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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Developing system robustness analysis for drought risk management: an application on a water supply reservoir" *by* M. J. P. Mens et al.

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Reply to first referee

Thank you for your positive response and interesting feedback. Please find our response to your comments below.

1) You ask us to reflect on why droughts are so much less well defined than floods.

We think there is less research available for droughts because of two factors: - It is more difficult to classify droughts and evaluate the impacts of their changing frequency with climate change. Floods have the straight forward approach of estimating return

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periods based on the peak discharge. Droughts are classified using multiple factors, such as severity and duration, and it is difficult to assign probabilities to them. Also, droughts build up slowly in different parts of the hydrological system (groundwater, surface water), which makes it difficult quantify the drought. Many flood designs are based on probabilities of one quantity, making the link between a change in statistical characteristics from climate change and impacts easier to evaluate. For droughts, however, this is not the case. - It is more difficult to quantify the damages from droughts. Floods happen quickly and have immediate, direct impacts. Droughts are a slower process with more indirect impacts. This makes economic analyses more challenging

2) Your second concern is that the paper seems to assume that climate change alters variability rather than the mean climate. And that this has implications for the effectiveness of options.

We agree that climate change may impact both means and variability. This paper however focuses on how to deal with (changing) variability. Managing for extremes asks for other methods than managing for changing means, while much of the literature is focusing on methods for dealing with changing means (such as adaptation tipping points). We also agree that demand reduction is an effective strategy under all scenarios, because it is independent of supply. But even when inflows are decreasing on average, storage increase can still have an impact. If looking at a 5-yr time period with a drought occurring in the last two years, a larger reservoir would be able to store more water from years 1-3 to manage the drought in years 4-5. Also, structural demand reduction may be a very costly solution, as it may have a negative impact on industries and the regional economy. Temporary demand reduction does occur in the form of voluntary and mandatory rationing.

3) Your third point is that other elements in supply increase that could alter the storage potential, such as increased evaporation potential with a larger surface area.

We agree that the impacts of increased evaporation potential with a larger reservoir

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should be considered in future research.

4) “I would think that a diagram that shows these concepts as alternative strategies would be very helpful”

We are confused about this comment. The robustness/resistance/resilience concepts are visualized in figure 1.

5) You suggest to present the three options ‘supply increase’, ‘hedging’ and ‘demand reduction’ as examples of three basic drought strategies: ‘infrastructure’, ‘operations’ and ‘demand management’.

We think this is a good suggestion.

6) You mention that there is an environmental component to the analysis that would in reality be an important consideration. We agree that in future research this should be taken into account. Environmental impacts should be one of the criteria in a multi-criteria assessment of drought risk management options. This highlights the importance of stakeholder involvement in drought risk management.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 203, 2015.