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Modelling sediment yield of a highly erodible catchment based on reservoir siltation volumes

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Distributed sediment models are a fundamental tool for the estimation of soil erosion and basins sediment yield. One of the main restrictions for its implementation at the catchment scale is data availability. Sediment yield records are necessary for a correct model calibration and validation. Nevertheless, continuous sediment yield measurements are very scarce, and almost exclusively available for small catchments or experimental plots. This problem can be overcome by using bottom reservoir and lake deposits as estimates of the total sediment yield.
In this study, the TETIS model is applied to the Ésera catchment (Central Southern Pyrenees), which flows into the Barasona Reservoir. The TETIS model is a distributed conceptual hydrological model widely used in the last two decades, and it includes a sedimentological extension. Hydrological processes such as soil static storage, infiltration and runoff generation are conceptualized by means of a simple tank structure, while sediment production is estimated by the modified Kilinc-Richardson equation and the sediment channel transport capacity is calculated by means of the Engelund-Hansen formula. The Ésera and its main tributary, the River Isabena, are highly erodible catchments due to presence of badlands stripes on marls located in the middle parts of the basins. Rivers drain into the Barasona Reservoir, a lake that experiences severe siltation. The reservoir has lost most of its original capacity and must be dredged regularly. Five bathymetrical surveys are available, carried out by the Experimental Studies Centre (CEDEX - 1986, 1993, and 1998) and the University of Lleida (2006 and 2007). The depositional history of the Barasona Reservoir has been reconstructed using these measurements and other studies carried out at the reservoir deposits in the last 20 years. This historical reconstruction provides estimated siltation volumes, which have been used for calibrating and validating the sediment submodel. Sediment dry bulk density was incorporated using the Miller formula, and the sediment trap efficiency of the reservoir was calculated by the Brune's formula. Model outcomes were compared to suspended sediment measurements on the River Isábena. Overall, results show a good behaviour of the model, which is able to estimate total deposited volumes into the reservoir and to detect high erosion zones all over the catchment. Nevertheless, some relevant differences with gauged sediments are observed, above all for the period 88-93 (the model error on the total volume is -60%, i.e. the model underestimates the observed sediment accumulation), which are worth a more detailed analysis, e.g. taking into account possible errors in trap efficiency estimation and in reservoir storage capacity estimation.