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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Minimizing the impact of vacating instream storage of a multi-reservoir system: a tradeoff study of water supply and empty flushing" *by* Chia-Wen Wu et al.

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General response: We sincerely appreciate the efforts of the reviewer to scrutinize the manuscript. The authors generally agree with the reviewer and will dedicate to revise the manuscript accordingly. The major revisions expected to address the reviewers' comments are summarized as the following: 1.The structure of the article will be re-organized as the following sections: (1)introduction, (2) qualitative conditions to implement empty flushing, (3) the case study area, (4)the adopted methods, (5)results and discussion, (6)potential future extension and (7)conclusion remarks. 2.The description in the introduction and methodology sections will focus more on the specific

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schematic of the case study system, and the extension to other general schematics will be moved to and more precisely addressed in the 6-th section. 3.All the materials about the supplemented data and references, including the field and numerical validation of the estimation of volume of flushed sediments, will be removed from the manuscript and provided in additional supplemented materiel files. 4.The description regarding the impact on downstream environment will be limited and shortened in the 5-th and 6-th sections with updated references. 5.The potential risks imposed by emptying reservoir on the following water supply and measures to alleviate or even offset the incremental water shortage will be more thoroughly presented in the 5-th section. 6.All the technical corrections mentioned by reviewers will be modified, improved and clarified in the revised version of the manuscript.

Point-by-point responses to the specific comments: 1.To recentralize the presentation on the theme of the research, all the suggestions by the reviewer will be undertaken accordingly.

2.The distributed information of the case study system will be gathered and integrated in the 3-rd section. The link between the case study area and the adopted method will also be more clearly and specifically explained.

3.The sections of the article will be reorganized as described in the general response.

4.The simulation model is designed to evaluate the performance of a water resources system under specific storage volume, water demand and operating rules. The simulation requires sequential daily routing of system operation for several decades of inflow series to reflect the long-term hydrological variation. Based on this aspect, comparing the simulation results with historical operating records may induce misinterpretations, since the reservoir storage and water demands were not stationary during the historical periods. The calibration analysis in the paper does not tune parameters related to physical movement process of water or sediment. Instead, it calibrates the optimal operating rules for the simulating duration. The validation is then testing the rules using the model with inflow series outside of the calibration timeframe to check its validity for general conditions. These points will be added in the associated sections in the revised manuscript.

5.The annual inflow volume to the Twengwen Reservoir in the original manuscript is a typo and should be corrected as 1.2 billion m3. This leads to a relatively small CIR ratio for the Twengwen Reservoir, and the general principles in literatures will not recommend the reservoir to implement empty flushing. Nonetheless, over 50% of the inflow volume concentrates within some significant flood events for Twengwen Reservoir. In addition, the presence of downstream off-line smaller reservoir adequately ensures short-term stable water supply, if properly managed. These conditions inspire the authors to elaborately create the opportune chances for potential empty flushing of Twengwen Reservoir, which suffers severely from both water insufficiency and siltation.

Except the shortage risk, any hydraulic-based desilting means impose impacts on the downstream river sections, including the currently adopted hydro-suction operation. Adequate flood spillage is a necessary condition for the effective removal of downstream deposited sediments. This condition might not be met during years without significant flood events, following which the hydro-suction operation will be halted and the impact on the depositing section of the river will last until the next adequate reservoir spillage. Nonetheless, the urgent need of achieving balance between annual inflowing and removing sediments require all the desilting means to cooperate rather than competing with each other. There are no conflicts between empty flushing, hydro-suction and sediment sluicing, as long as the shortage risk imposed by the first can be properly contained.

As for the incremental shortage risk, the problem comes from the rare situation while the frontal-induced inflow in the early flood season is abundant and the following invading typhoons are entirely absence for the remaining 5 months. Thus the water released for empty flushing cannot be recovered and incremental shortage is created. Nonetheless, this rare condition would inevitably lead to large scale suspension of the first semiannual irrigation, whether empty flushing in the previous year is performed or not. With or without empty flushing, the water originally supplied to the first semiannual irrigation, the volume of which ranges between 0.2∼0.3 billion m3, will be kept to secure public water supply. The annual demand of public purpose of this system is only 0.12 billion m3 and the empty flushing consumes water under 0.09 billion m3 according to the simulation. This shows the risk of increased shortage induced by empty flushing for this particular situation will be completely offset in reality.

In the last paragraph of the conclusion section, we do address that: "The high risk of water shortage in the case study area currently dictates the operating objective to solely focus on reliable water supply. This restricts the feasibility of not only empty flushing, but any other operations may cause additional consumption of reservoir storage, and leads to great reliance on hydrosuction to reservoir desilt, degradation of downstream environment and inefficient utilization of water resources. If this pressure can be somehow relieved, the practical benefits of the proposed method could be more evident, since all the problems stem from the same core: insufficiency of available water with acceptable quality for all purposes. While the operators are forced to myopically prevent the imminent water shortage risks, reservoir sedimentation also imposes equivalent and long-term threat to the degeneration of water supply yield. The urgent needs of both desilting and water supply may also endow a new role to the conventional projects of water resources development. In addition to elevating the yield of water supply, it may exploit more water to allow recovery and enhanced desilting of existing reservoirs, thus allowing the entire system to advance toward the goal of sustainability."

In addition, the first sentence in the same paragraph is considered by the authors as the major step forward from the current disciplines of both reservoir desilting and water resources management: "Integrating reservoir desilting considerations with water supply operation creates more facets into the multi-objective water resources management. In addition to irrigation, municipal, industrial and hydropower purposes, the competition

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of water extends to include sediment flushing, sluicing, vacating previous dredged and deposited sediments, and alleviating their impacts on downstream environment."

6.The authors agree with the reviewer and the content about the environmental impact will be more properly presented in the suggested section with shortened length in the revised manuscript.

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