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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Assessment of optimal empty flushing strategies in a multi-reservoir system" *by* F. N.-F. Chou and C.-W. Wu

**Anonymous Referee #1**

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Review "Assessment of optimal empty flushing strategies in a multi-reservoir system"

General comments: 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.

Specific comments: 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. The qualitative analysis does not include any environmental constraints on the problem; neither does the quantitative analysis which probably limits the sediment load discharged. 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? 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 $\Psi$ between 2.5 and 10, although for the study used 60 as used by Atkinson. It seems a huge difference with respect to measurements. 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? Was the cost function optimized for the period between 1975-2009? This is unclear. 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. 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. 5).

Technical corrections: Page 10, lines 1-5: efficiency of empty flushing ... is between 40 to 60mm? This is not a measurement of efficiency. Fig 1 could be improved by mentioning the parameters to be optimized. Fig 2 could be improved by matching

the notation of X axis with Fig 5 or vice-versa. Also, use a date notation (dd/mmm) to describe vertical lines. How is the water shortage dn,m in Equation 2 computed? Make notation of (di ĐĘ dj) in equation 5 clear. What is “ĐĘ”? 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? Page 25 line 10: why not until June 30 as it was described in 3.1? Page 26 line 2: identify Rows 3 and 4 with names. Table 2,3,4 could be merged into a single one, taking less space in the paper. Fig. 11: improve readability of lines, which one is which? Legend seems very similar with and without empty flushing.

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