Improving the prediction of extreme events with new-generation CRNS probes

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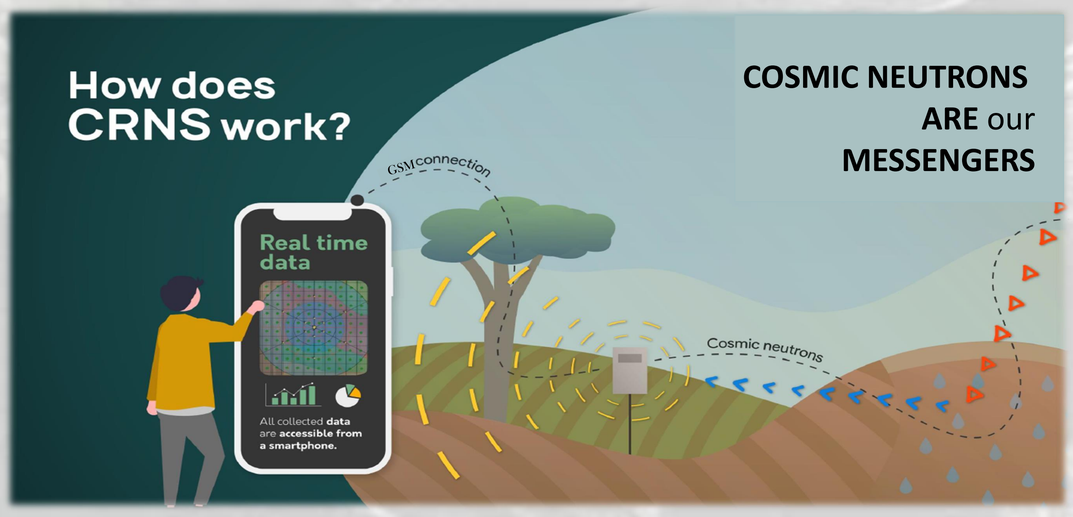
INTRODUCTION

Soil moisture is a key parameter in determining environmental risks like debris flows, mudslides, floodings, drought and wildfires. The ability to measure the accumulation of water in slopes, coupled with a knowledge of the geo-morphological characteristics of the site and with meteorological forecasting, is crucial to be able to provide site-specific early-warning systems to signal when the reduction of cohesion and friction may trigger landslides.

FINAPP COSMIC-RAYS NEUTRON SENSING (CNRS) TECHNOLOGY

Finapp measures water using cosmic rays. Neutrons coming from space penetrate the soil and bring back information about the water content. A Finapp probe mounted above-ground provides evaluation of the Soil Moisture:

- Over a large area (hectares)
- In depth (tens of cm)
- In continuous and real-time operation
- Remotely and autonomously



