life from cosmos finapp

Improving Landslide Early Warning with Soil Moisture Data



How Anas improved its understanding of landslide risk in the Dolomites using Finapp data

anas ‘ Challenge

Can soil moisture make landslide prediction more reliable?

Anas is responsible for managing Italy’s national road network, ensuring safety and resilience across thousands of kilometers of infrastructure. ANAS launched a call for innovative solutions within the Smart Road Belluno–Cortina project—the first Smart Road in Italy and a key access route to the 2026 Winter Olympics, the ideal testing ground for advanced monitoring technologies. The initiative focused on identifying and monitoring factors beyond the roadway itself which, despite being less controlled, have a significant impact on traffic flow and safety.

User : “Anas”, manager of 32 thousand km of roads and motorways in Italy

What: Landslide early-warning

Location: Road nr. 51, Alemagna

Problem: Traffic management beyond the asphalt strip

When: 2022-2025

Result: First site-specific landslide early-warning

Traditional landslide early warning systems rely primarily on rainfall thresholds, however:

- Rain alone does not fully explain slope instability
- Soil conditions play a critical role
- Existing models often generate false alarms or miss critical events

ANAS aimed to understand whether integrating measured soil moisture could enable:

- More accurate predictions
- Site-specific early-warning for known landslide areas
- Better allocation of operational resources

The Finapp Approach

Finapp deployed its **CRNS**-based **soil moisture** probes to continuously monitor water content in the soil on a **large scale, in depth and in real time** along critical sections of the road. The objective: combine real soil moisture data and rainfall to improve landslide prediction models.



Key Findings from the 3-Year PoC

1

Strong impact in soil-based landslides

Using a historical dataset of 17 soil landslides, Finapp evaluated predictive models combining:

- Rainfall only
- Rainfall + simulated soil moisture

Results showed that adding soil moisture **increased prediction accuracy by ~15%**.

This confirms that soil moisture is a key variable in landslides involving soil.

2

Real-world validation with Finapp measurements *(Fadalto, Belluno)*

In the Fadalto area—characterized by debris-type landslides—Finapp probes were installed and monitored over time. During the observation period, 4 landslides occurred. Comparing models:

- Rainfall + Finapp soil moisture
- Rainfall + simulated soil moisture

Finapp-based measurements delivered:

- **+4.6% improvement in predictive performance**
- **−48% reduction in false alarms**

A critical result for operational management.

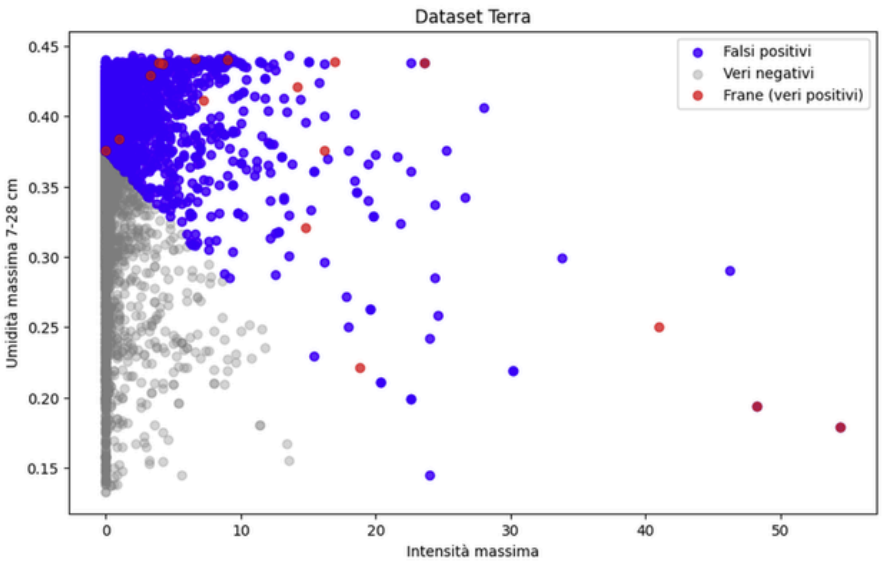
3

Improvement vs rainfall-only models

Fadalto's results show that:

- Finapp Soil moisture + rainfall **improves prediction by ~5.5%** compared to rainfall alone
- **True detection rate increased by 25%**

Meaning more real events are correctly identified, with fewer missed landslides.



Benefits

The PoC demonstrates that integrating measured soil moisture into early warning systems can:

- Improve landslide predictability
- Significantly reduce false alarms
- Increase detection of real events
- Enable site-specific early-warning systems

Conclusion

These findings have directly informed the development of **Fin4Earth**, Finapp's platform for **early warning management**. For ANAS, this opens the possibility to:

- Optimize deployment of crews and equipment
- Increase infrastructure safety
- Move to a more proactive risk management

"The work carried out by Finapp has been of high quality and demonstrated how measuring soil moisture with their probes can effectively improve early warning systems. We are now evaluating the extension of this solution to other areas across Italy."

Dr. Cristiano Lanni, Geologist and Landslide Expert at ANAS



From Data to Actionable Insights: Fin4Earth

Finapp develops advanced soil moisture monitoring solutions based on Cosmic Ray Neutron Sensing - **CRNS technology**.

Building on these findings and other field experiences, Finapp has developed **Fin4Earth**, a web-based platform designed for the **early warning of landslides, wildfires, and floods.**

Fin4Earth stands out from traditional approaches in several ways:

- It **integrates real soil moisture data** measured by Finapp probes into conventional models and formulas, significantly **improving overall performance**.
- **Site-specific system** tailored to each location, incorporating local characteristics and historical events to define **custom risk thresholds**.
- By combining site-specific **weather forecasts** with **proprietary AI** algorithms, Fin4Earth is able to project risk up to **72 hours in advance**, enabling timely and informed decision-making.

By turning complex environmental dynamics into clear, actionable insights, Finapp supports infrastructure operators and public authorities in moving from reactive responses to proactive risk management.

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Via del Commercio, 27
35036 Montegrotto Terme PD - Italy

+39 0490991301
info@finapptech.com
www.finapptech.com