

Estimation of Ribb Dam Catchment Sediment Yield and Reservoir Effective Life Using Soil and Water Assessment Tool Model and Empirical Methods

Authors : Getalem E. Haylia

Abstract : The Ribb dam is one of the irrigation projects in the Upper Blue Nile basin, Ethiopia, to irrigate the Fogera plain. Reservoir sedimentation is a major problem because it reduces the useful reservoir capacity by the accumulation of sediments coming from the watersheds. Estimates of sediment yield are needed for studies of reservoir sedimentation and planning of soil and water conservation measures. The objective of this study was to simulate the Ribb dam catchment sediment yield using SWAT model and to estimate Ribb reservoir effective life according to trap efficiency methods. The Ribb dam catchment is found in North Western part of Ethiopia highlands, and it belongs to the upper Blue Nile and Lake Tana basins. Soil and Water Assessment Tool (SWAT) was selected to simulate flow and sediment yield in the Ribb dam catchment. The model sensitivity, calibration, and validation analysis at Ambo Bahir site were performed with Sequential Uncertainty Fitting (SUFI-2). The flow data at this site was obtained by transforming the Lower Ribb gauge station (2002-2013) flow data using Area Ratio Method. The sediment load was derived based on the sediment concentration yield curve of Ambo site. Stream flow results showed that the Nash-Sutcliffe efficiency coefficient (NSE) was 0.81 and the coefficient of determination (R^2) was 0.86 in calibration period (2004-2010) and, 0.74 and 0.77 in validation period (2011-2013), respectively. Using the same periods, the NS and R^2 for the sediment load calibration were 0.85 and 0.79 and, for the validation, it became 0.83 and 0.78, respectively. The simulated average daily flow rate and sediment yield generated from Ribb dam watershed were 3.38 m³/s and 1772.96 tons/km²/yr, respectively. The effective life of Ribb reservoir was estimated using the developed empirical methods of the Brune (1953), Churchill (1948) and Brown (1958) methods and found to be 30, 38 and 29 years respectively. To conclude, massive sediment comes from the steep slope agricultural areas, and approximately 98-100% of this incoming annual sediment loads have been trapped by the Ribb reservoir. In Ribb catchment, as well as reservoir systematic and thorough consideration of technical, social, environmental, and catchment managements and practices should be made to lengthen the useful life of Ribb reservoir.

Keywords : catchment, reservoir effective life, reservoir sedimentation, Ribb, sediment yield, SWAT model

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