An Assessment of Sediment Loading into an Agricultural Reservoir in a Semi-Arid Region of Kenya

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Abstract

The 95.7 version of Water Erosion Prediction Project (WEPP 95.7) model was applied to an approximately 2.7 km^2 agricultural catchment to estimate the amount of sediment loading into the reservoir of Ndaragwiti Dam, Kenya. The reservoir had 1.9 ha surface area, 1.2 m mean depth and a total volume of 34000 m^3, and was fed by the catchment in a semi-arid region of Lakipia District of Kenya. The catchment was divided into three sub-watersheds based on existing three channels feeding the reservoir. The sub-watersheds were subdivided into 22 hillslopes (plots) according to the slope orientation. Annual sediment that entered the reservoir from each of the sub-watersheds, as well as the sediment that left the reservoir and that retained in the reservoir were generated by the WEPP (95.7) model based on the constructed data sets for the period of 1996. These estimated values were compared with the measured sediment to assess the performance of the WEPP (95.7) model. The estimated annual amount of sediment from each sub-watershed into the reservoir, sediment out of the reservoir through the spillway and the sediment retained in the reservoir ranged between 71% and 75% of the measured values. The WEPP (95.7) model estimated an annual total sediment yield of about 2206 t corresponding to an average sedimentation rate of 817 t km^{-2} yr^{-1}. This estimate is about 71% of the measured rate. The study constitutes a fairly test of WEPP (95.7)'s capabilities since no parameters were calibrated. The findings indicate that the WEPP (95.7) model can reasonably estimate sediment loading when executed without calibration on a catchment devoid of roads in semi-arid region.

Introduction

For many years, governments and individuals have been cooperating to reduce soil erosion and sedimentation on agricultural lands and water bodies (FAO, 1993). Yet much remains to be done as sediment is still the largest single pollutant of streams, lakes and reservoirs. Shahin (1993) noted that the assessment and understanding of erosion and sedimentation processes are essential components of water resource management.

The lower rainfall in semi-arid areas compared to that in humid climates does not imply a corresponding low level of soil erosion by water (FAO, 1987). Semi-arid areas have the potential of generating and transporting large quantities of sediments due to the torrential nature of the rains (Magfed, 1986; FAO, 1987). Almost the total lack of natural protection against detachment of soil due to sparse vegetation especially at the beginning of the rainy season (Pilgrims *et al.*, 1988) and increased biotic interference (FAO, 1973) are responsible for accelerated erosion in the semi-arid areas. The rate at which the process of erosion transport and sediment deposition act are dependent on such variables as rock or soil type, topographic relief, plant cover, climate and landuse (Elwell, 1984).

Sediment production is of great significance to water development because it often reduces the economic life of many