スリランカの畑地野菜生産システムにおける土壌侵食予測に対する WEPP モデルの適用性

The Applicability of WEPP Model in Soil Erosion Prediction under the Upland Vegetable Crop Production System in Sri Lanka

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Accelerated soil erosion by water has been identified as the primary cause of the land degradation which is considered for over last two decades as one of the major environmental problems of Sri Lanka. Soil erosion has been a severe environmental threat particularly to the upper watershed area of the country. The upper watershed area that accounts for one thirteenth of country's total land area feeds the focal points of 103 rivers running in various directions, used for vast range of purposes of which hydro-electricity generation and irrigation of drier parts of the country play a significant role in the economy. Inappropriate land use practices in agricultural sector, in subsistence farming systems in particular are recognized as the major cause of erosion by water in the environmentally sensitive and economically vital upper watershed area. Upland vegetable and other cash crop cultivation is characterized in the subsistence farming system in the troubled watershed area.

Thus the deterioration of highly important ecosystem, especially owing to erosion has been a matter of concern. Further, adverse off-site effects of erosion have been detrimental to the healthy downstream environments and economic activities that use water flowing through channels and streams originated in upper watershed areas. Sedimentation and siltation of downstream water bodies severely affects electricity generation and irrigation activities and make lowland areas vulnerable for flooding. Soil erosion assessment is one of the key components in watershed management as it is very much useful in planning, designing and implementation of soil conservation programs and formulating necessary policy initiatives. However, the accuracy and the reliability of the erosion assessment has also been a concern as the methods used for erosion assessment and erosion prediction are not always appropriate for the conditions prevailed in complex agricultural watersheds. The Universal Soil Loss Equation (USLE), the widely used erosion prediction model and its derivatives have been the most commonly used methods for water-induced erosion assessments in agricultural lands and other forms of land use in upper watershed area.

The USLE is an empirical model that gives the total annual soil loss or sediment load on a specific area of upland under specific management conditions. This method has been described as a straightforward method and it does not provide any information on soil deposition on sloping landscape and the spatial and temporal variation of the erosion. Water Erosion Prediction Model (WEPP) is a physically based model developed by USDA (United States Department of Agriculture) that estimates soil loss and sediment deposition using a spatially and temporally distributed approach. The 'hillslope' version of the model computes the erosion along a single slope profile while the 'watershed' version assesses the erosion soil loss at large scale watershed or catchment level. However, the scientific literature shows that WEPP model has not been used for erosion prediction in Sri Lanka. Since the model has not been validated for the local conditions in Sri Lanka it can be assumed that the application of the model is held back. Therefore, this study was undertaken with the prime objective of examining the applicability of WEPP model in erosion prediction on upland crop production systems in upper watershed area in Sri Lanka.

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The research study was carried out on an agricultural land in Uma-Oya watershed, one of the problem watersheds in soil erosion aspect. The location of study was in IU_3 (Up-country Intermediate Zone – 3) agro ecological region where the mean annual rainfall (for last ten years) were 1750 mm. In order to validate the WEPP model for the local conditions in IU_3 region the research was designed to collect the observed data on soil erosion under upland crop cultivation. The slope of the farmland used for the study was 30%. A total of twenty one experimental units were established to assign six different soil conservation measures and control unit (three replicates of each treatment). The each experimental unit was separated with wooden board. The size of the each plot is 1.5m x 8m. The experiment was conducted for a complete one year period from April 2012 to March 2013 covering two main cropping seasons and one fallowing period. Cabbage and potato was grown in first and second cropping seasons respectively while horse gram was cultivated as cover crop/green manure in the fallowing period. The runoff volume, suspended sediment and total eroded sediment were separately measured for each experimental unit on each rainy day.

The climate data; daily rainfall, minimum and maximum temperature, soil data; clay, sand and rock composition of the farm land, bulk density, CEC and crop management data; maximum root depth, root shoot ratio, maximum canopy height, average yield etc. were collected as the input of WEPP model. The 'hilslope' version of the WEPP model was used to calculate the soil loss for each experimental unit. The observed sediment yield values and model generated values were tested for the validity of the model for the local conditions. The results showed that the WEPP model can successfully apply for the erosion prediction on upland crop cultivation system in upper watershed area of Sri Lanka.

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