organization unlikely to come about in the near future, not least because the concept of a precipitationshed is very new. However, we have drafted additional text to be included on p. 10502, before the last sentence: "In the short-term, precipitaitonshed analysis may enable proactive assessments of the long-distance (teleconnected) effects of major land-use changes such as through REDD (Reducing Emissions from Deforestation and Forest Degradation), million-tree campaigns, and/or desertification trends."

9. Comment: "Side note: Elaboration on data (itemized) that was used in the study in the form of a dedicated subsection would be useful."

Response: We thank the Reviewer for the side note asking for an itemized data section, and we refer the Reviewer to section 2 (2.1-2.6) and ask if this is sufficient. If this is not sufficient we can expand these sections. Additionally, we can also more explicitly refer

BGD

8, C4781–C4787, 2011

to the water accounting model from van der Ent et al. 2010.

10. Comment: “On the boundary of the shed, does water balance work better than at the watershed scale? Authors should attempt to do the simple P-E=Q type of water balance over the domain defined by the precipitation shed, including the ocean evaporation, and river discharge into oceans to prove that their precipitationshed boundaries are physically consistent and have value for water management.”

Response: We emphasize that the precipitationshed, as used in this research includes neither 100% of precipitation nor 100% of evaporation in the precipitationshed boundary. The precipitationshed calculation includes only the evaporation that directly contributes to the sink region, and only the precipitation that falls in the sink region (Eq. (3)). Therefore, large volumes of evaporation and precipitation (and all discharge) are not included in the precipitationshed definition, making the P-E=Q calculation beyond the scope of this analysis.

References:

Gangoiti, G., Gómez-Domenech, I., Sáez de Cámara, E., Alonso, L., Navazo, M., Iza, J., García, J. A., Ilardia, J. L., and Millán, M. M.: Origin of the water vapor responsible for the European extreme rainfalls of August 2002: 2. A new methodology to evaluate evaporative moisture sources, applied to the August 11–13 central European rainfall episode, J. Geophys. Res., 116, D21103, 10.1029/2010jd015538, 2011a.

Gangoiti, G., Sáez de Cámara, E., Alonso, L., Navazo, M., Gómez, M. C., Iza, J., García, J. A., Ilardia, J. L., and Millán, M. M.: Origin of the water vapor responsible for the European extreme rainfalls of August 2002: 1. High-resolution simulations and tracking of air masses, J. Geophys. Res., 116, D21102, 10.1029/2010jd015530, 2011b.

Kunstmann, H., and Knoche, H.-R.: Tracing water pathways from the land surface through the atmosphere: a new RCM-based evapotranspiration tagging method, iLEAPS Science Conference, 2011, Garmisch-Partenkirchen,

BGD

8, C4781–C4787, 2011

http://www.ileaps.org/sci_conf_book/pdf/20110415195004_Kunstmann-ET-Tagging-ILEAPS2011-GAP.pdf.

Interactive comment on Biogeosciences Discuss., 8, 10487, 2011.