FLASH FLOODS AND PLUVIAL FLOODING

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

REGIONE AUTONOMA DELLA SARDEGNA

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

Working Group F Thematic Workshop

DEBRIS FLOW MONITORING AND WARNING SYSTEMS: A NEW STUDY SITE IN THE ALPS

Comiti F[1], Macconi P[2], Marchi L[3], Arattano M[4], Borga M[5], Brardinoni F[6], Cavalli M[3], D'Agostino V[5], Hellweger S[3], Trevisani S[3], Vischi M[7]

[1] Faculty of Science and Technology, Free University of Bolzano, Italy
[2] Dept. Hydraulic Engineering, Autonomous Province of Bolzano, Italy
[3] CNR-IRPI , Padova, Italy
[4] CNR-IRPI, Torino, Italy
[5] Dept. Land and Agroforest Environments, University of Padova, Italy
[6] Dept. Geological Sciences and Geotechnologies, Università of Milano-Bicocca, Italy
[7] Dept. Civil Protection, Autonomous Province of Bolzano, Italy

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Adaptation to Climate Change in the Alpine Space

Alpine SPACE
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• Flash flooding in steep mountain catchments may result in the development and propagation of hyperconcentrated and debris flows

• These phenomena represent the most relevant natural hazards in mountain regions.

