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Use of artificial tracing (Br^- and Cl^-) for investigating infiltration processes and their impact on landslides stability. The case of the Super-Sauze mudslide (04, France)

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1. Context

This research work is part of the TRIGGERLAND ANR project (TRIGGERing mechanisms of LANDslides: analysis and modelling), which aims to (1) identify the modification of behaviour and processes which control gravity instabilities (landslide, rock failure) during the pre-rupture and rupture phases; and (2) to deliver new technologies (numerical and analogical models) to move towards a better quantification and forecasting of the processes involved. In the slope stability question, one critical point to address relates to the hillslope flow processes. In this study, an artificial rainfall has been carried out to investigate groundwater flow and subsurface flow in the saturated and unsaturated zones. The simulation has been performed on a small portion of the

Super-Sauze mudslide using Cl^- and Br^- enriched water. The objectives were to provide information about the area heterogeneity of infiltration processes and to estimate the evolution of hydrodynamics characteristics of the mudslide during the rainfall.

2. Presentation of the experimental field

The Super-Sauze mudslide is located in the South-East France (Alpes-de-Haute-Provence, French South Alps). The elevation ranges from 1740 to 2105 m and the area is 17 ha. The geology is mostly Callovian-Oxfordian black marls. Artificial rainfall has been carried out on a 92 m^2 plot where ground slope was 40 %. The equipments have been composed of 6 rotary sprinklers, 15 rain gauges; 8 tensiometers, 7 soil moisture sensor (TDR method), 4 tensiometers (Watermark®) and 38 piezometers for water level measurements at different depths (1, 2 and 3 m).

Artificial rainfall has been applied over a period of 14 days (10-23/7/2007). Br^- has been used as tracer during the first week (10-16/7/2007) whereas Cl^- has been used during the second week (17-23/7/2007). The mean rainfall intensity was 8.5 $mm.h^{-1}$ with a mean tracer concentration of 100 $mg.l^{-1}$ (for both Cl^- and Br^-).

Soil moisture, groundwater level and electrical conductivity have been recorded all over the experimentation. Temperature, pH, eH and EC have been measured in-situ and waters have been sampled for chemical analyses (both surface water and ground water). A total of 1200 samples have been collected during the fortnight's experimentation.

3. Results

The monitoring of the aquifer hydrodynamic over space and time (saturated and unsaturated zones) enabled us to: (1) confirm the existence of spatial variability of the infiltration conditions and specify the location of vertical preferential flow and (2) estimate the water residence time.

The water chemistry showed a different behaviour of the tracer in the piezometers at different depths (due to vertical heterogeneity or the contribution of other flow components) and probably resulted in the change of the hydrodynamics characteristics of soil (macroporosity) due to the drop of pore water concentration during the experimentation.