Water Balance in a Moist Semi-Deciduous Forest of Ghana

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Abstract

The hydrological cycle has been studied in temperate regions for many years, but only few measurements of its components have been made in tropical areas. The water balance is important for agriculture and forestry, and available soil water is an essential requirement to evaluate plant growth potential. Hence, the moist semi-deciduous forest of Ghana was selected for this study because most food and export crops are grown there. Available water capacity (AWC) was determined for three typical soils selected on a catena in the forest of Kade. Monthly actual evapotranspiration (AET) was calculated by using the Penman formula and the temporal variation and magnitude of deep percolation was assessed. Available water capacity was high for all soil types averaging about 170 mm m^{-1}. It was found that available soil water is important both for the amount of deep percolation and AET during the year. AET was highly variable on monthly basis but, on average, it was about 1200 mm $year^{-1}$. Deep percolation was found to be 16% - 18% of annual average rainfall. This study suggests that a simple water balance model can be used in place of complicated models in the determination of soil water balance in the tropics.

Key words: water balance, Ghana, forest, soil

Introduction

The moist semi-deciduous forest is being exploited in many places of the world (Palo *et al.*, 1996), and this adversely affects the forest hydrology on a local and global scale. In Ghana, for example, this forest occupies approximately 20% of the land area. In order to evaluate the impact of human activities on the forest, it is necessary to have a basic knowledge of natural hydrological processes. The water balance is useful for forestry, agriculture and engineering hydrological studies. Ledger (1975), Calder *et al.* (1986), Shuttleworth (1988), Hodnett *et al.* (1995), Veenendaal et al. (1996) and Cook *et al.* (1988) have used the water balance in the study of the hydrology in the humid tropics.

The water balance which is a simple way to assess inputs and outputs of the water cycle may be expressed as follows:

$$P = AET + DP + A + DS$$

where P is precipitation, AET is actual evapotranspiration, DP is deep percolation, A is overland flow, and DS is change in soil moisture storage of the root zone.

AET is the most difficult parameter to estimate accurately in the hydrological cycle. Hitherto, AET has been determined by rather complex micro-meteorological and soil physical methods (Shuttleworth, 1988; Hodnett *et al.*, 1995). The micro-meteorological technique often used is the eddy correlation or the Bowen ratio method, where several climatological parameters are measured on towers placed above the forest canopy (Shuttleworth, 1988). Soil moisture measurements are done with neutron probes (Calder *et al.*, 1986) or tensiometers (Veenendaal *et al.*, 1996) or both (Hodnett *et al.*, 1995). A combination of micro-meteorological, soil physical and ground water chemical measurements has also been introduced (Cook *et al.*, 1998).

Simpler methods have been presented where approximate estimates of AET are