Where Does All the Water Go in Subtropical Karst Areas of Southwest China

About 25% of the world's population obtains water from karst aquifers. But when rainfall falls on the karst system, where does the water go? What flow path does the water take? What is the percentage of water that can be used by humans? And will the climate extreme cause more severe water shortage in the karst area of southwest China? To answer these questions, scientists need to understand the relationships between soil-epikarst architecture and runoff generation mechanism in the karst environment.

Carbonate rocks are characterized by high solubility resulting in a distinctive morphological and hydrological karst system, characterized by well-developed underground drainage systems. Karst areas are often regarded as major recharge zones due to the

A typical landscape of cockpit karst (fengcong) in Southwest China.

intensively enlarged fissures by solution weathering and the sparse vegetation and shallow soils which limit evapotranspiration losses to the atmosphere. A complete understanding of the karst hydrology can only be achieved using an integrated soil-epikarst system perspective. Most previous karst hydrology investigations were usually limited to the surface. This limits a thorough understanding of the role that the soil-epikarst architecture system plays in the rainfall partitioning of landscapes underlain by carbonate rocks.

Using plot-scale rainfall simulations on a trench excavated to the epikarst lower boundary (with a depth of about 4m), a team of researchers from the Institute of Subtropical Agriculture, Chinese Academy of Sciences (ISA) investigated the rainfall partitioning pattern of a soil-mantled, humid subtropical soil-epikarst system characterized by shallow soils overlaying a highly irregular epikarst surface.

The researchers found that more than 70% of the total rainfall water moved vertically through the shallow soil layer, and then was redistributed by the epikarst. "This result proves most of the rainfall water gets deep into the underground in karst hillslope. The underground hydrological processes are more dominant than the aboveground hydrological processes in karst landscapes," said lead researcher Dr. FU Zhiyong from ISA. "The soil profile architecture that develops in this karst hillslope is a shallow soil layer in abrupt contact with an underlying epikarst surface. These soil features a high aggregate stability and a high organic content resulting from a calcium-rich environment. A dense root mass below the soil layer combined with these features creates a high soil infiltration capacity greater than most normal rainfall intensities. A result was that infiltration-excess overland flow was rare in the study area."

The researchers also found that the soil-epikarst system was characterized by shallow soil overlaying a highly irregular epikarst surface. The epikarst surface had a relatively high infiltration capacity (about 35 mm h^{-1}) but the conductivity contrast between the soil and the epikarst surface was sufficient to facilitate subsurface flow at the soil-epikarst interface during simulated rainfalls. Epikarst surface topography exerted strong effects on subsurface flow generation. Total runoff from the soil-epikarst system showed a threshold process controlled by epikarst storage capacity (storing as much as 181 mm of rainfall water under dry antecedent condition).

Their research was supported by the National Key Basic Research Program of China, the National Natural Science Foundation of China, the Natural Science Foundation of Hunan Province, and the "Western Light" Program of Talent Cultivation of the Chinese Academy of Sciences.

The study entitled "Subsurface flow in a soil-mantled subtropical dolomite karst slope: A field rainfall simulation study" has been published in Volume 250, December 2015 of Geomorphology.