Interactive comment on "Real-time reservoir flood control operation enhanced by data assimilation" *by* Jingwen Zhang et al.

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The article describes a decision support system for the real-time operation of water reservoirs. The system, named ROMEDA, integrates some methodologies that are well established in the water management area, namely optimization and data assimilation. While the topic is probably of interest for this community, I found the paper to be very weak.

Reply: Thanks for your comments.

The first important problem is the lack of novelty: the problem of integrating optimization algorithms in decision support systems has been tackled for decadesâĂŤwith the rationale, as rightfully pointed out by the authors, of aiding decision-makers, rather

than controlling reservoirs in a fully automated fashion. There are indeed many tools that can tackle reservoir operation problems, such as HEC-ResSim (US Army Corps of Engineers), MIKE HYDRO Basin (DHI), or FEWS (Deltares). Importantly, all of these tools integrate optimization algorithms with different kinds of hydrologic-hydraulic models. Some of them, such as FEWS, use Data Assimilation routines. Therefore, I think that ROMEDA does not represent a step forward in the domain of decision support systems.

Reply: First, please allow us to clarify the purpose of our work. We aim at a real-time human-machine interactive method for reservoir operation during a flooding event, using data assimilation of real-time observations to reduce the uncertainty from the simulation model. This method is new (according to our knowledge) by directly linking the reservoir operator with a traditional real-time reservoir operation model (integrated optimization and simulation). The computer model runs by rolling time windows. For one time window, it assimilates the observation of water levels and adopt the actual release the operator makes (which can be the same or different from the model recommended optimal value) at the end of the time period, and then moves to next and generates recommended release again. Meanwhile, the operator checks the recommended release from the model during each time window and decides to take it or do it differently based on their own justification. As you mentioned, HEC-ResSim (US Army Corps of Engineers), MIKE HYDRO Basin (DHI), or FEWS (Deltares) all tackle reservoir operation using optimization algorithms coupled with as hydrologic or hydraulic simulation, as well as data assimilation. However, all these decision support systems are not used in the way as ROMEDA by reservoir operators. They can provide decision support information, which can be used or not by the real reservoir operators, but they do not track the actual decisions made by the operators. In other words, ROMEDA proposes "online" interactions between model and user while such interactions with existing DSSs are usually "off-line." Besides, the data assimilation routine in FEWS (Deltares) handles predictive environmental disturbance, such as weather forecast uncertainty, similar to Model Predictive Control (MPC) (Camacho & Alba, 2013; Garcia et al., 1989; Macian-

Sorribes & Pulido-Velazquez, 2019), while the data assimilation in ROMEDA mitigates the uncertainty from the simulation model (e.g. a 1D hydrodynamic model solved by Preissmann) that takes into account actual releases made by reservoir operators. Thus regarding the novelty, we would argue that this study proposes an online (or real-time) human-machine interactive method for reservoir operation.

References:

Camacho, E. F., and Alba, C. B.: Model predictive control, Springer Science & Business Media, 2013.

Garcia, C. E., Prett, D. M., and Morari, M.: Model predictive control: theory and practiceâĂŤa survey, Automatica, 25, 335-348, 1989.

Macian-Sorribes, H., and Pulido-Velazquez, M.: Inferring efficient operating rules in multireservoir water resource systems: A review, Wiley Interdisciplinary Reviews: Water, n/a, e1400, 10.1002/wat2.1400, 2019.

Another problem is the way with which the manuscript is conceptualised. I think any reader would expect to see a demonstration of the decision support system, with emphasis on a comparison with the "human's mental model" vaguely mentioned by the authors in the Introduction (see Figure 1). Instead, the manuscript shifts its emphasis on the methods underpinning ROMEDA, which, as mentioned above, are not novel.

Reply: Thanks for your comments. Indeed some studies (Hejazi & Cai., 2011; Hejazi et al., 2008; Castelletti et al., 2010) couple a "mentor model" (made via machine learning methods such as ANN) with a numerical simulation/optimization model to explore better reservoir operation plans. However, this is not what we want to do in this paper. As stated above, reservoir operators directly interact with the model (coupled simulation and optimization) and thus there is no need to use a computer-based mentor model to mimic the operators' behaviors. By the way, such models are usually limited in its effectiveness.

References:

Hejazi, Mohamad I., and Ximing Cai. "Building more realistic reservoir optimization models using data mining–A case study of Shelbyville Reservoir." Advances in water resources 34.6 (2011): 701-717.

Hejazi, Mohamad I., Ximing Cai, and Benjamin L. Ruddell. "The role of hydrologic information in reservoir operation–learning from historical releases." Advances in water resources 31.12 (2008): 1636-1650.

Castelletti, A., et al. "Tree‐based reinforcement learning for optimal water reservoir operation." Water Resources Research 46.9 (2010).

I also have a gripe about the experimental setup, which is not clear, transparent, and reproducible. If the goal is to carry out a comparison between human operators and ROMEDA, I would then expect to read a detailed explanation of the operators behaviour (or of the rules that they must follow), rather than the confusing description provided at the beginning of Section 4. Unfortunately, the quality of the presentation is not a problem limited to Section 4, but an issue spanning across the entire document.

Reply: As stated above, the construction of a human's mental model to mimic the reservoir operators' behaviors/experiences/considerations is not the purpose of this paper. However, we have to admit that in the demonstration of the ROMEDA method, we assume some simple (but reasonable) rules for the interaction between operators and the model, i.e., reservoir operators do not follow the model suggested reservoir releases but take some actions based on their own consideration and experiences, when the storage is below the maximum storage required for leaving space for coming storms. This is one of the possible ways of the operators and the model interact. As reservoir operators' considerations vary by person and by reservoir and involve multiple factors, such as policies and regulations, how to set more realistic rules for an operator to follow or not follow the modeled recommended releases is worthy of additional research, which is beyond the scope of this study, i.e., demonstrating that

the proposed ROMEDA works.

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