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The role of groundwater in streamflow in a headwater catchment with sub-humid climate

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Recent studies have suggested that bedrock groundwater can exert considerable influence on streamflow in headwater catchments under humid climate. However, study of the role of bedrock groundwater is still challenged due to limited direct observation data. In this study, by utilizing observed hydrometric and hydrochemical data, we aimed at characterize the bedrock groundwater's response to rainfall at hillslope and catchment scales in a small headwater catchment with sub-humid climate. We selected Xitaizi catchment with area of 6.7 km in the earth-rock mountain region, which located in the north of Beijing, China, as study area. The catchment bedrock is mainly consist of fractured granite.

Four weather stations were installed to observe the weather condition and soil volumetric water content (VWC) at depth of 10-60 cm with 10-minute interval. Five wells with depth of 10 m were drilled in two slopes to monitor the bedrock water table by pneumatic water gauge. At slope 1, the soil VWC at depth of 10-80 cm were also observed by soil moisture sensors, and surface/subsurface hillslope runoff at three different layers (0-20cm, 20-80cm, 80-300cm) was observed by three recording buckets. Field works were conducted from July 2013 to November 2014. During the period, precipitation, river, spring and groundwater were sampled nearly monthly. Water temperature, electrical conductivity (EC) and pH were measured in site with portable instruments. In addition, the precipitation, river and groundwater were also sampled intensively during two storm events. All the samples were subjected to stable isotope analysis, the samples taken monthly during the period from July 2013 to July 2014 were subjected to hydrochemistry analysis.

Our results show that: (1) the bedrock groundwater is the dominant component of streamflow in the headwater catchment with sub-humid climate; (2) stream is recharged by groundwater sourcing from different mountains with different hydrochemistry characteristics; (3) the contribution of bedrock groundwater to the peak part of hydrograph was not observed from both hydrometric and isotopic data.