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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Influences of plantation forests on hydrological processes in mountainous watersheds
（山地流域におけるプランテーション林が水循環過程に及ぼす影響）

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The management of watershed should consider the occurrence of every change in two factors such as climate, land-use. Land-use is the only manageable factor that could affect the flow and the quality of the water resource; conversely the development of water resources affects the land-use. As a result, it is essential that watersheds and water resources development should be managed in concert with one another.

Land-use composition and land-use changes at the upstream area would affect the water availability both for surface water and groundwater at the downstream area of the watershed. Land-use activities that alter the type or extent of vegetative cover on a watershed would frequently change water yields and, in some cases, maximum and minimum streamflows. Influence of the land-uses type and portion to water resources condition in a watershed is an important issue that should be investigated. Hydrological modeling would be an instrument to estimate the influence of land-uses to the hydrological processes. It is widely acknowledged that a hydrological model is a tool for conceptualization of hydrological phenomena.

As an main input for hydrological model, areal average rainfall is a necessary to be estimated. Application of linear relation between elevation and monthly rainfall was led by the necessity of predicting rainfall at high elevation area in the mountainous Kamo River watershed. By comparing between measured and predicted monthly rainfalls, linear relationship was evaluated to be applicable for predicting rainfall even at a high elevation and very helpful for predicting AAR in a mountainous watershed. This relationship between elevation and monthly rainfall would be the principle to the some AAR estimation methods

The relation between elevation and monthly rainfall has shown that in some months, higher elevation would give lower monthly rainfall amount. As a result, elevation regression was applied to predict areal rainfall in upstream Saba watershed. due to elevation range of the watershed. Next discussion would be about mechanisms of rainfall interception processes; throughfall and stemflow and revealed differences of the partitioning of gross rainfall to throughfall and stemflow and factors influenced on them in the clove and the coffee plantation forests in the upstream Saba river basin.

Comparison among results of throughfall and stemflow measurement led to a conclusion that the canopy in managed clove plantation would intercept more rainwater than the canopy in natural forest. Although clove plantation canopy would intercept more rainwater, the difference in land cultivation method would cause different value of soil infiltration and evaporation from the soil. In clove plantation, the fallen leaves of clove are collected and then utilized for essential oil extraction. The collecting of clove leaves causes thin litter layer on the topsoil. On the contrary, there is relatively thick litter layer on the topsoil in a natural forest. More litter layer on the topsoil would increase the rain amount that can be retained in the soil. The litter layer also limits the evaporation from the soil. Another difference is in plant spacing between managed clove plantation and natural forest. Managed clove plantation was monoculture cultivated with relatively low density of tree with uniform plant spacing. On the other hand, a natural forest is established naturally with varied tree species, random tree spacing, and relatively dense. This condition resulted in relatively dense rooting zone within the natural

forest. The dense rooting zone in the natural forest would lead more porous soil structure that can infiltrate and hold more water in the soil layer.

Consideration about canopy interception capacity, litter containment, and soil water retention would be able to answer the question about hydrologic role of managed plantation and natural forest in this river basin. Cultivation method in clove plantation, which also considers the capacity of litter containment and soil water retention, will be required to give hydrologic services in maintaining water resource as natural forest does.

Comparison between lumped model and distributed model has shown that distributed model has given better result in river discharge simulation. Distributed model has advantage in consideration of different land-uses portion and location in Titab sub-watershed. This conclusion led to another conclusion that land-use distribution and portion should be considered in management of watershed. Ongoing trend, where more land owners converted their land (i.e. coffee plantation, paddy field, or forest) into clove plantation or residential area, would lead to a result where surface flow was generated proportionally to more portion of clove plantation or residential area as simulated in ACL scenario. Properties of clove plantation to generate larger surface flow are related to the capability of clove plantation to retain water in the ground layer. Larger throughfall rate combining with less water retained in the ground, and wide area of clove plantation, would be the main factors of high peak discharge in the Saba River. The larger generated surface flow also indicated that clove plantation has less role in recharging the groundwater resource because portion of infiltrated water to ground is inversely proportional to generated surface flow. In the other hand, the PLC and AF scenarios would reduce the peak flow, but also raised the baseflow, particularly in dry season. Total discharge simulated in PLC and AF scenarios were lower than measured discharge in present land-use condition. These simulation results have shown that coffee plantation and natural forest has better role than clove plantation in recharging water to the aquifer layer. Improvement of clove cultivation method is necessary in purpose to increase the capability of clove plantation to retain water in the ground