

Table 1 The authors' responses to the comments of Reviewer #1

General Comments	Authors' responses
<p>The manuscript describes the selection of an empty flushing strategy applied to a two-reservoir system in Taiwan, first by using a qualitative and quantitative analysis that defines the most suitable period to flush the upper reservoir, and second by optimizing storage thresholds related to the empty-flushing conditions. The main contribution of the paper is on the assessment of empty-flushing in a reservoir system rather than a single reservoir. The paper shows a two reservoir system as a case study which seems insufficient to extend the methodology to multiple-reservoirs systems. The optimization component is also rather small, and it is limited to setting up threshold values after a modified storage-balance curve. In multiple-reservoir systems, this modification might not be that obvious and a complex minimization would be required. The manuscript includes a very useful overview of current cases of empty flushing experiences in multiple reservoirs, as well as a well-explained list (although it could be summarized for a more easy read) of key factors required to successfully carry out empty flushing. I recommend the publication this manuscript for publication, after minor revisions.</p>	<p>The reviewer's recommendation is very much appreciated.</p>
Specific comments	Authors' responses

<p>The paper focuses empty-flushing of the primary reservoir, located upstream. Some discussion on how to address the empty-flushing problem for downstream reservoirs should be included.</p>	<p>Suggestions on how to extend the proposed method to other systems have been provided in the fourth paragraph in subsection 3.6 of the revised manuscript.</p>
<p>The qualitative analysis does not include any environmental constraints on the problem; neither does the quantitative analysis which probably limits the sediment load discharged.</p>	<p>The potential impact of the environmental constraints on the empty flushing operation has been added in the second paragraph in subsection 3.6 of the revised manuscript.</p>
<p>Please explain how the storage balancing curves (example presented in Fig.3) are obtained in the first place; are they based on historic time series without empty-flushing operation?</p>	<p>The original storage balancing curves such as Fig. 3 were designed to ensure efficient utilization of water resources and adequate supply during which the agricultural demand peaks, without any consideration of empty flushing. It was derived initially based on field operating experiences and revised through trial and error process.</p>
<p>Equation (1) is an important limitation of this study. Some kind of sensitivity analysis would be expected in this case to assess how much it influences the optimized thresholds. This is also somehow captured by the differences shown in Fig.8. Measurements suggest using a between 2.5 and 10, although for the study used 60 as used by Atkinson. It seems a huge difference with respect to measurements.</p>	<ol style="list-style-type: none"> 1. The range of water surface level of the reservoir is beyond El. 190 m in Figure 8. In this case, the operation is categorized to not free flow flushing but to pressure flushing without fully draw down. Thus the flushing coefficient from the measurements is merely between the range of 2.5 and 10, which is significantly below the situation of empty flushing. 2. This study attempts to investigate the feasibility of empty flushing of a large reservoir with heavy water supply burden. It is essential that field measurements which precisely represent the condition of free surface flushing are currently unavailable, since the reservoir

	<p>has never gone through such operations. Due to the lack of field data, we can only directly assign the flushing coefficient as the most common and conservative value found in literatures. While using a different coefficient value might lead to a linearly-varied value of the flushed sediment volume which is also the objective function, the optimized storage thresholds are remained unchanged due to the impact of the water shortage constraints.</p> <p>3. We do recognize that the accuracy of the estimated flushing volume should still be investigated when more field measurements become available, for a more accurate evaluation of the benefits of empty flushing. A more detailed statement of this limitation and suggestions for future works are provided in the first paragraph in the subsection 3.6.</p>
<p>An important limitation of using the modified storage balancing curve from March until June is losing water at Wushanto. This is not well-explained in the paper. What are the trades-offs of having an increased probability of Tsenweng Reservoir storage dropping below 20M m³?</p>	<p>The trade-off of creating favorable conditions for empty flushing is that preserving the storage of Wushanto Reservoir before and during empty flushing might cause unnecessary spillage when the reservoir is full and the inflow from Guantien Creek cannot be stored. Nonetheless, the water shortage ratios generated by the modified balancing curves are no more than 0.01 higher than those from the original balancing curves, which means that the modification has only a trivial impact on the efficiency of water resources utilization.</p>

Was the cost function optimized for the period between 1975-2009? This is unclear.	Yes. A sentence “Coupling the established simulation model which simulates the water supply and empty flushing process from 1975 to 2009 with the optimization algorithm leads to the optimal solution of Eqs. (4), (9) and (10)” has been added to subsection 3.4 to more clearly explain the calibration period.
For the conclusions, a comment on the use of short-term forecasting and its implementation in Model Predictive Control applications to the case of empty-flushing problems would be appreciated.	It has been included in the third paragraph in sub-section 3.6. Thanks!
A more detailed description of the limitations applied in this study, as well as further improvements should be included (the only one mentioned is the empirical formula Eq. 1).	The newly added subsection 3.6 serves to more thoroughly present the assumptions and potential future improvements of this study
Technical corrections:	Authors’ responses
Page 10, lines 1-5: efficiency of empty flushing ...is between 40 to 60mm? This is not a measurement of efficiency.	The sentence has been revised as “The operating experiences of Jianshanpi Reservoir in southern Taiwan also revealed that the efficiency of empty flushing peaks during heavy rainfall events when daily rainfall on the reservoir watershed is between 40 to 60 mm.”
Fig 1 could be improved by mentioning the parameters to be optimized.	The figure has been modified accordingly.
Fig 2 could be improved by matching the notation of X axis with Fig 5 or vice-versa. Also, use a date notation (dd/mm) to describe vertical lines	Fig. 2 has been modified accordingly.

