Evolutions of spatial structures in hydrology through the interactuions between water, soil, and forest

*Makoto Tani[1]

1.Graduate School of Agriculture, Kyoto University (Former affiliation)

Hydrological processes depend on the geographical differences on the earth. In a huge continent like Eurasia, the water recycle between land and the atmosphere governs the local precipitation amount (Numaguti, JGR,1999), and constantly large evapotranspiration from forest contributes to a sustainable humid climate in the inland area (Yasunari, JMSJ, 2007; Kumagai et al., HP, 2013). In an tectonically active region, heavy rainfall works as a trigger of landslide (Tsukamoto and Ohta, JoH, 1988), and a close relationship exists between water and soil movements by strong erosional forces. The root-system mediation of forest contributes to the soil stability on a steep hillslope (Abe and Ziemer, USDA, 1991).
Although the geographical conditions are different, it should be noted that a spatial structure engaging each of the hydrological processes is created by the evolution at a long timescale based on matryoshka (nesting) doll interactions between the inherent earth activities and terrestrial ecosystems. A pollen analysis in Lake Baikal (Shichi et al., Palaeogeogr. Palaeoclimatol. Palaeoecol., 2013) demonstrated that forests covering Siberia had a dynamic glacial-interglacial spatial cycle, suggesting the spatial expansion/shrinkage fluctuation of water recycle system there has been accompanied with the vapor supply from the boreal forest. Therefore, we should pay a special attention to anthropogenic impacts on the destruction of interaction system between forest and the atmosphere. The deforestation at a huge spatial scale as well as the climate change may cause unexpected environmental devastations in the Anthropocene.
In an tectonically active region, the spatial structure of rainwater flow processes is created by geomorphological and soil-layer evolutions, and the heterogeneities including preferential pathways composed of connected macropores are developed with them (Tani, HESS, 2013). Such long timescale co-evolutions may account for a contrast between the complexity of flow processes and the simplicity involved in rainfall-runoff responses (Sivapalan, HP, 2003). The nonlinearity shown in the responses that hydrologists have studied for several decades (Takagi and Matsubayashi, 1979; Harman and Sivapalan, WRR, 2009) may also be produced by the co-evolutions.
My presentation here will focus on how the long timescale co-evolutions play roles in the flow processes and rainfall-runoff responses. A remarkable contrast in the hydrogeomorphological process between forested and denuded hillslopes will provide clear evidences not only for the role of co-evolutions but also the mitigation effect of forest on the stormflow responses.

Keywords: Hydrogeomorphological evolution, Interactions between Earth and Ecosystems, Water recycle system

