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Incorporating water isotopic concentration to estimate surface roughness coefficient of Manning formula in catchment scale

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Runoff velocity of surface runoff, controlled by land use configuration within a catchment, is a main indicator for estimating the time lag of a flood. Therefore, it's a critical factor necessary to be considered in the policy of soil-water conservation and management. The Manning formula originated from open channel experiments has been commonly utilized in hydrological modeling, surface runoff particularly. However, it is always a challenge to validate the surface roughness coefficient due to lacking of observation in-situ. Recently, the Isotopic approach is a powerful tool to measure the transit time of new water during short-term events and storms, and then provides a reliable estimation of travel time distribution. This estimation is helpful to calibrate the roughness coefficient in a heterogeneous catchment with various land use pattern. In this study, the amount and water isotopic 18O of rainfall and streamflow during 8 typhoon events between 2012-2015 were examined. First, we applied a water isotopic model, TRANSEP, to estimate the transit time. Second, a 3-layer TOPMODEL with a diffusive wave module for surface runoff was also applied. Incorporating the transit time driven from TRANSEP provides an independent validation for the roughness coefficient estimation. The results showed that the transit times of the event water in this catchment varied from 3 to 34 hours, negatively correlated with maximum rainfall intensities. Meanwhile, the performances of streamflow simulation from TOPMODEL could reach to 0.60-0.85 of NSE with the roughness coefficient of 0.3-0.6. The results indicated that the runoff depth controlled by maximum rainfall intensity in hillslopes may change the hydraulic radius and the runoff velocity. Hence the roughness coefficient derived from TOPMODEL could be applied to other catchments with intensive observations, and subsequent the soil and water conservation.