Drainage and storage properties of rain water on a natural forested slope in the Shimanto River basin

Yoshiki Shinomiya[1]; Shuichiro Yoshinaga[2]

[1] Shikoku Res. Ctr., For. and For. Prod. Res. Inst.; [2] F.F.P.R.I.

The water movement at the surface soil has closely related to the generation of stream runoff and the mechanism of occurrence of collapse. Therefore, it is important for the geographical change in the mountainous district. In this study, drainage and storage characteristic at surface soil of forest with abundant rainfall was discussed based on the result of investigating the water movement at the surface soil in the natural forest.

The experimental site was located in Takatoriyama national forest, Yusuhara Town, Kochi Prefecture, Shikoku Island, southwestern Japan. Vegetation of the experimental site was a natural forest predominately consisted of fir (Abies firma) and Japanese hemlock (Tsuga sieboldii), whose stand age is about one hundred eighty years old. Geology was mudstone and sandstone. TFL (Tension free lysimeter) was buried at 20 cm and 50 cm in depth, and the outflow from TFL was measured by the rain gauge. The TFL outflow water was thought to be water flow moved through non-capillary pore, including the macropore. To estimate soil water storage, soil water content was measured automatically by the TDR (time domain reflectmetry) method. They were observed at 10 cm, 30 cm and 50 cm in depth. The rainfall was observed about 1 km away to the southwest from the experimental site. The number of events analyzed in this study was 26, which occurred in the period from February to November in 2005. A very large scale event (the total rainfall was 642 mm) in September, 2005 was contained in these events.

There was the response of TFL(20 cm) when the total rainfall was larger than approximately 10-20 mm. The outflow of TFL(20 cm) increased in almost proportion to the total rainfall (the slope was about 0.9). On the other hand, S(0-30 cm), which indicates the sum of increased soil water storage within 30 cm in depth, has not increased as much as TFL(20 cm). This is suggested that rain water is transported rapidly to the layer deeper than 20 cm in depth at the early stage of rainfall event, concerning the forest soil within about 20 cm in depth. The response of TFL(50 cm) started when the total rainfall was larger than approximately 40-50 mm. Although the averaged value of the ratio of S(0-50 cm) to the total rainfall was 69 % when total rainfall was smaller than 50 mm, it was 41 % when the total rainfall was greater than 50 mm. It is thought that although a rapid flow downward occurs at the surface soil in the small scale event, transported water was stored in subsoil (which was comparatively shallow up to 50 cm in depth). However, when large scale event, the great amount of water drained rapidly to subsoil layer deeper than 50 cm in depth.

When the large scale rainfall event (total rainfall 642 mm) in September 5 in 2005, TFL(20 cm) started the response from an initial of the precipitation, and changed corresponding to the change of the rainfall sharply. On the other hand, the response of TFL(50 cm) have became active since around 18:00 on September 5 when the total rainfall reached about 85 mm (S(0-50 cm) was 46 mm at this time). After that, the outflow of TFL(50 cm) changed corresponding to the change of the rainfall sharply. The outflow of TFL(20 cm) and TFL(50 cm) were 538 mm(84 %) and 314 mm(49 %) compared to the total rainfall 642 mm, respectively. Soil water content reacted quickly even in deeper layer, and the increase of soil water content was great as deeper layer. From these results, it has been shown that the large amount of rain water was transported rapidly to subsoil deeper than 50 cm when the scale of event becomes greater.

It was shown that the forested hillslope with abundant rainfall had the system that was able to drain rain water even in a large-scale rainfall event.