Impact of climate changes on sediment delivery and deposition in a dammed reservoir

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Introduction: Advanced mathematical models allow to track precisely soil particles, from the moment they are detached from the catchment surface layer until they are deposited in the selected profile of a river. However, it should be remembered that the course of many rivers, especially in the mountainous areas, has been significantly altered by numerous water structures. Such as dammed reservoirs, which most often become the final stage of the journey for most sediment particles, especially those with larger diameters. To address fully transport of sediment particles in the catchments with a dammed reservoir a multi-stage modeling approach has been applied for the Raba River and Dobczyce Reservoir system (southern Poland, Carpathian Mts.), combining the Macromodel DNS/SWAT & AdH/PTM models.

Methods: The average sediment load delivered from the Raba River catchment to the Dobczyce Reservoir was estimated as 2.43 Gg y^{-1} by the Macromodel DNS/SWAT. Moreover, its monthly/seasonal/yearly variability was followed under the RCP 4.5 and 8.5 climate change predictions [1]. These values served as input data for the AdH (an Eulerian hydrodynamic model) and PTM (a Lagrangian particle-tracking model), which gave the opportunity to track the further fate of sediment particles directly in the reservoir waters [2].

Results: The Macromodel DNS/SWAT & AdH/PTM tool has been run for the adopted climate change scenarios, separately for each month of the year. As a result numerical maps of representative sediment particles deposition were obtained. These maps allowed not only to predict sedimentation rate under the various scenarios, but also made it possible to see how the transport processes sort the grains of various types (mineral/conglomerate) and diameters along the reservoir each month.

Discussion: As an example of this combined modeling tool possibilities, the month of April has been selected due to the pronounced increase of precipitation for the RCP 4.5 scenario observed in the studied catchment (up to 80%). This change resulted in the April sediment load increase (by over 1300 tonnes) and noticeable change of particle deposition pattern in the reservoir (Fig. 1). The total number of sediment particles deposited in April out of the reservoir backwater region for RCP 4.5-H1 (Fig. 1B) has been 8.2 times higher than for the base scenario (Fig. 1A).

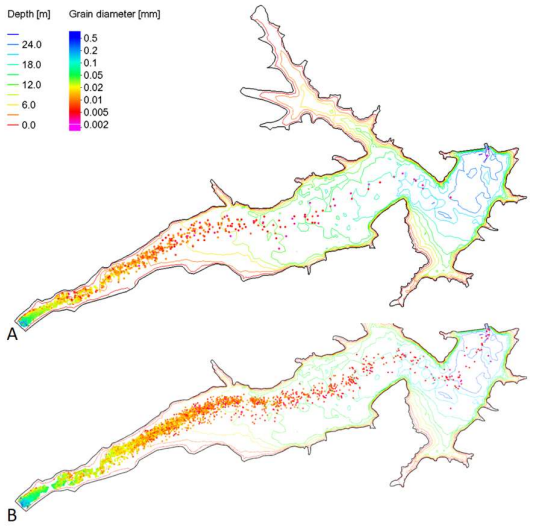

Fig. 1: *Deposition maps of mineral grains for April in scenarios: base (A) and RCP 4.5-H1 (B).*

The applied multi-stage modeling approach enabled not only tracking sediment particles but also predicting sediment accumulation rate and remaining reservoir capacity under adopted scenarios. Moreover, the detailed maps of depositional zones can be created with the use of this tool.

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References: [1] Szalinska et al. (2020) *J Soils Sediments* **20**:2641–2652; [2] Szlapa & Hachaj (2017) *Technical Transactions* **7**:113–126.