# Analysis of flowpath dynamics in steep unchanneled hollows

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To evaluate the spatial and temporal aspects of flowpaths in steep unchanneled hollows, simultaneous measurements of runoff, soil pore water pressures, soil temperatures and water chemistry were conducted in two hollows, central Japan. Observations were conducted at Toinotani and Fudoji. Toinotani is 0.64 ha wide and its mean hollow gradient is 36 degrees. The catchment is covered with a closed secondary forest, and is underlain by Paleozoic shale. Fudoji is 0.1 ha wide and its mean hollow gradient is 37 degrees. The catchment is covered with a closed natural forest of predominately Chamaecyparis obtusa, and is underlain by Tanakami Granite.

To predict a hazard to human life, property and natural resources in mountainous terrain, a number of hydrological studies have focused on the variations in positive pore water pressures that control shallow landslide. However, recent models for predictions of locations prone to shallow landsliding did not consider effects of water flow through both bedrock fractures and soil pipes on pore water generation. Thus it can be pointed out that an improvement knowledge of stormflow pathways in steep slopes is important for the prediction of landslides caused by heavy rainfall. To evaluate the spatial and temporal aspects of flowpaths in steep unchanneled hollows, simultaneous measurements of runoff, soil pore water pressures, soil temperatures and water chemistry were conducted in two hollows, central Japan.

Observations were conducted at Toinotani and Fudoji. Toinotani is 0.64 ha wide and its mean hollow gradient is 36 degrees. The catchment is covered with a closed secondary forest, and is underlain by Paleozoic shale. Fudoji is 0.10 ha wide and its mean hollow gradient is 37 degrees. The catchment is covered with a closed natural forest and is underlain by Tanakami Granite.

In Toinotani, measurements of pore water pressure head, pipeflow and streamflow showed that when the total rainfall amount was less than 30 mm, the runoff process could be explained by Darcy law with the saturated hydraulic conductivity measured on cores. When the total amount was greater than 80mm, the important process for the lateral movement shifted to preferential flow by pipeflow. Temperature measurements indicated three key points, (1) during base flow condition, bedrock groundwater dominated streamflow, (2) soil water was as important as bedrock groundwater in storm runoff generation in headwater catchment and (3) during storm flow condition, the source of pipeflow was the same as that of the streamflow. These results indicated that pipeflow also consisted of soil water and bedrock groundwater. Both of the hydrometric and temperature measurements indicated that the transient perched groundwater at the upper hillslope, which mainly consisted of the pre-event soil water, was delivered to the stream via preferential flowpath during heavy rainfall.

In Fudoji, tensiometers which were installed in the catchment indicated that a saturated area was formed and downward hydraulic gradient exhibited continuously in an area near the spring. The amplitude of the soil-bedrock interface temperature in the area near the spring was lower than that in upper slope area, although the soil depth of the near spring area was shallower than that upslope. From these points, it summarized that during the baseflow period, two flowpaths (infiltration in soil layer and water emerging from the bedrock) meet in a small area near the channel head to form a perennial saturated area. During summer rainstorms, the soil-bedrock interface temperature increased with the formation of transient saturated groundwater. This suggests that both the rainwater and the shallow soil water had important effects on the formation of transient saturated groundwater at the upper hillslope. In this case, the temporal variation in streamflow related to the soil pore water pressure variation at the upper hillslope, but the soil pore water pressure in the area near the spring remained almost constant. Moreover, the spring temperature was almost the same as the transient groundwater temperature in the upper hillslope. This indicates that the transient groundwater in the upslope was delivered to the spring via lateral preferential flowpaths. Consequently, the inflow of bedrock groundwater to the spring decreased with the increase of rainfall.