A modeling Approach to Evaluate the impact of Conservation Practices on Water and Sediment Yield in Sasumua Watershed, Kenya.

J. K. Mwangi, C. A. Shisanya, J. M. Gathenya, S. Namirembe, D. N. Moriasi

Abstract

Degradation of agricultural watersheds often reduces their capacity to provide ecosystem services such as sediment retention, flow regulation, and water quality improvement. Soil and water conservation practices can be used to enhance the capacity of watersheds to produce these services. The objective of this study was to evaluate the impact of agricultural conservation practices on water and sediment yield using the Soil and Water Assessment Tool (SWAT) model. The study area was Sasumua Watershed (107 km2 [43 mi2]), where land degradation has affected watershed's capacity to regulate flow and maintain water quality. The model was calibrated and validated for streamflow at the watershed outlet. Data on annual average erosion rates for the area was used to constrain soil erodibility factor (KUSLE) and practice erodibility factor (PUSLE) parameters during sediment calibration while measured three month sediment concentration data was used for validation. Model performance was assessed using the coefficient of determination (r2), Nash-Sutcliffe efficiency coefficient (ENS) and percent bias (PBIAS). Results gave monthly streamflow r2 values of 0.80 and 0.85, ENS values of 0.74 and 0.81, and PBIAS values of ±5% and ±6% during the calibration and validation. The model also satisfactorily simulated daily sediment concentrations with an r2 value of 0.54. However, ENS and PBIAS values were low, which was attributed to the short duration of measurement. The validated model was used to simulate sediment yield for the period 1970 to 2010. Mean annual watershed sediment yield was 40,934 t y−1 (90,243,096 lb yr−1). The impacts of filter strips, contour farming, parallel terraces, grassed waterways, and their combinations on water and sediment yield were simulated by adjusting relevant model parameters. The effectiveness of filter strips increased nonlinearly with width being optimum at 30 m (98.4 ft). A combination of 30 m (98.4 ft) wide filter strips and grassed waterways reduced sediment yield by 80%; parallel terraces, 10 m (32.8 ft) filter strips, and grassed waterways reduced sediment yield by 75%; 10 m (32.8 ft) filter strips and grassed waterways reduced yield by 73%; contour farming and grassed waterways reduced yield by 66%; and grassed waterways reduced yield by only 54%. Parallel terraces reduced surface runoff by 20% and increased base flow by 12%, while contour farming reduced surface runoff by 12% and increased base flow by 6.5%. Implementation of conservation practices can reduce sediment yield and increase

water yield marginally. The results give an insight into the implications of the present land use management practices and can be used to devise ecologically sound watershed management and development plans.