• In Europe, these flows cause extensive damages and casualties every year

FLASH FLOODS AND PLUVIAL FLOODING

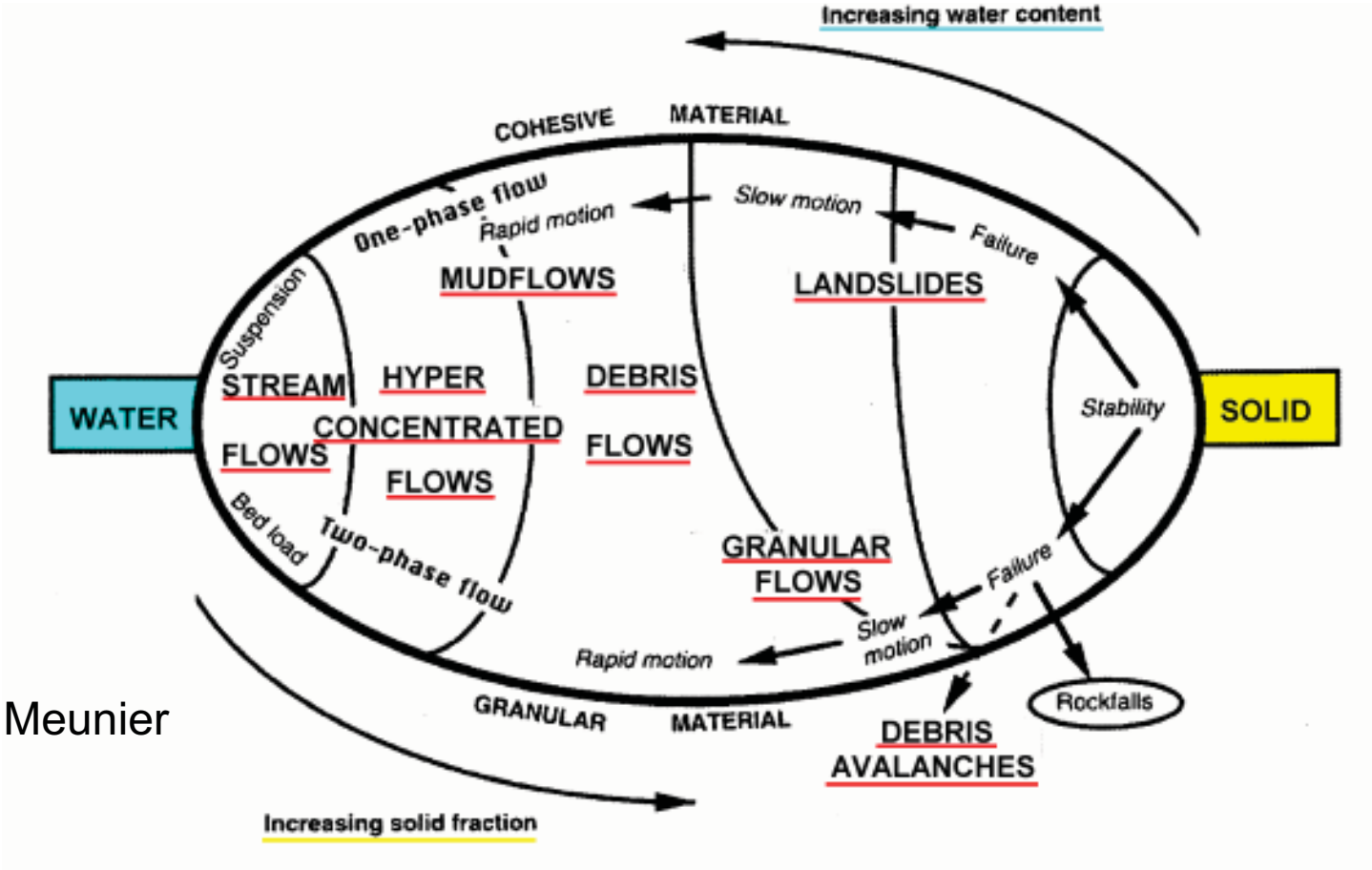
Definition

- Rapid gravity-driven mass flows of water and sediment, with large solid concentrations such that their rheology is non-newtonian (i.e. non linear stress-strain relationship)

Flow	C_v (%)	Density (g/cm^3)
Water flood	0 - 20	1.0 - 1.33
Hyperc. flow	20 - 47	1.33 - 1.80
Debris flow	47 -77	1.80 - 2.30

(Debris flood)

Caution ! Boundaries between types differ among authors !



Coussout & Meunier (1996)

Monitoring stations

An invaluable contribution for the understanding of such processes

