Spatial and temporal variability of soil moisture patterns related to the preferential flow measured using distributed temperature sensing in large scale infiltration test

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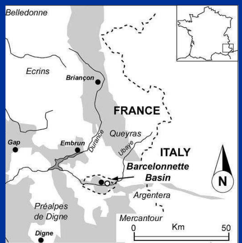
INTRODUCTION:

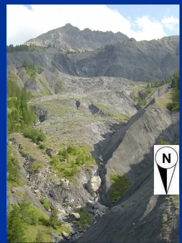
The observed increase in disastrous events over the last years shows that adequate security in the mountain areas remain limited despite preventive measures. Advanced development and improvement of mountain risk issues is fundamental.

One of the major landslide triggers is precipitation. The temporal occurrence of landslides and movement activities is controlled by the rainfall patterns. Quantifying the ground-water recharge processes of preferential infiltration of rainfall is important to develop advanced understanding of landslide behaviour and investigate the role of preferential flow in landslide initiation and reactivation.

LOCATION:

France, Southern Alps — *Barcelonnette Basin* — *Super-Sauze*



The Super-Sauze earthflow is located in the headwater basin between 2105 (crown) and 1740 m (toe of the flow). The average slope is 25°.

LARGE SCALE INFILTRATION EXPERIMENT:

- Place of the experiment: black marls mudslide of Super-Sauze.
- Duration: 2 periods of 3 days, 24h/day artificial rainfall of proxy 15 mm/h.
- Equipment: 37 piezometers, 9 nests of soil moisture profiles, water quality sampling for tracer detection, resistivity and seismic geophysics.
- Aim: to study the hydrological system of the slope and the role of preferential flows on landslide triggering.

Infiltration research area (IRA) during the experiment

OBJECTIVE:

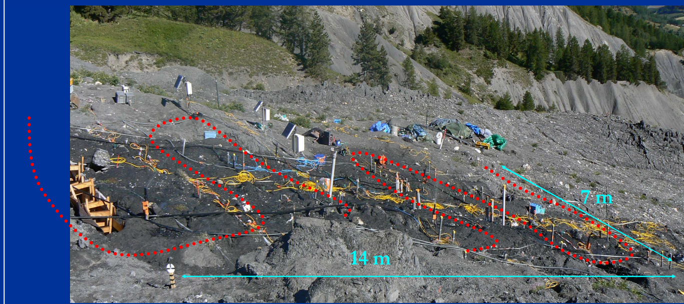
Use temperature (T) as indirect measure for heterogeneity of soil moisture conditions and preferential flow paths.

METHODOLOGY:

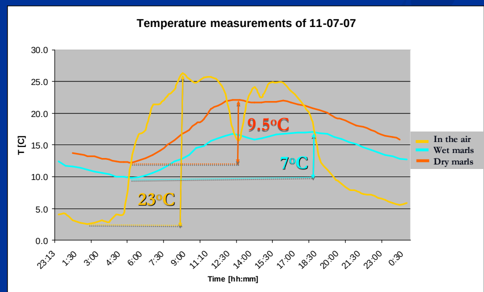
- Distributed temperature sensing (DTS) measurements with use of fiber optic cable (Selker *et al*, *Water Resour. Res.*, 2006)
- Cable length: 130 m
- Installation depth: ± 0.25 m
- Temporal resolution: 1 min
- Spatial resolution: 1 m
- Accuracy: ~0.1°C

Cable installation

RESULTS (1):



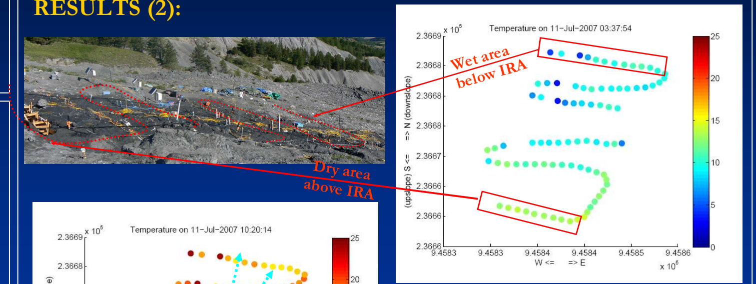
Location of fiber optic cable within IRA

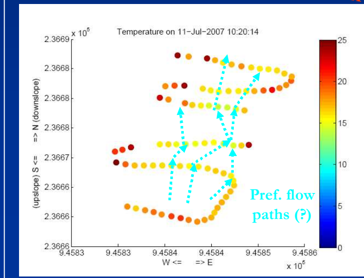


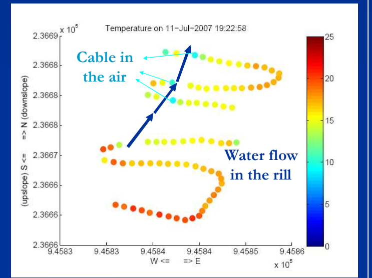
Daily temperature profiles measured in 3 locations: dry area, wet area and area where the cable is in the air

- Difference between temperature profile behavior of wet-dry soil and air can be clearly observed.
- Difference in temporal behavior of the measured temperature in the wet and dry areas is significant.

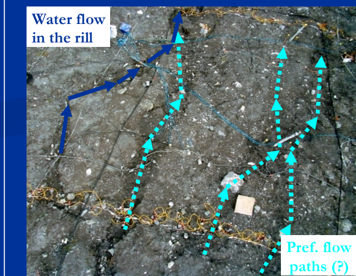
RESULTS (2):





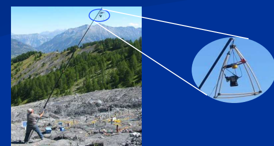


Temperature measurements along the cable at 3 different times of the day (spatial and temporal variability of temperature behaviour)



NESCAFE picture (comparison with T measurements results)

Near Sensing Camera Field Equipment (NESCAFE) pictures were taken from an altitude of 8m using a carbon fiber fishing rod



NESCAFE equipment

CONCLUSIONS:

Based on the temperature behavior it is possible to estimate preferential flow paths within IRA. Estimated flow paths correspond to the in-situ soil moisture observations and NESCAFE pictures analysis.

FUTURE WORK:

Qualitative: relate T observations to the detailed Digital Elevation Model of the area, soil moisture measurements and groundwater maps.

Quantitative: invert temperature signal to estimate soil moisture and position of ground water level (Behaegel et al, *Applied Geophysics*, 2007).

Relate temperature signal to soil bulk density and to fissures appearance and their characteristics.

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Mountain Risks Research Training Network

MARIE CURIE ACTIONS