Incorporating Channel Network Type in a Nonlinear Synthetic Unit Hydrograph Method

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Abstract. In ungauged basins, storm flows are most commonly estimated from excess rainfall using synthetic unit hydrograph (SUH) methods. Current SUHs either consider very limited aspects of basin shape or require complete specification of the water flow paths. For example, the Clark method uses a typical basin shape and a specified basin length (Clark, 1945) to develop the SUH, and the modified Clark method requires an explicit definition of distribution of travel times to obtain the SUH (Kull and Feldman, 1998). Similarly, the geomorphic instantaneous unit hydrograph method either uses Horton's ratios to characterize the basin (Rodríguez-Iturbe and Valdés, 1979) or requires explicit definition of the flow paths (Gupta et al., 1980). No available method explicitly considers the distinct channel network structures that are observed in nature. Specifically, five distinct channel network types commonly occur depending on the geomorphological conditions under which the network developed: dendritic, parallel, pinnate, rectangular, and trellis. In this research, we hypothesize that the network classification is useful for identifying an appropriate SUH. To test this hypothesis, SUHs are found from the distribution of travel times for ten basins in each of the five classifications. The travel times are determined from the celerity of a kinematic wave. The proposed SUH model isolates the effect of channel network structure in two random variables A_{sh} and A_{sc}, representing the flow network structure for hillslopes and channels, respectively. Statistical approaches are used to find the best fitting distributions for the two random variables. The generated SUHs are compared for three cases: (1) A_{sh} and A_{sc} are obtained from the network structure for each basin, (2) A_{sh} and A_{sc} are found from the network classification alone, and (3) A_{sh} and A_{sc} are the same irrespective of the network classification. The results suggest that considering the channel network classification is beneficial for developing SUHs in some cases.