GC8-Hydro-105, updated on 20 Apr 2024
https://doi.org/10.5194/egusphere-gc8-hydro-105
A European vision for hydrological observations and experimentation

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

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It is of the utmost importance to know the water content in a soil, or soil moisture, for its role in triggering destructive events. In recent years, soil moisture has been recognized as a key information to improve wildfire predictions, proving more reliable than predictions based on weather data. Accumulation of water in slopes can reduce cohesion and friction thus triggering landslides and mudslides, while indeed the water quantity in the form of snow (SWE – Snow Water Equivalent) is responsible for avalanches.

Cosmic Ray Neutron Sensing (CRNS) technology provides unique capabilities to determine water content in soil, snow, and biomass by filling the gap left by current methods in term of scale and depth. A single, autonomous probe placed over the ground, requiring little maintenance, is able to provide real-time data on a large scale (hectares), in deep (tens of cm in soil, meters in snow).

The new generation of CRNS probes allows the contextual detection of muons, which provides detailed information about variations of the local flux of incoming cosmic rays. Previous probes rely on a public network of reference stations to monitor flux variations, with the closest station possibly being hundreds of km away from the site and the data availability being reliant on an external entity. On situ monitoring of the incoming flux is therefore a key improvement of the method reliability.

In 2022 ANAS, the Italian company responsible for road infrastructures, funded a Proof-of-concept project called MY-LAND, with the aim of verifying on field the capability of CRNS probes to support risk assessment. In the framework of this project, FINAPP installed two CRNS probes for large-scale soil moisture measurement along the Longarone - Belluno Smart Road, obtaining data that were used together with hydrological models of the area to assess the risk of landslides or flash floods. The first probe was installed in Acquabona (Cortina d'Ampezzo), where a high risk of debris flows is expected, and the second in Perarolo di Cadore, where a landslide is considered a threat to the town.

Two significant landslide events were observed in the sites during the experiment. Results show how CRNS technology, when supported by the knowledge of specific hydrological models of the land and weather forecast, is able to provide a valuable contribution to risk assessments and decisional processes.