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Comment on hess-2022-99

Anonymous Referee #2

Referee comment on "Operationalizing equity in multipurpose water systems" by Guang Yang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-99-RC2, 2022

This paper explores the impact of including an equity measure during multiobjective search for reservoir operating policies in the Lake Como system. Using four rival framings of the search problem, the authors show how including equity as an objective impacts the Pareto approximate set. The authors further explore the sensitivity of solutions discovered through each formulation to the definition of the equity measure. This paper is well written and within the scope of this journal. I believe it will represent a significant contribution to the field after the authors undertake revisions to improve the clarity of their results and contextualize the impact of their findings. My main comments are listed below:

- My main concern with the current submission is that the results don't clearly highlight to potential benefits of including the equity metric for the higher dimensional formulation of the problem. The authors assert that adding the equity indicator generates more solutions that mitigate conflicts between conflicting objectives (lines 245-249). While this is clearly the case when comparing problem framings 1 and 2 (the "traditional" and "traditional and fair" framings), the difference between framings 3 and 4 ("inclusive" and "inclusive and fair") is hard to assess from Figure 2e. The number of solutions plotted in Figure 2 makes it hard to distinguish the differences between formulations 3 and 4, and it is all but impossible to see trade-offs between conflicting objectives. The paper would benefit from additional visualizations that highlight compromise solutions discovered using each formulation and demonstrate how (or if) including the equity metric discovers favorable compromises that are not found by other formulations. One way to do this could be to filter the Pareto approximate set according to a set of desired performance criteria for each objective and compare how many solutions each formulation discovers that meet the criteria.
- The paper could be strengthened by including a deeper discussion of how equity fits into the decision context of the management problem. The methodology proposed in this paper serves to facilitate the discovery of equitable compromise policies - but will these policies be examined by a social planner balancing the trade-offs across multiple performance interests, or serve as the basis for a negotiation process where multiple stakeholders must find an acceptable compromise? Could this methodology be extended to systems with multiple stakeholders with similar performance objectives, and how would that change the application?

- I find it confusing that P2 outperforms P3 in the environmental objective. While lines 225-228 explain that the lower performance of the environmental objective from P1 incentivizes high values of the environmental objective, I have a hard time believing that this sends a stronger signal than directly optimizing for the objective. Could this indicate a search failure in P3?

Minor comments:

1. I would recomend including the following papers in the review of equity in water resources research (lines 44-59):

Osman, K. K., & Faust, K. M. (2021). Toward operationalizing equity in water infrastructure services: Developing a definition of water equity. *ACS ES&T Water*, 1(8), 1849-1858.

Jafino, B. A., Kwakkel, J. H., Klijn, F., Dung, N. V., van Delden, H., Haasnoot, M., & Sutanudjaja, E. H. (2021). Accounting for multisectoral dynamics in supporting equitable adaptation planning: A case study on the rice agriculture in the Vietnam Mekong Delta.*Earth's Future* *9*(5), e2020EF001939.

Fletcher, S., Hadjimichael, A., Quinn, J., Osman, K., Giuliani, M., Gold, D., ... & Gordon, B. (2022). Equity in water resources planning: a path forward for decision support modelers. *Journal of Water Resources Planning and Management*. 148(7), 02522005.

2. I don't find the trade-offs between J_R and J_F/J_I under P3 to be "remarkable" (line 194). To me, these trade-offs make sense and would be expected. Non-dominated solutions in P3 include solutions that maximize J_R, which may come at the expense of J_I and J_F. P2 does not have this incentive. Though the equity objective incentivizes J_R more than P1, it does not do so at the cost of other objectives.