Moscardo Torrent
Eastern Italian Alps

How to cope with debris flow risk ?

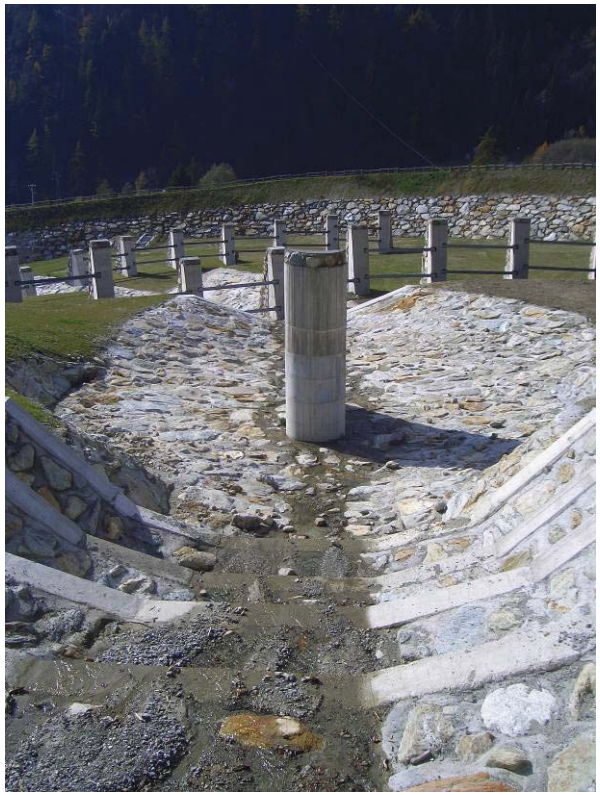
- Structural measures → Reduce hazard
- Non-structural measures → Reduce vulnerability

→ Their combination is in most cases needed

Structural measures

- Check-dams, retention basins, dikes, and artificial channels to stop, divert or “flush” debris flows

- Effective in most cases, but may present management problems (maintanance costs)



Non-structural measures

• Reduce permanently (land use planning) or temporarily (warning systems) the probability that humans and their belongings might be hit by debris flows

