



Magnitudes and dynamics of runoff and sediment yield: an extensive analysis of hydrological responses of three sub-watersheds in the Ethiopian highlands

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In addition to soil loss, flooding and sedimentation being critical problems in the sub-humid Ethiopian highlands, lack of adequate datasets has greatly inhibited the understanding and effective management of runoff and sedimentary processes. In this study, quantitative relationships were established among rainfall features, runoff characteristics and sediment yield patterns measured during 2014-2015 in three sub-watersheds of Koga catchment, NW Ethiopia. Multiple regression models were formulated to predict sediment discharge using daily data on: rainfall, 10-minute maximum rain intensity, average rain intensity, suspended sediment concentration (SSC) and runoff discharge. Very strong seasonal and event variability in rain intensity, runoff and sediment yield was observed in all sub-watersheds. The rain intensity was found to be the strongest predictor of sediment discharge. Area-specific sediment yield was 35.6, 24.4, and 31.7 t/ha/y for Asanat, Debreyakob and Rim sub-watersheds. The importance of individual events was very high: more than 53% of the total annual sediment load was produced by the five largest events. The average annual transport capacity during the rainy season was 0.86, 0.17 and 0.55 kg/s/m in Asanat, Debreyakob and Rim respectively. This is higher than the measured suspended sediment discharge and indicates that a considerable amount of sediment discharge occurs in the form of bed load. Runoff and SSC event analysis showed four different types of hysteretic loops: clockwise and linear (mainly for early rain season), complex and negative for middle and late rainy season, indicating the complex and heterogeneous nature of runoff and sediment source areas and yield response of the sub-watersheds. Also, a striking trend of decreasing SSC with time was observed, unrelated to the increasing runoff and rainfall. Thus, hydrological and sediment response to rainfall is highly variable and dynamic in these Ethiopian catchments. Understanding the variations and relationships between controlling factors and dynamics of runoff and sediment yield could greatly improve our understanding of soil erosion and sediment load, which ultimately lead to better management of watersheds.