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Discussions
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Interactive comment on "A novel framework of deriving joint impoundment rules for large-scale reservoir system based on a classification-aggregation-decomposition approach" *by* Shaokun He et al.

Anonymous Referee #1

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General comments

This manuscript describes a numerical optimization approach for the operation of large-scale water reservoir systems. Specifically, the authors attempt to tackle the so-called "curse of dimensionality", that is the fact that the computational requirements grow exponentially with the number of state (e.g., storage) and control (e.g., release decision) variables. Their approach relies on a classification-aggregation-decomposition scheme: first, reservoirs are classified and grouped based on location and operating targets; then, the problem of designing operating rules is solved for a smaller number

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Discussion paper

of hypothetic reservoirs representing the groups identified in the previous step. Finally, the decisions designed for these equivalent reservoirs are applied to the original system. The scheme is tested on a 30-reservoir network in the Yangtze River Basin.

I think that the topic of water resources management and reservoir operations is potentially relevant to the audience of HESS, but I do have several major concerns regarding this specific study.

Novelty. In my opinion, this work does not provide a novel, substantial contribution to the field of water reservoir operations. The idea of hierarchical multilevel decomposition has been around for a long time–see the work of Turgeon (1981), Saad and Turgeon (1988), or Archibald et al. (1997). Here, the authors just implement the same concept through the use of different optimization algorithms, such as NSGA-II and PPOA (whose description is rather unclear; see below).

Implementation and experimental setup. I believe the execution of this research presents some important flaws:

- The description of the inflow data is a concern here. First, the model requires inflow data for all reservoirs, but there appear to be only two gauging stations (see Figure 1a). How did the authors calculate the inflow to all reservoirs? (Unfortunately, the information provided at Line 140-144 is unclear.) Second, I would guess that not all reservoirs were built before 1956. So, how did you calculate the inflow to these reservoirs?

- The use of the current operating rules as a benchmark is likely to bias results and conclusions–a well-known concept in the water system analysis literature. That's because operators may not necessarily follow the objectives captured by the optimization problem. If the authors want to demonstrate that the proposed scheme advances the state-of-the-art, then they ought to compare it against existing optimization techniques.

- The optimization of the operating rules is carried out over the period 1956-2012; no data are used to validate these rules. This is likely to invalidate (or, at least, affect)

the conclusions: the genetic algorithm used to solve the problem is likely to "learn" decisions that work well only under these hydrological conditions. This is another well-known fact in the field of reservoir operations. In addition, this specific use of the inflow data does not seem to address the problem of "complex inflow stochasticity" mentioned in both Abstract and Introduction.

- There are no data showing that the experimental setup of NSGA-II is reliable (Line 245).

- There is no discussion of results and limitations.

Presentation. The overall quality of the presentation is very poor, largely below the standards of this journal. There are a few problems here:

- Many sentences contain grammatical mistakes or unclear and ambiguous statements, often preventing the reader from understanding entire paragraphs or sub-sections (see, for example, Section 3.4.2);

- The Introduction fails to explain some fundamental concepts, such as the "complex inflow stochasticity", which is mentioned throughout the manuscript;

- The manuscript, and in particular the Introduction, is not fully accessible to the audience of HESS, as it relies on a large amount of jargon that can only be grasped by the (narrower) reservoir operations community (see my detailed comments);

- There are some ambiguous / unclear / wrong statements that are likely to accidentally deceive the readers. See, for example, Line 45-50: while it is true that several studies on reservoir operations focus on small systems, it must also be acknowledged that there are dozens of works targeting the curse of dimensionality using either hierarchical multilevel decomposition or functional approximation (see Castelletti et al., 2010, and references therein).

Overall, I praise the attempt to tackling a difficult reservoir operation problem, but I believe that the limited novelty, unreliable results, and poor presentation provide ample

ground for recommending a rejection.

Specific comments

- Line 16: “the large-scale reservoir system”. Which system?

- Line 17-19: In what terms do the existing techniques fail?

- Line 19: “high dimensionality”. High dimensionality of . . .?

- Line 26-27: Check grammar.

- Line 28-29: What do you mean here?

- Line 30: “89.50% to 94.16%” of . . .?

- Line 32: “0.06”. What is this variable? How is it measured?

- Line 43-44: do not add references in the middle of a sentence. It’s better to use them to prove / consolidate a point you are trying to make.

- Line 51-55: The Introduction should be accessible to a broad audience in hydrology. The use of these concepts does not make it possible.

- Line 55-57: What does this mean?

- Line 60-62: Again, what does this mean? Make your thoughts available to the audience–do not rely on unknown jargon.

- Line 67-68: “seldom” implies that there have been some applications. Can you add these important references?

- Line 75-79. What does this mean?

- Line 87: Which “empirical equations”? What does this mean?

- Line 87-89: What does this mean?

- Line 97-98: If you want readers to follow you, you must explain the underlying concept

of PPOA.

- Line 105: “without IE and FCR distortion”. What does this mean?

- Line 132-233: What does this mean?

- Line 144: “for the five months per year”?

- Line 163: “The vast reservoir community results in ‘dimensionality disaster’. What does this mean?

- Line 160-168. This is just a repetition of previously-stated concepts.

- Line 248-250: what does this mean?

- Line 262: Is this supposed to be a new section?

- Line 300: You should explain what the “universal projection pursuit method” does.

References

Archibald, T., K. McKinnon, and L. Thomas (1997), An aggregate stochastic dynamic programming model of multireservoir systems, Water Resour. Res., 33(2), 333–340.

Castelletti, A., S. Galelli, M. Restelli, and R. SonciniâĂŘSessa (2010), TreeâĂŘbased reinforcement learning for optimal water reservoir operation, Water Resour. Res., 46, W09507

Saad, M., and A. Turgeon (1988), Application of principal component analysis to longâĂŘterm reservoir management, Water Resour. Res., 24(7), 907–912.

Turgeon, A. (1981), A decomposition method for the longâĂŘterm scheduling of reservoirs in series, Water Resour. Res., 17(6), 1565–1570.

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