Distribution of soil depth and soil water content at Lambir hills catchment

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Introduction

In the process of rainfall-runoff, the soil temporarily stores water. Grasping fluctuation of water storage in the soil is important in understanding the water cycle in tropical forests. Soil water storage is not uniform spatially, for they are strongly affected by topography, geology, vegetation, etc. Therefore, to know the soil moisture environment, it is necessary to make observation at many points. In this study, we observed vertical distribution of the soil moisture and its change over time at four points of different slopes, and analyzed their relation with topographical factors.

Materials and Methods

The area for study is located in Lambir Hills National Park, Sarawak, Malaysia (4° 20′ N, 113° 50′ E, where the annual mean temperature is 26.7℃, and annual rainfall is 2685mm). The forest is composed of various dipterocarp trees. Soil moisture observation points A, B, C, D are located separately in one catchment. The areas of watersheds A, B, C and D are about 0 m^2 (ridge part), 400 m^2, 3200 m^2 and 40400 m^2, respectively. The soil moisture contents were monitored by soil moisture gauges (TDR) and tensiometers at different depths of the respective watersheds. The TDRs and tensiometers were embedded at depths in centimeters of 10, 30 and 60 for points A, C and D; 10, 20 and 50 for point B (additionally, we set tensiometers at 100, 150 and 200 for point B; 100 and 200 for point C; 100 and 140 for point D). To clarify the distribution of soil depth, soil depths of 50 points in the catchment area were measured by using a handy dynamic cone penetrometer (Fig.1).

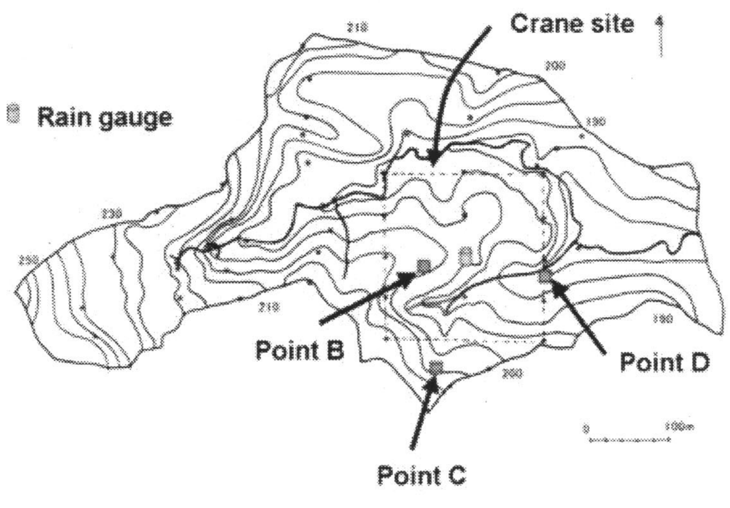

Fig.1 Soil water observation and soil depth check points (circles)

Results and Discussions

Relationship between distribution of soil depth and topography

According to the tests at 50 points by the penetrometer, the maximum depth was 5.49m and the average depth was 2.27m. To analyze the relationship between distribution of soil depths and topography, we made DEM (Digital Elevation Model) from the topographic map and obtained the areas of watersheds and the angles of slopes (Fig.2). As a result, a tendency was seen that, the larger the watershed area, the thinner the soil layer; where the area was more than 1 ha, the soil layer turned out to be a saturated zone as thin as 0-2m or a bare bed rock. When the area is small, we could not find any clear relationship between watershed areas and soil layer.

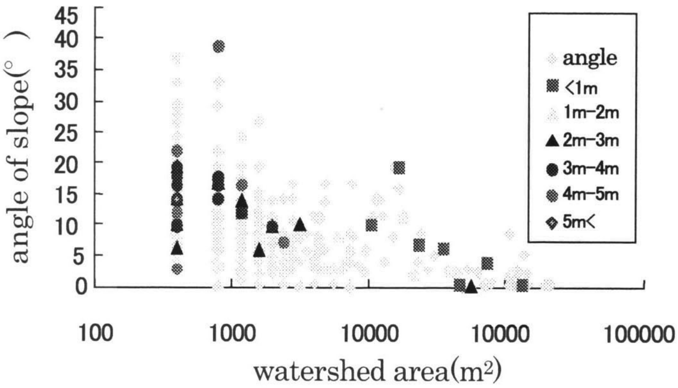

Fig.2 watershed area and angle of slope

Comparison of soil moisture changes at four different points

We compared changes of soil suction from tensiometric responses. When a dry period continues, point A, at depths of 10 and 30cm, tends to undergo a big change, while points D and C, located downstream, a small change. At point C, at depth of 100cm (point D, at depth of 140cm) positive pressure was seen at most time, indicating that the ground water level reached these points. From TDR data (volumetric water content), points A and B made a big response to rainfall and depletion was rapid. Points C and D made a small response to rainfall and depletion was slow. Fig.3 shows change of the soil water content, which was calculated by multiplying each volumetric water content by the depth of the soil layer (the amount of change when Apr.1, 2004, is set to 0). As to the soil water content, at point B, the difference between the maximum and minimum soil water contents was as large as 89 mm; however, at points C and D, the difference was as small as 29mm. Therefore, dependence on rainfall situation differed greatly according to location. It is considered that the difference in change is due to local moisture movement by topography of observation points.

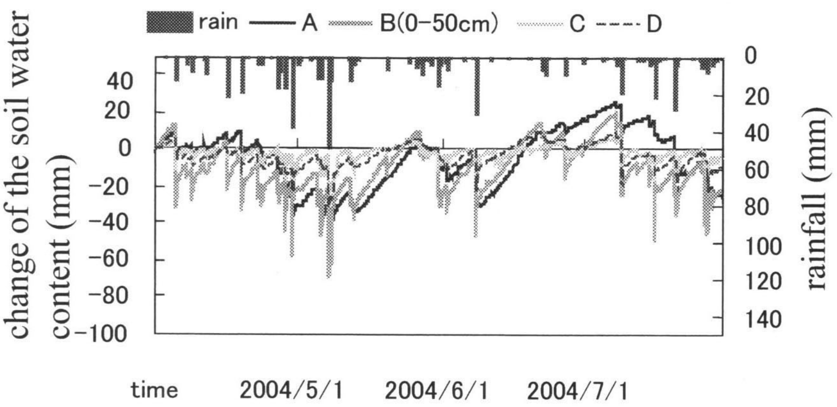

Fig.3 change of the soil water content