# Conceptual Modeling Approach to Explain the Spatial Variability of Streamwater Chemistry in the Meso-scale Forested Catchment under Asian Monsoon Climate: Focusing on variability-scale relationship

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Even within homogeneous geological and climatological settings, the spatial variability of specific discharge and some solute concentrations in headwater catchments often increases with decreasing stream order and sub-catchment area, and there is a certain catchment size where the variability is minimized. A simulation model based on the subsurface-bedrock groundwater-mixing concept was proposed to determine mechanisms of this scale-variability relationship. Generally, it is difficult for the headwater small catchment to be determined its catchment area of the bedrock groundwater discharge while that of the subsurface groundwater can be measured based on topographical information, and the actual catchment area for the bedrock groundwater is often different from that for the subsurface runoff. The model presented in this paper focuses on this discrepancy in the actual catchment area between the subsurface and bedrock groundwater runoff as an origin of the variability among the lower-order sub-catchments. The model simulates the relationship between the sub-catchment size and the variability of specific discharge and stream solute concentrations of the catchment as expressed as an aggregate of the zero-order catchments. The model assumes that 1) the variability of specific discharge is generated by the discrepancy of the actual catchment area between subsurface and bedrock groundwater runoff, 2) the variation of the stream solute concentrations is determined by the mixing proportion of subsurface and bedrock groundwater discharge, 3) n th order catchment consists of m pieces of n-1 th order catchments, and m can be a function of n. The catchment simulation is made by accumulating zero-order catchments that have different subsurface and bedrock groundwater contributions that are assigned for each zero-order catchment using a random number generator. The model was applied to a dataset from the Fudoji Experimental Catchment located in weathered granitic mountains of central Japan under the Asian monsoon climate. The area-variability relationship of the geochemical solutes such as SiO2 in streamwater was reproduced by this model using values for subsurface and bedrock groundwater concentrations that were determined from the observations. The simulated results suggested that the major controls are 1) the size of the zero-order catchment, and 2) the range of the difference in catchment area contributed from subsurface or bedrock groundwater. The simulations also imply that the catchment size where the variability is minimized depends on the scale of the zero-order catchments.