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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Balancing ecosystem services with energy and food security – assessing trade-offs for reservoir operation and irrigation investment in Kenya's Tana basin" *by* A. P. Hurford and J. J. Harou

Anonymous Referee #1

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The paper applies multi-objective optimization and visualization to analyze the tradeoffs in the water-energy-food "nexus" in the Tana Basin. It is well-written with a clear narrative, and the results are presented in a logical sequence. The approach is significant for water-energy-food problems, as it allows decision-makers to balance preferences after the optimization rather than before. Furthermore, the objectives do not need to be expressed in monetary terms. As the authors note, this is an improvement over traditional cost-benefit analysis, which often struggles to assign value to environmental sustainability.

The paper is nearly ready for publication subject to minor revisions. A few suggestions:

(1) The motivation is clear and focused, but links to broader literature are missing from the introduction. Is this the first time that multi-objective analysis has been applied to a water-energy-food nexus problem? The advantages of MOEAs over classical optimization approaches are discussed well, but more reference should be made to the implications of this approach for this particular type of problem.

(2) The same goes for the conclusion. How does this improve on prior studies in the Tana Basin? Are there broader implications of using this approach for the field of water-energy problems?

(3) The figure sequence is logically constructed and informative, but a bit long. It may be possible to combine several figures as subplots: - Figures 3 and 4 - Figures 5, 6, and 7 - Figures 12, 13, and 14 This would reduce the number of figures from 14 to 9. The suggested combinations are usually discussed in the same or adjacent paragraphs, so it should not alter the narrative at all.

Specific Comments

(4) There is some confusion throughout about the term "Pareto-optimal". The authors note in Section 3.2 that these solutions are "only approximately Pareto-optimal", which is of course a requirement of black-box heuristic optimization – we don't know where the true "optimal" solutions are. This should be made clearer up front. For example in the abstract, replace "to identify the Pareto-optimal tradeoffs" with "to approximate the Pareto-optimal tradeoffs", etc.

(5) Use of the term "visual analytic plots" to describe the tradeoff surfaces in Figures 3, 5, and 8-12 is a bit vague. Surely there are other plotting styles that fall under the heading "visual analytics". Perhaps there is a more specific term such as "tradeoff plots" or "multiobjective plots" that could be used.

(6) Some details of the optimization itself are glossed over. Is there evidence that

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100,000 model evaluations were sufficient? Were multiple trials performed? In Section 4, Line 10 the authors note: "The two cases presented here each converged..." is there evidence of convergence? Typically it's difficult to make such claims with heuristic optimization techniques.

(7) Figure 2 (showing the decision variables for the piecewise linear release curve) is very helpful. Is there any reason to choose a piecewise linear function here rather than a smoother function? (except perhaps ease of use). Would performance be any different?

(8) In the conclusion, the authors mention a future exploration of uncertainty. What are the potential implications for this? Do the authors feel that uncertainty could change the recommendation made to decision-makers from this study?

Overall this is a strong paper with a well-crafted narrative and figure sequence. It should prove to be of general interest to the HESS readership.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 1343, 2014.