<p>How is the water shortage $d_{n,m}$ in Equation 2 computed? Make notation of $(d_i \Delta E_c d_j)$ in equation 5 clear. What is “ΔE_c”?</p>	<p>$d_{n,m}^0$ is from simulating the default regular water supply process using the GWASIM and $d_{n,m}$ is obtained by incorporating empty flushing operations according to the activating and terminating conditions defined by the parameters. $\max_{n=1,\dots,n^y} (d_{n,m}^R d_{n,m}^I > 0)$ represents the maximum water shortage ratio of the m-th month from the n^y simulating years given that the shortage is induced by empty flushing. The above explanations are added into the revised manuscript, thank you!</p>
<p>The term Permanent River Outlets (PRO), page 21 line 13, seems not to be often used. Do you mean total outlet structures or the bottom outlet structure?</p>	<p>PRO is the major bottom outlet of the Tsengwen Reservoir to perform hydraulic flushing and sediment venting. Since the abbreviated term appears in five separate places in the manuscript, we think it should be appropriate to remain the current form for a more precise presentation.</p>
<p>Page 25 line 10: why not until June 30 as it was described in 3.1?</p>	<p>The preliminary water supply simulation in 3.1 shows that the condition that the storage in the Tsengwen Reservoir drops below 20 million m^3 while Wushanto Reservoir storage simultaneously exceeds the lower limit of the operating rule curves only occurs between May 11 and June 20. It is thus selected as the feasible period for empty flushing in the Tsengwen Reservoir. To extend the modification of storage balancing curves beyond June 20 will have no impact on promoting sediment flushing.</p>

Page 26 line 2: identify Rows 3 and 4 with names.	The sentences are re-written, in adaption to the merging of the original tables 2, 3 and 4.
Table 2,3,4 could be merged into a single one, taking less space in the paper..	The revision has been made, as the Table 2 in the revised manuscript.
Fig. 11: improve readability of lines, which one is which? Legend seems very similar with and without empty flushing	These figures are improved in the revised manuscript, thank you!

Table 2 The authors' responses to the comments of Reviewer #2

General Comments	Authors' responses
Reservoir sedimentation management is important worldwide and this paper will contribute to introduce empty flushing operation in multiple reservoirs by considering both flushing efficiency and keeping suitable storage for water supply conditions. This optimization scheme will be valuable in case reservoir sizes are too large to recover storage volume in a short period after emptying flushing.	The reviewer's recommendation is very much appreciated.
Specific comments	Authors' responses
In the calculation of empty flushing, Eq.(1) is very much important but still unknown parameters are still exist. $W = 12.8 Q^{0.5}$ and ψ are those key factors. In case higher than EL.185 in Fig.8, we hardly say this is empty flushing and cannot apply Eq.(1) for sediment flushing volume. These are categorized to not free flow flushing but to pressure flushing without fully draw down. If so, there is very limited or almost no data for Tsengwen Reservoir lower than EL.185. This is very much critical defect in this paper.	<p>The comment by the reviewer is certainly true. But currently there is no way for us to have field data precisely presenting the free flow flushing condition beforehand, since the reservoir have never gone through such operations. In this situation, we can only refer to the most common and conservative value for the flushing coefficient appeared in the literatures.</p> <p>Nonetheless, since the optimized storage thresholds are primarily dictated by the water shortage constraints, changing the value of the coefficient will only affect the objective function value which varies linearly along with the flushing coefficient and leave the optimal parameter unchanged.</p>

<p>Another issues are environmental constraints. Generally, free flow flushing should be designed to minimize environmental impacts by high turbidity flow conditions. If so, periodical and short period draw down is suitable. In this regard, every year like in the Kurobe River, Japan or every three years in the Rhone River, Swiss-France are the good examples. Additionally, in order to avoid too much social stress to downstream water users, total duration of empty flushing should be limited less than couples of days because they should stop intake river water during high turbid water passing and they have the maximum acceptable duration for stopping intake. In this paper, if possible, such conditions should be considered.</p>	<p>Although the environmental constraint is not explicitly considered in our analysis, fortunately, the patterns of empty flushing operations from the optimized results conform well to the reviewer's suggestion. This is because that the strict requirement on the stability of water supply in the case study system has already restricted the frequency and duration of empty flushing. Further, the empty flushing is designed to be performed during the first flood in the wet season. The flood discharge from the downstream watershed is expected to transport the flushed sediments to the downstream water receiving body. Otherwise, the primary reservoir may have to release extra water to assist carrying sediments downstream.</p>
<p>Lastly, one graph which shows sedimentation progress with and without empty flushing should be included.</p>	<p>Figure 15 in the revised manuscript depicts the sedimentation progress with and without empty flushing.</p>
<p>Technical corrections</p>	
<p>P3, Line 4, The Tarbela Reservoir is not in Iran but in Pakistan. P21, Line 4, Fig.1 should be changed to Fig.2.</p>	<p>The corrections have been made in the revised manuscript, thank you!</p>