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Discussion
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Dams and Reservoirs

Discussion: Evaluation of sediment management strategies for Tarbela reservoir

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We are discussing the paper 'Evaluation of sediment management strategies for Tarbela reservoir' providing some additional information, based on our studies.

Keywords: dams, barrages & reservoirs/hydraulics & hydrodynamics/sedimentation

Sediment management options should always be considered when planning, designing and operating reservoirs. Therefore, we congratulate the authors for exploring this topic in one of the world's largest dams. Tarbela is a key asset for Pakistan in terms of irrigation and hydropower and it has been an object of several studies, including the ones we were involved (WAPDA, 2015). We refer to the paper by Rashid *et al.* (2023). As already discussed in Petkovsek and Roca (2014), reservoir operation levels clearly influence sediment deposition, and in turn the storage capacity of the reservoir and the amount of sediment arriving at the dam area. Figure 1 shows the sediment inflows and outflows from the Tarbela reservoir considering different minimum operating levels (from 400 to 440 m). The results are obtained with the RESSASS (reservoir survey analysis and sedimentation) model, which is applicable to river and reservoir systems (including one or more reservoirs) and simulates long-term deposition in reservoirs.

In the paper, the characteristics of the sediment used in the HEC-RAS (hydrologic engineering center-river analysis system) modelling are not specified. Petkovsek and Roca (2013) showed that although models could perform reasonably well with three fractions only (clay, silt and sand), increasing the number of fractions improves the performance in terms of root mean-square error when comparing the model results against observed profiles. Furthermore, for long-term runs, consolidation of fine deposits has an impact on storage volume, and it is therefore advantageous if modelling can simulate this process.

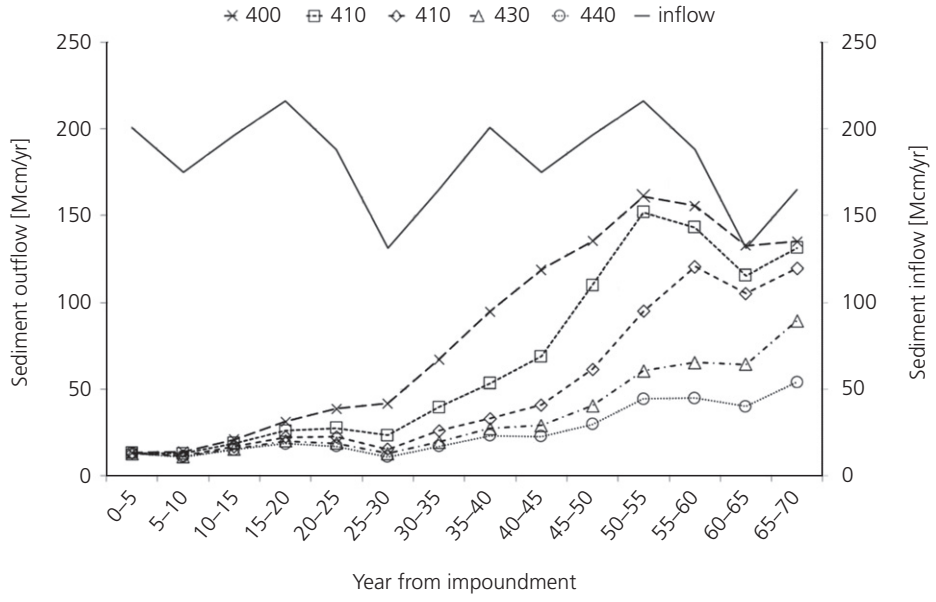

Figure 1. Sediment inflows and outflows considering different minimum operating levels (400–440 m) (source: Petkovsek and Roca (2014))

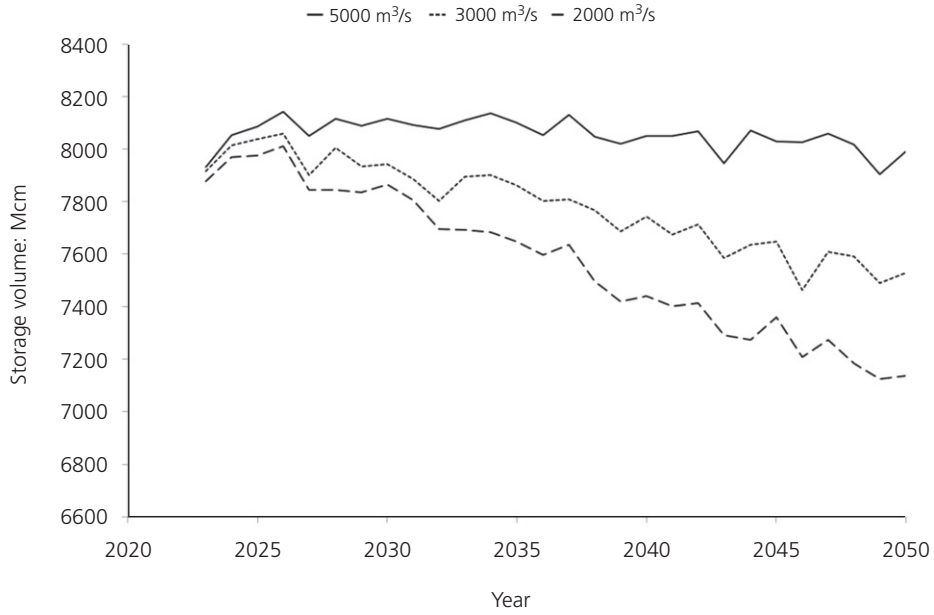

Figure 2. Gross storage volume at Tarbela with annual 30 day flushing starting in 2023 with three different target discharges, 5000, 3000 and 2000 m^3/s (source: extracted from HR Wallingford (2013))

The authors explore the technical viability of flushing by estimating the SBR (sediment balance ratio) and LTCR (long-term capacity ratio) parameters and by comparing the bed profiles before and after one flushing operation with a duration of three months. To provide further assurance, we would suggest performing longer-term runs taking into account the annual variability of flood discharges. The duration of the flushing operation is also an important parameter (Petkovsek *et al.*, 2020). We found that a 30 day flushing operation, instead of the 90 day operation explored by the authors, was feasible to maintain the storage volume in the reservoir. Figure 2 presents the loss of storage obtained by us with RESSASS for different annual flushing operation scenarios, for a period of 40 years starting from 2023.

We agree that if Diamer Basha, upstream of Tarbela, is commissioned, the sediment inflow into Tarbela reservoir will be significantly lower for the next 20 years. This solution will gain some time for Tarbela, albeit that will be dependent on the sediment deposition rates and therefore, sediment management options at Diamer Basha reservoir.

The paper would benefit from a discussion of uncertainties related to the numerical model results. For example, sedimentation processes can develop faster (or slower) if real future sediment and flow discharges into the reservoir are higher (or lower) than the ones used by the model.

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