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Discussions

Interactive comment on "Adaptation of water resource systems to an uncertain future" *by* C. L. Walsh et al.

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This is an interesting manuscript that contributes to a growing body of research that applies probabilistic climate information and resource system analysis to determine efficacy of adaptation options. The Thames Basin, UK has been the subject of numerous climate risk assessments. However, the paper adds new insights on the significance of future water demand relative to other key uncertainties. The authors have also applied end-user relevant water resource indicators, and introduced technical advances in the form of a new spatial weather generator. Some methodological details require further elaboration (e.g. treatment of change factors, groundwater exploitation, return flows) and the assumptions behind the water demand estimates could be more transparent.

The plausibility of some adaptation options (e.g. 35% demand reduction by 2020) is highly questionable and, arguably the most serious threat to the system – multi-season droughts – warrants further consideration.

On this basis, publication is recommended subject to the following modest revisions, minor corrections and clarifications.

Main comments

[Abstract] Please incorporate a few more headline statistics and link any projected impacts to the specified time horizon. Presumably, the cited five-fold increase in drought order occurrences pertain to the 2050s?

[Methodology/Results] The UKCP09 projections suggest an average 18% reduction in summer precipitation and 15% increase in winter for the Thames Basin. However, a fundamental limitation of the change factor methodology is that it does not readily produce hitherto unseen sequences of exceptionally dry periods that would truly stress the water supply system (such as two or more dry winters and summers in a row). It would be helpful to know what the longest below average sequence was generated by the method of adjusting observed rainfall and refitting the STNSRP to the perturbed series.

[Methodology] Given the heterogeneity of land cover in the Thames basin, the decision to apply a single Potential Evapotranspiration (PET) record at the centroid of the basin should be further justified. For instance, how representative is this of the moisture loss from the urban sub-catchment?

[Methodology] Explain how groundwater abstraction was handled by the catchment/ water resource modelling. What input data were used for the groundwater source node shown in Figure 4? Likewise, what values were applied for return flows to the Thames from the water treatment works node?

[Methodology/Results] How well does the LARaWaRM replicate the historic frequency of demand saving days when given observed climate and water use profiles?

[Methodology] Provide a summary table of all the demand measures that were factored into the analysis whether implicitly or explicitly. Explain how demand per capita was altered to reflect technological advances and efficiency measures. State the assumed consumptive water demand (i.e. fraction of used water that is not returned to the Thames as treated effluent).

[Results] The 10th percentile change in precipitation shown in Figure 5 is based on the ensemble uncertainty. However, what proportion of weather generator runs produced a decrease in precipitation in all months? This is no doubt a much rarer likelihood than 10% of ensemble members. In other words, 10th percentile scenario (and attendant adaptations) is actually much rarer than implied for a continuous simulation.

[Discussion] As noted before, further comment is needed on the treatment and effectiveness of the adaptation measures under conditions of multi-season drought. For instance, how more/less frequent are 24-month periods with below average precipitation under SCN20 and SCN50? Would the preferred mix of adaptation measures differ if these particular climate threats are considered?

[Conclusion] Please add a paragraph spelling out the priorities for further research.

Minor corrections and clarifications

[P8856, L10] Exactly what "changes" in upland river catchments were analysed?

[P8856, L17] "…greater proportion of uncertainty…" by when? Note that the relative importance of different uncertainty components varies with time in the future i.e. climate variability (near-term), climate model (medium-term), emissions scenario (long-term). Hence, it is critical to attach the time-stamp to any such impact or uncertainty statement.

[P8857, L25] In what ways are the PET data "consistent"?

[P8858, L1] Ditto for "consistent river flows"?

[P8858, L20 and P8871, L26] Given the large uncertainties, better to use "could" rather than "will".

[P8859, L19 and P8870, L29] Comment: Given that the longest time horizon investigated was the 2050s, uncertainty due to emissions scenario can be largely discounted.

[P8860, L7] At what time-scale were the change factors produced? Was it annual, seasonal, or monthly? Please specify.

[P8861, L5] Please cite the Nash-Sutcliffe efficiency (and other performance metrics) for the validation period.

[P8865, L23] Justify the assumption that per capita demand remains the same as present in SCN20 and SCN50.

[P8865, L25] The existing level of service for severe water rationing (DS4) is set at zero frequency (Table 1). What criteria were used to determine when the DS4 measure is invoked under SCN20 and SCN50?

[P8866, L22-24 and P8872] Please explain how a 100% reduction in the mean number of DS4 days can be achieved twice over (first by leakage reduction and a new reservoir, second by adding a desalination plant to the portfolio).

[P8868, L22] Should Fig.10c be Fig.8c?

[P8868, L29] Comment: Water use for industry and mining may have declined, but fracking of natural gas reserves in southeast England could add to future water demand.

[P8869, L10] How sustainable is the expected 10-15% water saving in metered households? Some studies suggest that demand creeps up in the long run.

[P8869, L18] Note that a 35% reduction in per capita demand by 2020 is unrealistic. It is much better to reframe these results as a sensitivity analysis that demonstrates the scale of the challenge ahead.

[P8869-P8870] Note that the water supply-demand outlook could be even more finely balanced if more stringent treatment of environmental flow requirements are taken into account. This factor might be particularly problematic under the multi-season drought episodes noted above.

[P8871, L23] Note that climate change impacts on water balance risks might exceed those due to population growth beyond 2050.

[P8872, L19] Please clarify the sentence "Given the typical time. . ."

[Table 1] Add a column of the precise triggers/thresholds used by Thames Water to invoke the different levels of restriction.

[Figure 1] Please add boxes/arrows for "Observed data" and "Performance metrics" to complete the picture of the whole analytical framework.

[Figure 3] Add the Nash-Sutcliffe scores to each panel.

[Figure 10] For clarity, replace "No" with "No supply measures", and spell out "D", etc. on the x-axis.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 8853, 2015.