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Estimation groundwater recharge using DFM and water budget in different land use

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City of Kumamoto is located in Southwestern Japan and has a population of about 0.7 million people. Kumamoto region is a unique area in Japan because almost 100% of the tap water supply in this region is dependent on groundwater. Prefecture government of the Kumamoto has much concern about the sustainable use of groundwater resources for their future generations. Thus, Groundwater recharge rate was estimated by using Displacement Flow Model and water budget ware studied in two adjacent forest and grassland watersheds at the western foot of Mt. Aso known as recharge area of major local aquifer of Kumamoto region. The forest watershed consists mainly of Japanese cypress plantations. But the surrounding areas have Japanese cedar and mix forest. The grassland watershed consists mainly of pasture and Japanese silver grass. The geological structure of both watersheds consists of the Aso-2 pyroclastic sediments. The soil structure of forest watershed is laid on tuff, volcanic ash 1 and litter from the bottom. On the other hand, the soil structure of grassland watershed is laid over andesites, volcanic ash 1 and 2. As for the hydrometric observation system for each catchments, parshall flume runoff weir for the river discharge, meteoric tower for the evapo-transpiration monitoring purpose, and precipitation gage are installed to calculate groundwater recharge rate by catchment scale water balance method. Also soil column profile was taken for each catchments to evaluate the vertical recharge rate and soil water movement through unsaturated soil.

Normally, water budget is expressed by P-E-R=I, P is rainfall, E is evapotranspiration, R is runoff and I is groundwater recharge, respectively. However, this study has been conducted detail water budget that stream discharge component was separated direct runoff and groundwater runoff components. Stream discharge composed of groundwater runoff and direct runoff components ratio was decided by two component hydrograph separation during two different rain storms. EC value as a tracer for two component hydrograph separation was applied to a two storm events. Two storms from dry and wet soil conditions in forest watershed, old water percentages at the hydrograph peak was estimated from EC value as a tracer for two component hydrograph separation were almost 100% and 37%, respectively. Two storms from dry and wet soil conditions in grassland watershed, old water percentages at the hydrograph peak was estimated from EC value as a tracer for two component hydrograph separation were 40% and 43%, respectively. Groundwater recharge rate in forest watershed was estimated using detail water budget and it was less than grassland watershed. On the other hand, groundwater recharge rate in forest watershed was estimated using displacement flow model that was estimated groundwater recharge rate from stable isotope composition of rainfall and soil water contain unsaturated zone and it was large than grassland watershed. Groundwater recharge rate in forest watershed agreed two results, water budget and displacement flow model using unsaturated soil zone stable isotope profiles. Groundwater recharge rate from water budget was larger than Displacement flow model using unsaturated soil zone stable isotope profiles in grassland watershed. But, there is a possibility for large error because number of events of two component hydrograph separation or short term of observation in detail water budget. Thus, Groundwater recharge rate from Displacement flow model using unsaturated soil zone stable isotope profiles was suggested reasonable value in both forest and grassland watersheds. As a future work, it is necessary to re-evaluate groundwater recharge rate from water budget and enrich accuracy of observation by keep observing.

Keywords: Groundwater recharge, Water budget, Displacement Flow Model, vegetation