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Hydrological responses in a pre-alpine head watershed: the role of hillslopes and riparian zones

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Mountainous watersheds are characterized by generally high precipitation inputs and very heterogeneous landscape properties, which make them very dynamic hydrologic systems that play an important role in the water cycle. Their groundwater systems sustain downstream baseflow in larger catchments in many parts of the world, particularly in the densely populated lowlands of Switzerland. Hillslope aquifers are often categorized as one of the dominant groundwater resources in mountainous watersheds. These aquifers may also act as source areas for pollutants in rivers due to intensive agricultural land use. In our study we seek to improve the understanding of the groundwater flow processes and runoff generation mechanisms in high altitude watersheds, under explicit consideration of the joint behaviors of climate and groundwater.

The role of the hillslope groundwater contribution to catchment outflow and streamflow composition was investigated in the pre-alpine Rietholzbach catchment ($\sim$1 sq km) in northeast Switzerland. The field site, equipped with an extensive hydrometric setup, facilitates the monitoring of annual, inter-seasonal and short-term dynamics of water flow and composition, as well as its links to associated parameters describing atmospheric, surface and subsurface properties. In this study, we focused on the effects of antecedent moisture, rainfall characteristics and landscape properties on groundwater and river responses in order to develop a conceptual model of runoff generation.

Our observations indicate generally low hydraulic conductivities and average groundwater travel times of several months in the hillslope aquifers resulting from high clay-contents of the unconsolidated glacial Moraine deposits. Event analysis revealed that only a small portion of the total watershed area generates event discharge and we have identified the saturated valley bottom (riparian zones) and lower hillslopes as the two dominant hydrological landscape units. Runoff generation from the riparian zones is mainly driven by rainfall characteristics, whereas antecedent moisture conditions regulate groundwater discharge from the hillslopes.

For the late summer season 2012, we could correlate an accumulation of nutrients in the riparian zones with agricultural land use on the hillslopes and downhill groundwater flux. From this, we expect an increased flushing-out of nutrients from the near-stream areas into the river during rainfall events. In order to incorporate solute transport into our conceptual model, the ongoing research focuses on the role of rainfall characteristics and antecedent moisture conditions on the buffer-capacity of the riparian zones to filter the nutrient input from the hillslopes.