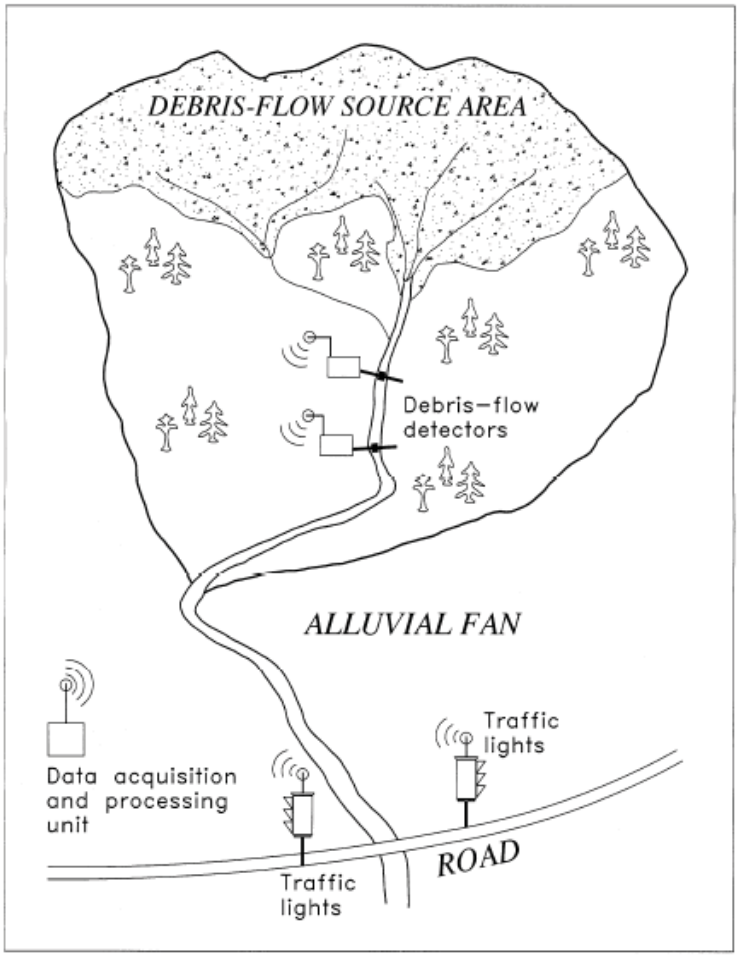
• Permanent solutions are ideal, but socio-economic conflicts !

• Two types of warning systems:

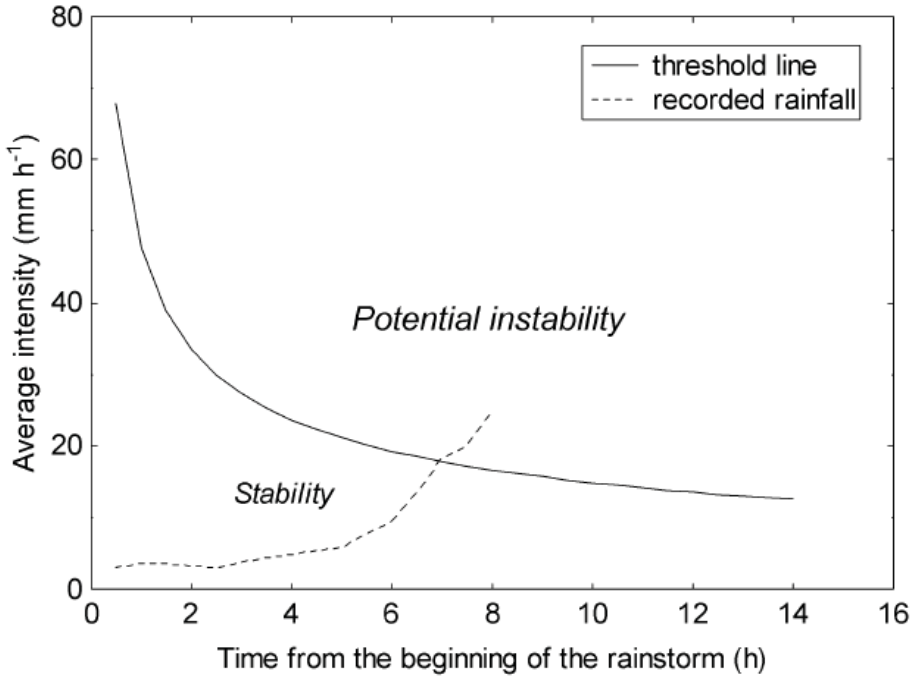
▪ "Advance" (early) warning systems predict the possible occurrence of a debris flow event by monitoring the possible onset of triggering conditions (rainfall threshold). → Longer lead time, but low reliability

▪ "Event" (alert) warning systems detect a debris flow when it already started its propagation. → Reliable, but shorter time (few minutes) !