SMART ROAD CASE STUDY

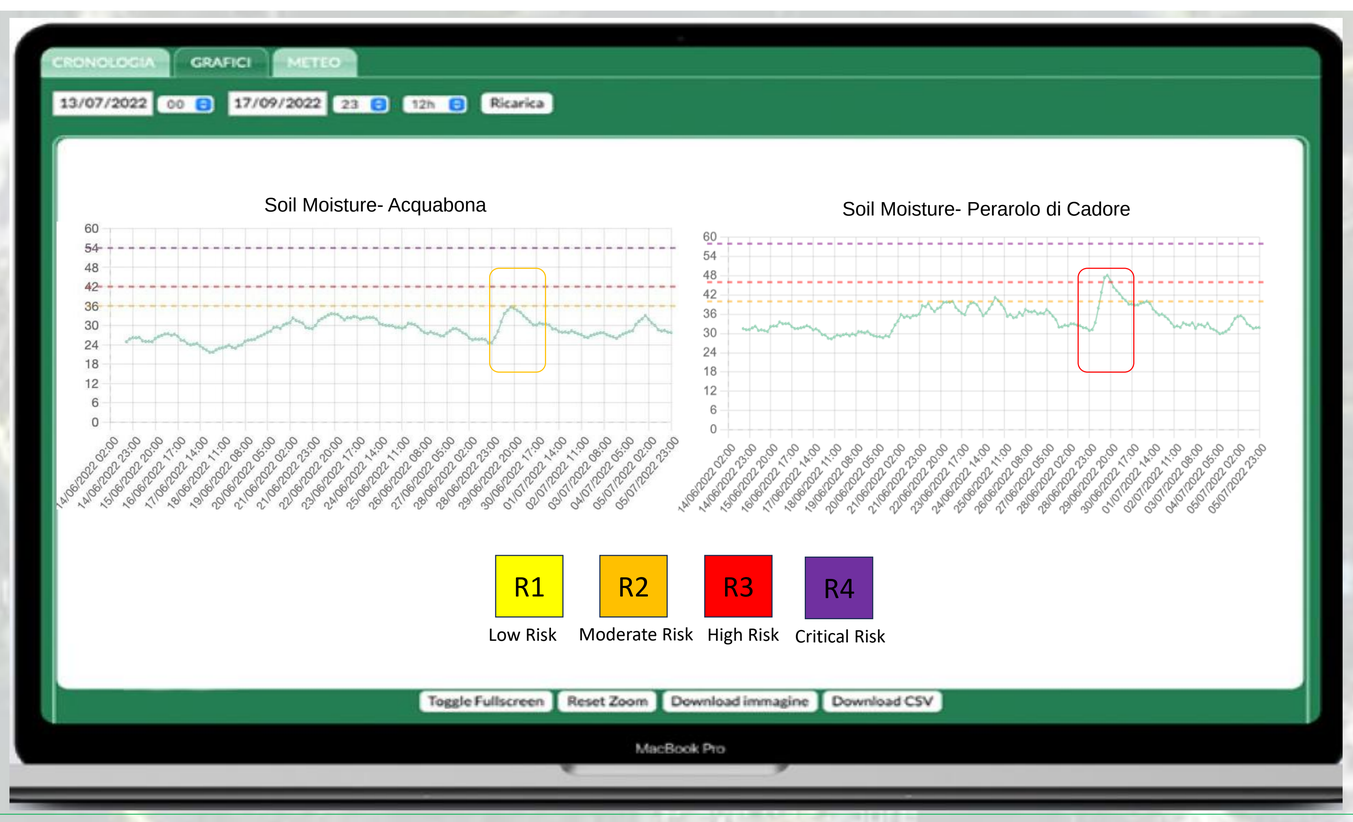
During 2022 two Finapp probes were installed along the ANAS-managed Alemagna smart-road, in Perarolo di Cadore and in Acquabona (Cortina d'Ampezzo). The Alemagna highway is notorious for being prone to be interrupted by landslides, especially below the Acquabona debris flow.

SITE-SPECIFIC MEASUREMENTS AND MODELLING

1. Finapp Soil Moisture measurements are correlated to the meteorological events
2. To preliminary set Warning Thresholds, the correlations found above are applied to a retrospective analysis of historical series (rain events and landslides/mudslides) to estimate the past soil moisture preceding landslide events
3. Four site-specific Warning Thresholds are set representing probability thresholds for the event of a landslide
4. Future (24 h) Warning level is provided by estimating the future soil moisture basing on the current Finapp measure and the meteorological forecast by 20 meteorological models
5. Warning levels are automatically updated in real-time and newly acquired data are continuously integrated in the historical series, therefore increasing accuracy

RESULTS

The system provided site-specific Warning levels that suggested a Moderate risk for Acquabona and a High risk for Perarolo di Cadore amid the massive rains of June 29th, 2022, based on the different initial conditions and rain forecasts. No landslide event affected the monitored sites. A significant debris flow occurred in another location, along SP 619 road in Vigo di Cadore, where the geomorphological characteristics were probably more susceptible to an event of this kind. This outline the importance of a site-specific monitoring.



CONCLUSIONS AND PERSPECTIVES

FINAPP is a promising technology to provide valuable information for local early warning systems, whose main innovative characteristic is to be site-specific. This allows to keep into account local characteristics of the site as opposite of using wide zones with homogeneity assumptions that may often be unrealistic.

REFERENCES

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