（学位第３号様式）

学 位 論 文 要 旨

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題　目	The influence of soil physicochemical properties on the quality and quantity of water discharge in subtropical small-island coastal forest catchment (亜熱帯島嶼沿岸森林流域における流出水の質・量に及ぼす森林土壌の物理化学的特性の影響)

Forests are among the main sources of water in the Ryukyu archipelago. Yet, little is known about the linkages between the physicochemical aspects of the forest soil and the properties of water being delivered. Surrounding sea and frequent typhoons also influence the hydrology. This study aims to understand those linkages by holistically studying the related processes that water is undergoing, since its entry into the forest until the discharge. Main experimental plots were located in a catchment in northern Okinawa Island.

Water quality was assessed in terms of major ions, pH and conductivity. Continuous sampling was done for one year starting from February 2013. The quality and quantity of rainfall (RF), stemflow (SF) and throughfall (TF), processes through which water enters into the soil, were studied in each plot. Influencing the water movement in the soil, soil water repellency (SWR) and soil aggregation were studied. Litter decomposition dynamics were evaluated by an incubation experiment. Potential soil solute movement was evaluated with undisturbed soil columns, soil solution extracts and ion exchange membranes. Water discharge was measured with a broad-crested weir at the catchment outlet, where the quality of baseflow and two arbitrary levels of stormflow were studied.

Chloride, sodium and sulfate were the dominant ions of the influx (SF+TF). Although it indicates a possible influence of sea salts, the ratio of Na^+ to Cl^- is lower than that of the sea water. The influence of vegetation on TF and SF quality is not clearly visible and so was the case of anthropogenic inputs. Further, the influx has higher K^+ and Ca^{2+} content compared to seawater. An exchange of K^+, Ca^{2+} and NO_3^- within the canopy might have occurred.

Potential SWR was found in the catchment at varying levels and is not likely to cause significant influence on the water infiltration under regular moisture regime. However, long dry spells may induce severe SWR levels. In the soil aggregates, the highest carbon content was observed in association with the clay and silt fractions. Therefore, the topsoil having clay and clay-loam texture indicates favorable conditions for soil aggregation and hence, facilitating water movement through the surface soil layers. Higher organic matter decomposition rates explain an active biochemical transformation, promoting organo-mineral interactions. Soil column evaluations confirm the near-surface and preferential pathways of water in the shallow soil. Ion exchange membranes were found to qualitatively predict the composition of the soil solution when it is about to start flowing.

Indicating a possible influence of the sea salts, the ions of the litter leachate, topsoil and subsoil are also dominated by Cl^-, Na^+ and SO_4^{2-}. Litter leachate and topsoil have comparatively higher amounts of Ca^{2+}, K^+ and Mg^{2+} and, the litter decomposition products could be the main source. The efflux (discharge) has relatively high Ca^{2+} and Mg^{2+} and low K^+ and Cl^- percentage compared to the influx. Therefore, K^+ seems to be subjected to biotic retention while Ca^{2+} is being released from soil to the streamwater. The Mg^{2+} content across the other phases remains more or less constant. Inconspicuous dilution effect during storm flow also indicates higher surface runoff during storms. Overall, the quality of the streamwater delivered by small-island coastal forests was found to be determined mainly by the composition of the water influx; the contribution of soil is limited to certain ions. The river discharge response to rain events is comparatively higher than the catchments with similar geology. The total runoff accounts for nearly 36% of the precipitation, an amount on par with the findings related to nearby catchments under similar rainfall conditions.