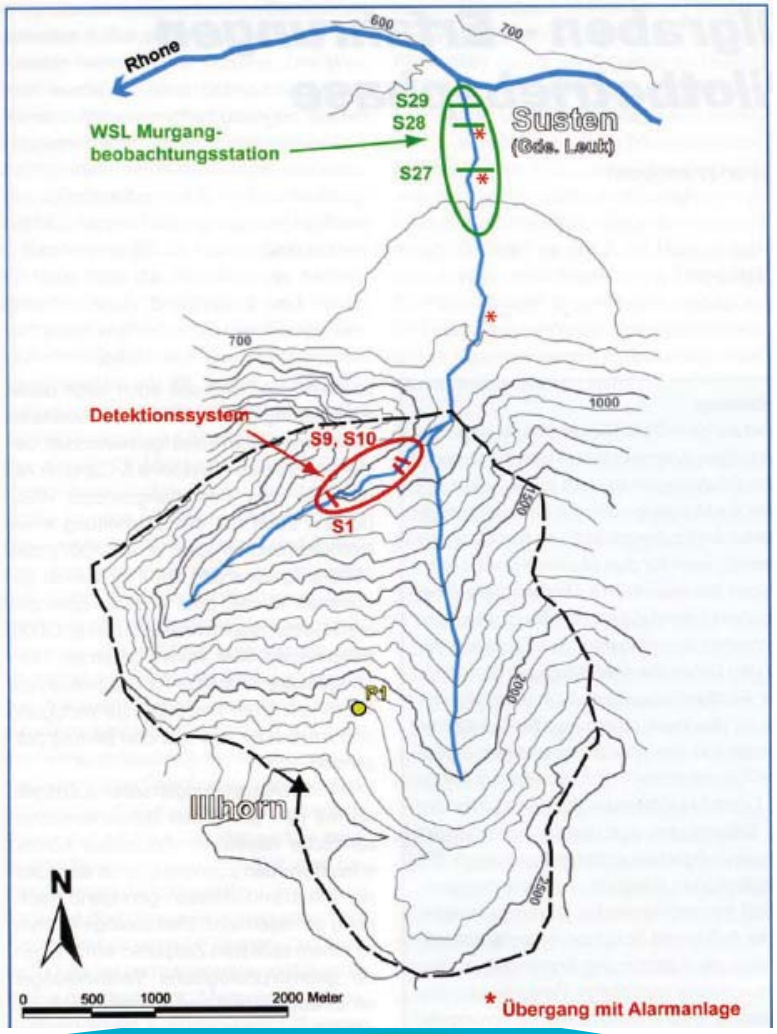
Sketch of event warning system



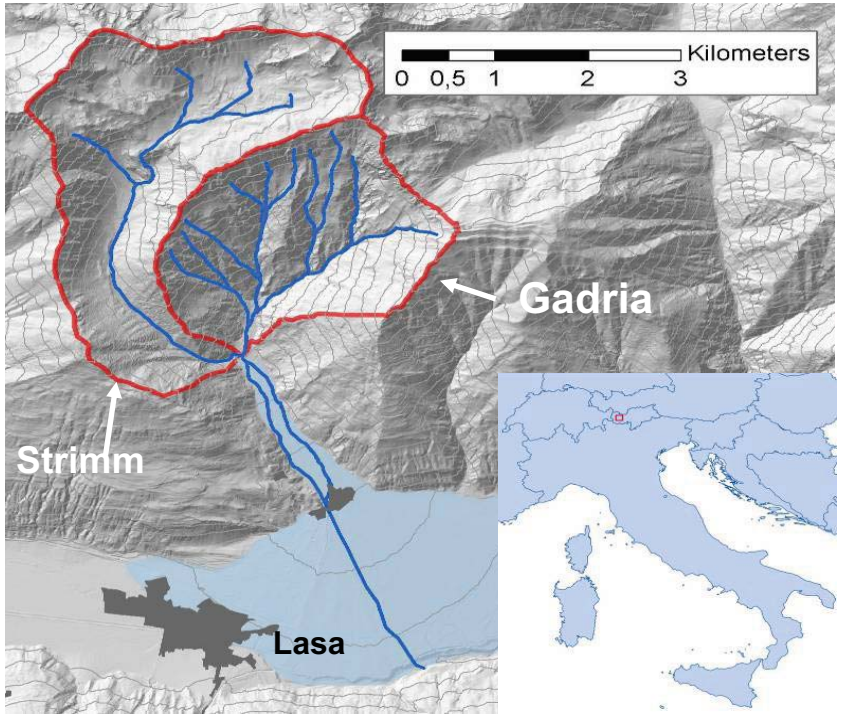
Rainfall thresholds curves



The best example in the Alps:
The Illgraben torrent in Switzerland



A new study site for monitoring and testing warning systems in the Italian Alps



Basin area: 6 km^2

Min elevation: 1,400 m a.s.l.

Max elevation: 2,930 m a.s.l.

Average annual precipitation: 500 mm

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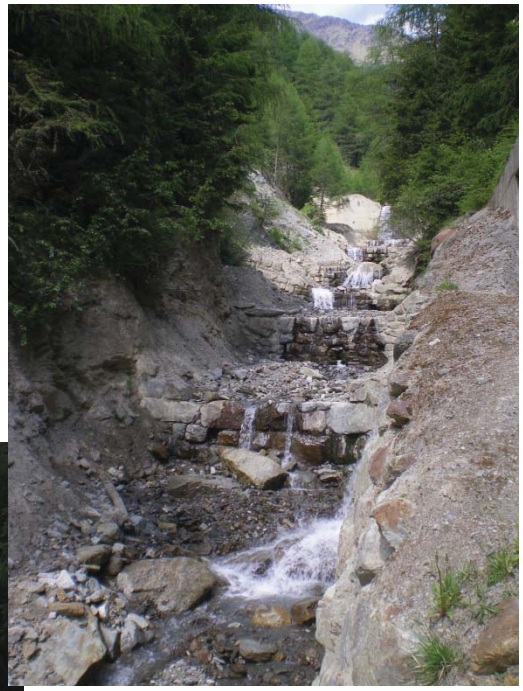
Diffuse dissection
In the upper part

Consolidation
check-dams
along the channel



Retention basin &
open check-dam

..but the open check-dam is not actually open !

- Each year the Province of Bolzano spends 200,000 € for sediment removal and disposal

Objectives of the project

• Determine deposition patterns in the retention basin, in order to design improved filters of the check-dam

• Assess debris flow triggering and propagation dynamics (i.e. triggering conditions, flow velocity)

• Tests protocols of warning systems (to be applied in other basins), including the alert and evacuation stage (civil protection management)

