SOME HYDROLOGICAL INVESTIGATIONS FOR THE DESIGN OF SAND DAMS IN WEST POKOT DISTRICT, KENYA

BY

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ABSTRACT

Sand dams are a low technology option for water supply in arid and semiarid land (ASAL) regions that is being resorted to in Kenya. Although they are not new, sand dams have not been subject to much scientific inquiry and there is little written about them in the literature. Design approaches vary from place to place with equally varied results. The specific storage and step heights of a sand dam are dependent on hydrologic and topographical factors of the catchment.

The purpose of this study, therefore was to investigate and determine the role of hydrological and topographical factors in the design of sand dams. The study was conducted in West Pokot District. Historical rainfall and evaporation data from the weather station at Kacheliba were retrieved for analysis. Data collected in the field consisted of evaporation, rainfall and stage of flow at two ephemeral streams. Other field activities consisted of sampling of suspended and bedload samples and sampling of residual sediments in the sand dam at Nasukuta. Channel slopes and other variables were measured at Nasukuta and eight other sand dams.

The United States Soil Conservation Service (SCS) curve number (CN) model was fitted for prediction of runoff volumes. Runoff hydrographs were simulated using the SCS method of unit hydrograph synthesis and Bernard's distribution graph. The SCS method proved superior as indicated by statistical tests. Sediment transport rates were also modeled using two different bedload equations, namely the streampower approach and the Engelund-Hansen method. The latter method was found to perform better for the study site.

The historical rainfall data was analysed for runoff producing events. The exponential probability density function was fitted to the depths of rainfall per event while the binomial approximation to the normal was fitted to the number of runoff producing events in a season. The rainfall model was coupled with the sediment transport model and used to predict sediment yields.

Using the models described above it was possible to estimate the sediment yields of individual floods for the Nasukuta catchment and to predict seasonal yields. The study area has a mean of 21 runoff producing events annually with a median depth of 15 mm. Events of this magnitude yield about 15 m^3 of coarse sediment to be deposited in the sad dam. A minimum incremental step height of 0.3 m is recommended for Nasukuta and sand dams in general. Step heights at any site can only be estimated based on the physiographic and hydrological factors affecting the site. The characteristics of residual sediments were found to vary with depth and distance from the dam wall. The sediments at Nasukuta had a median particle diameter of 0.64 mm, a mean porosity of 43.7%, specific yield of 23.3%, specific retention of 19.5% and a hydraulic conductivity of 28 m per day. The amount of available water in the nine sand dams assessed ranged from just over 40 m^3 to over 5500 m^3. The results also indicate that the highest specific storage in sand dams are obtained for river slopes between 1 and 2%.