C
333.913
NAY

LAND USE EFFECTS ON HYDROLOGICAL PROCESSES AND THEIR IMPLICATIONS ON WATERSHED MANAGEMENT: A STUDY IN THE MID COUNTRY INTERMEDIATE ZONE OF SRI-LANKA

Heenbanda Nayakekorala

Department of Geography

University of Peradeniya

A dissertation submitted in partial fulfilment of the requirement for the Degree of Doctor of Philosophy

533967

UNIVERSITY OF PERADENIYA
14-12-2000
LIBRARY

ABSTRACT

Land use effects on hydrological processes and their implications on watershed management: a study in the mid country intermediate zone of Sri-Lanka

H.B.Nayakekorala
Department of Geography
University of Peradeniya

Degradation of land and water resources in the country is considered to be a major problem at present. Soil erosion, fertility decline, increasing rainfall runoff ratios, declining dry weather flow, increasing peak flows and high sediment rates are major symptoms of the land degradation. Watershed management programs have been initiated in order to address the land degradation problem. Changing of vegetation in the lands has been given high priority in these watershed programs. These programs are based on assumptions that have never been validated. Therefore, there is an urgent need to determine the basic relationships among vegetation and hydrological processes under various land use systems to assist planning of watershed management programs in the country.

The objectives of the study were to determine the hydrological processes and their inter relationships under different land use systems namely, hedgerow cropping, mixed tree cropping (Kandyan forest garden), grassland and natural forest in the mid country inter mediate zone (IM3) of the Upper Mahaweli Catchment (UMC).

The study was conducted at four sites in IM3 of the UMC during the period from January1995 to July 1997. Evapotranspiration of different vegetation under the four land use systems was determined by the water balance approach in plots of land. The following water balance equation was used. $ET = RF - RO - P - \Delta S$ where, ET= evapotranspiration, RF = rainfall, RO = runoff, P = percolation and ΔS = change in soil water storage. The

water balance was done for the periods when percolation was negligible. Percolation was estimated using hydraulic conductivity and diffusivity of the soil. RF, RO, and ΔS were measured at each site. Infiltration rates at each land use system were determined by standard techniques. Rainfall interception by different vegetation was measured. The rainfall characteristics such as amount, duration and intensity of one rainfall station of the study area were analysed to determine their relationship to different hydrologic processes.

Results revealed that the four land use systems significantly influenced the three hydrological processes namely, ET, interception and infiltration. The annual ET of the reference crop in IM3 zone was amounted to about 2000mm. However, the potential ET of the vegetation in land use systems namely hedgerow, grassland, mixed tree crop and the natural forest was 1365, 1530, 1700 and 1690 mm respectively. The actual ET of the vegetation in four land use types was less and amounted to 1050, 1115, 1380 and 1324 mm respectively. Accordingly, the annual ET of vegetation under mixed tree crop system and the natural forest was on average about 28% more than that of the hedgerow system and 21% more than that of the grassland.

The ET rates varied with the water content of the soil. The soil water content varied with the rainfall. The lowest water content was observed in dry months namely August and September. During this period the soil water deficit was at its highest. The rainfall of all months but November was less than the soil water deficit observed at the beginning of those months. The rainfall in November exceeded the soil water deficit experienced at the beginning of the month. The higher soil water deficit and higher infiltration rates of the soil compared to the rainfall intensity kept surface runoff at negligible levels in all months of the year.

Based on the results of this study following water balance model was developed for the study area.

$RF = E + \Delta S + Y$ where, RF = the rainfall, E = the water loss due to ET and interception, ΔS = the change of water storage and Y = the water yield from the catchment. Y includes surface and sub surface runoff. According to monthly water balance estimation, only the November rainfall contributed to the catchment yield

under the four land use systems in 1996. Annual water balance estimates for 1996 showed that water yield from the grassland was about 14 % of the rainfall while that from other three land use systems remained around 7%. The difference in water yield was mainly due to the differences in ET rates of the four vegetation types. Under these four land use systems, surface runoff was very low and it also reduced the soil erosion rate. Mixed tree crop system (Kandyan forest garden) and the natural forest showed similar hydrological behaviour. Study of subsurface flow was identified as a priority area for future research.