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Estimate of cumulative sediment trapping by multiple reservoirs in the Yangtze River basin

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In the Yangtze River basin, rapid economic growth has increased the pressure for greater hydropower production and other water-related developments, such as large-scale irrigation. The mainstream and its tributaries are being dammed at a dazzling pace. Since the 1950s, numerous reservoirs have been constructed in the river basin. There are 44,000 reservoirs of different sizes in the Yangtze River basin with a total storage capacity of approximately 290 km^3, among which 1358 reservoirs are large and medium-sized with storage capacity greater than 0.01 km^3. As a result of reservoir construction, sediment discharge data from the upper, middle, and lower reaches of the river indicate that the reduction of the Yangtze sediment load has occurred in different periods. In this study we developed and applied a framework on 1358 of large and medium-sized reservoirs ($\geq 10^7$ maximum storage capacity) for calculating reservoir sedimentation rates in the multi-reservoir Yangtze River system while accounting for the effect of reduced sediment input due to upstream traps. We further used statistical inferences to assess the sedimentation rates of remaining 42,000 smaller reservoirs. Our results indicate that annual sediment accumulated in the Yangtze reservoirs is approximately 691 ($\pm$ 93.7) million tons (Mt), 669 ($\pm$ 89.1) Mt of which is trapped by 1358 large and medium-sized reservoirs and 22 ($\pm$ 4.6) Mt is trapped by smaller reservoirs. Despite the large amount of sediment trapped by reservoirs, the reduction in sediment load at outlet (Datong station) was merely 305 Mt over the last 60 years. The difference may reflect uncertainties in estimates; but it also indicates the important discrepancy between the estimate of the current rate of sediment sequestration in reservoirs and the estimate of the reduction in the land–ocean sediment flux. We further estimated a mean annual rate of storage loss of 5.3 $\times$ 10^8 m^3 yr^{-1}; but against the world trend, the Yangtze River is now losing reservoir capacity much lower than new capacity is being constructed.

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