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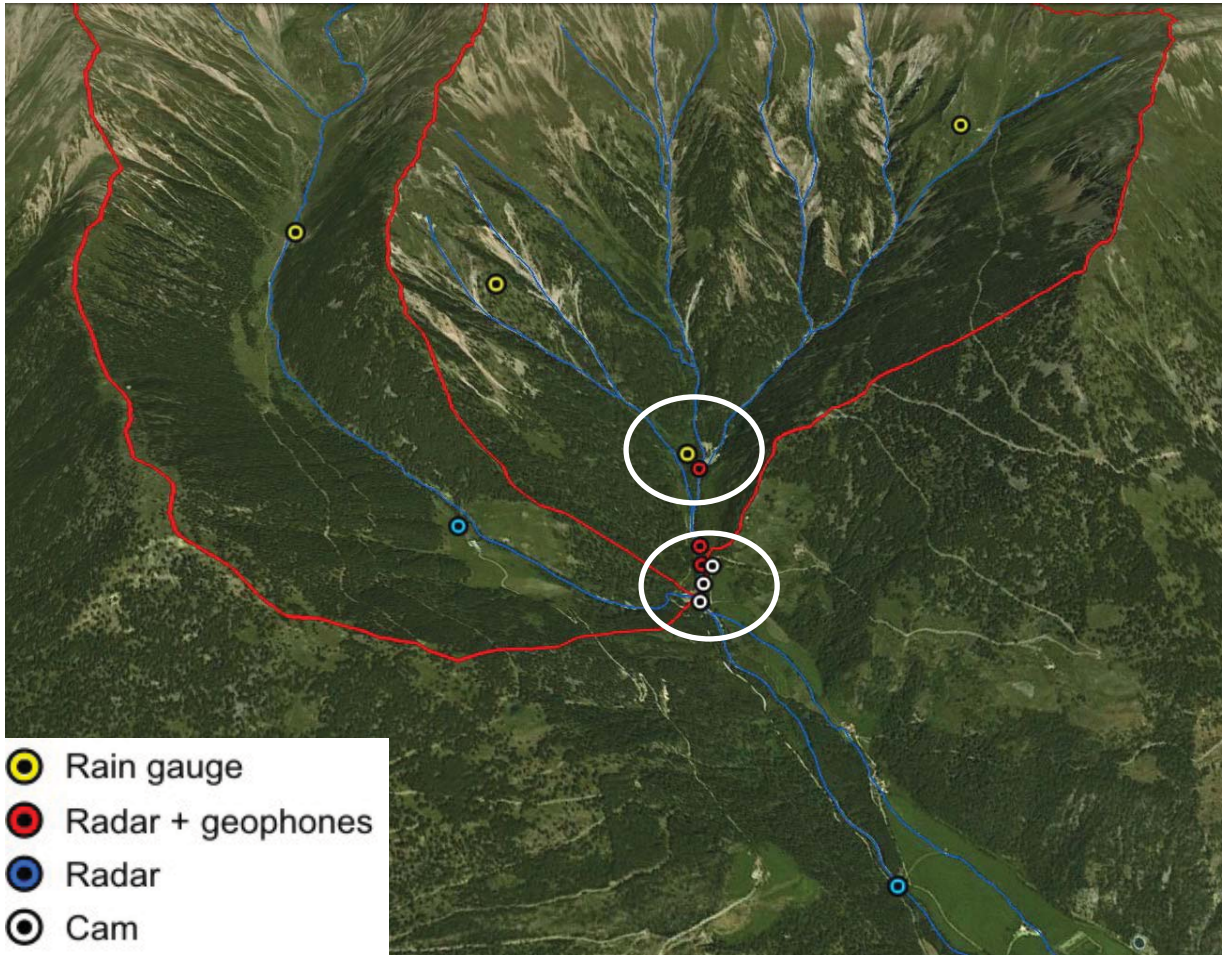

Rain gauges
In the upper
basin

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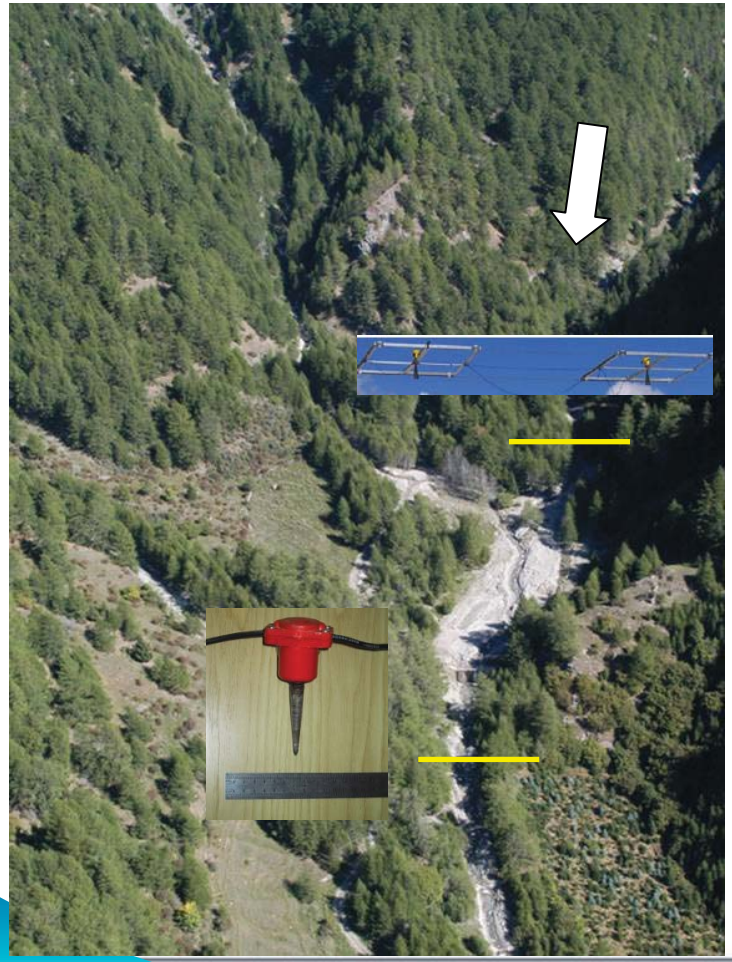

