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Is there any general rainfall-runoff response function in mountainous catchments?

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Clarifying rainfall-runoff response function in mountainous catchments is one of key issues for flood and sediment disaster prediction, management of aquatic environment, water supply and so on. So, rainfall-runoff response function in mountainous catchments has been debated in more than several decades. A variety of studies, observation, modeling, theoretical studies etc., has been conducted. Many noble efforts have been conducted for clarifying complex systems in catchment hydrology through intensive observations. These observations were effective for documentation of the idiosyncrasies of each catchment environments. However, it has been difficult to derive general rainfall-runoff response function from these basin-centric approaches. So, several researchers emphasized the importance of intercomparison so as to better see first order controls of hydrologic responses. Except for several exceptions, intercomparisons for rainfall-runoff responses in many catchments are still limited. Thus, still it is very hard to predict rainfall-runoff response function at ungauged basin.

Thus, we compiled rainfall and stream flow data for around 150 catchments in Japan. We focused relatively small catchment (<100 km2) and a variety of geological, topographical and climatic conditions. We removed catchments where strongly affected human activities, such as urbanized catchment etc., from our intercomparison.

In this study, we randomly sampled 10 storms, i.e., total rainfall amounts were large than 50 mm, for each catchment and calculated three indices, peak specific discharge, peak lag time and direct runoff ratio, to characterize rainfall-runoff response. Also, we defined rainfall-runoff responses using three reservoirs model. We parameterized all of catchments using four storms data using SCE-UA method and validated these parameters using other four storms data. Then, we tested the roles of rainfall condition, climate, geology and topography on rainfall-runoff responses. We used multiple regression analysis to define first order controls of rainfall-runoff responses.

We found large variability in rainfall-runoff responses and it is hard to define general response patterns. While, through multiple regression analysis, we found several interesting results, as follow;

-Climatic conditions affected peak specific discharge and direct runoff ratio, suggesting that climate might give impacts on hydrological characteristics soil and bedrock.

-Geology, such as type of rocks and geological age, gave impacts on rainfall-runoff responses, but effects of geology were not so large, although many study focused on rock-controls on hydrology.

-Flowpath length, calculated by DEM, was one of important topographic parameters for describing rainfall-runoff responses.

Keywords: headwater catchment, rainfall-runoff response, database, multiple regression analysis