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Sediment budget including the role of floodplains: the case of Lake Tana Basin (Ethiopia)

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Based on the collection of a large new dataset, we quantify the sediment 1) mobilized on the hillslopes surrounding Lake Tana (Ethiopia), 2) stored on the floodplains, 3) transported into the lake, 4) deposited in the lake and 5) delivered out of the lake so as to establish a sediment budget. In 2012 and 2013, suspended sediment concentration (SSC) and discharge measurements were made at 13 monitoring stations, including two lake outlets. 4635 SSC samples were collected and sediment rating curves that account for land cover conditions and rainfall seasonality were established for the 11 river stations, and mean monthly SSC was calculated for the outlets. Effects of the floodplain on rivers' sediment yield (SY) were investigated using the measurements at the upper and lower stations of Gilgel Abay, Gumara, Megech and Rib Rivers. SY from ungauged rivers was assessed using a model that includes catchment area and rainfall, whereas bedload and direct sediment input from lake shores were estimated. As a result, the gross annual SY from both gauged and ungauged rivers, bedload and lake shores was ca. 3.14 million tons, dominantly from Gilgel Abay and Gumara Rivers. The 0.48 million tons sedimentation in floodplains indicate that the floodplains serve as sediment sink. Moreover, annually about 1.09 million tons of sediment leaves the lake through the two outlets. Annual deposition in Lake Tana was about 1.56 million tons with a trapping efficiency of 60%. Furthermore, SSC and SY are generally higher at the beginning of the rainy season because soil in cultivated fields is bare and loose due to frequent ploughing and seedbed preparation. Later on in the season, increased crop and vegetation cover lead to a decrease in sediment supplies. Based on the established sediment budget and its calculated components, one can conclude that the expected lifetime of Lake Tana (20,396 years) is longer than what was anticipated in earlier studies.