Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09750, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09750
EGU General Assembly 2008

Field observations of persistent preferential flow paths in volcanic ash soils as a result of hydrophobicity

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Preferential flow processes were investigated in a small, data-scarce catchment in the Chilean Andes. The research area is located on the slope of volcano Lonquimay which last erupted in 1990, and young volcanic ash soils dominate the catchment. Despite the fact that young volcanic ash soils are very common in Southern Chile, they are still little understood in their hydrological behaviour.

Rainfall runoff response in this catchment was investigated during several field campaigns. This included the continuous measurement of soil moisture profiles at three points along a hillslope transect as well as the measurement of additional soil moisture profiles at irregular time intervals. Flow paths in the unsaturated zone were visualized with dye tracer experiments on the plot scale. By carrying out dye tracer experiments at the location of the soil moisture probes it was possible to connect the patterns of soil moisture response with the flow patterns marked by the blue dye. Additional laboratory measurements included the determination of porosities, hydraulic conductivities, pF-curves as well as potential hydrophobicity.

It was found that preferential flow (finger flow) dominates in all dye tracer plots under forest. The effects of preferential flow were also found in the soil moisture data. A change in flow pattern from wet to dry season indicates the influence of hydrophobicity on runoff generation. The effects of highly variable throughfall as a result of redistribution processes in the forest canopy, together with strong to extreme potential water repellency of the upper soil horizons, is likely to lead to self-reinforcing, persistent preferential flow paths. (Dry patches receiving less input rainfall become more

and more dry due to increasing water repellency; wet patches then receive even more water as the dry patches grow more water repellent, thus increasing their unsaturated hydraulic conductivities and becoming even more efficient in fast water transport to greater depths.) A decrease in response times of soil moisture as well as streamflow during the dry season suggests that these changes in flow patterns observed at the plot scale seem to have an effect also at the catchment scale. While the extent of preferential flow shows seasonal variation, the location of the flow paths is persistent over time.