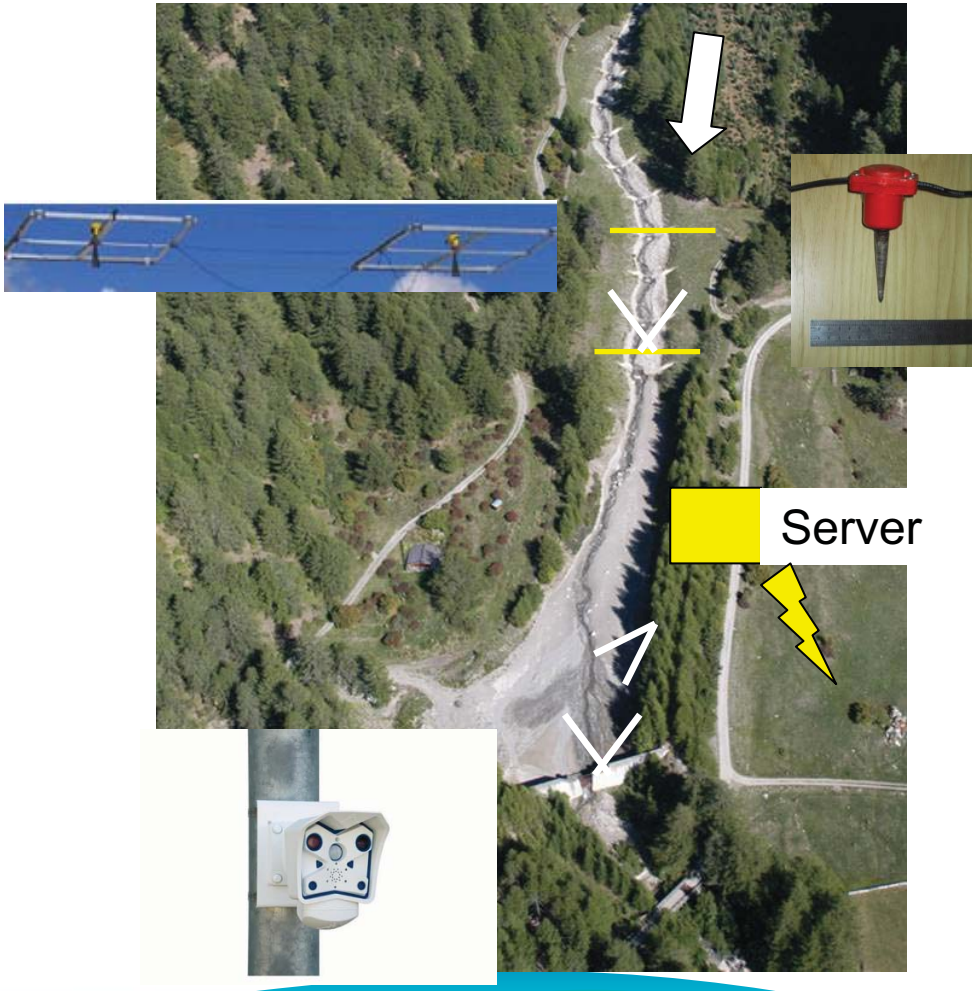

Main technical issues of the project

• The main technical problem in similar basins is the communication of remote instruments (not cable transmission possible)

• GSM-GPRS may work well, but in certain areas (as in the Gadria) there is no coverage

• Radio transmission is then needed, but it suffers from certain limitations: range, power supply, costs

• Continuous instruments self-checks and redundancy is fundamental to guarantee reliable warning.

• Who is eventually responsible to issue the evacuation alert ? When ?
We will test different protocols with Local Fire dept. and Civil protection

Conclusions

• We still know little about debris flow processes ! We need to invest in long-term monitoring programme

• Combined use of structural and non-structural measures is often required. But need to achieve a positive cost-benefit balance.

• It is vital to map debris flow hazards also in presently unpopulated areas, because once urbanization starts, mitigation costs soar !!