finapp

fin4flood

Fin4Flood is Finapp's early warning service for hydrological and hydraulic risks, providing flood forecasts at river basin closure points for the current day and the next two days, with four possible alert levels: ordinary, low, medium, and high





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What we do?

Finapp has invented a new way to measure water.
We are the first company in the world to **use cosmic rays to calculate:**

Soil Moisture

a. **On a large scale**: approximately 5 ha (125m radius)
b. **In depth**: up to about 50 cm
c. **In real-time** and continuously

Using a single CRNS -Cosmic Ray Neutron Sensing- Probe

a. **Non-invasive** – measurements are taken without direct contact with the soil
b. Easy to install – lightweight and compact, weighing only 5 kg and 35 cm in size
c. User-friendly – energy self-sufficient, requiring no electrical connection
d. Low maintenance – not buried, requiring no maintenance as it has no consumable or moving parts

Finapp is the first company in the world to offer an early warning service for the risk of:



Surface landslides / mudflows



Floods



Wildfires

With unique features:

1. Provides **site-specific analysis**
2. Takes into account **both meteorological thresholds and soil moisture levels**
3. Delivers **warning up to 72 hours in advance**





Fin4Flood

Definition

Fin4Flood is Finapp's early warning service for hydrological and hydraulic risks, providing flood forecasts at river basin closure points for the current day and the next two days, with four possible alert levels: ordinary, low, medium, and high.

The ongoing climate change has caused and will increasingly result in extreme rainfall, leading to devastating flood events with severe consequences, including loss of life and damage to property. Currently, there is a lack of timely information about the locations and arrival times of river flood waves, especially in critical hydraulic areas such as low-lying areas near riverbeds, anthropized floodplains, and inadequate bridges.

The Fin4Flood early warning system addresses these gaps by offering precise, localized, and statistically reliable predictions of expected flood waves. This is made possible through a multidisciplinary approach and Finapp's unique expertise in soil moisture monitoring.



Soil moisture is a crucial factor in accurately assessing hydrological and hydraulic risks. While extensive scientific literature exists on the subject, measuring it precisely, in real-time, and with values representative of a large scale is extremely challenging. As a result, this parameter is often simulated rather than measured, compromising the accuracy of the results and increasing uncertainty.

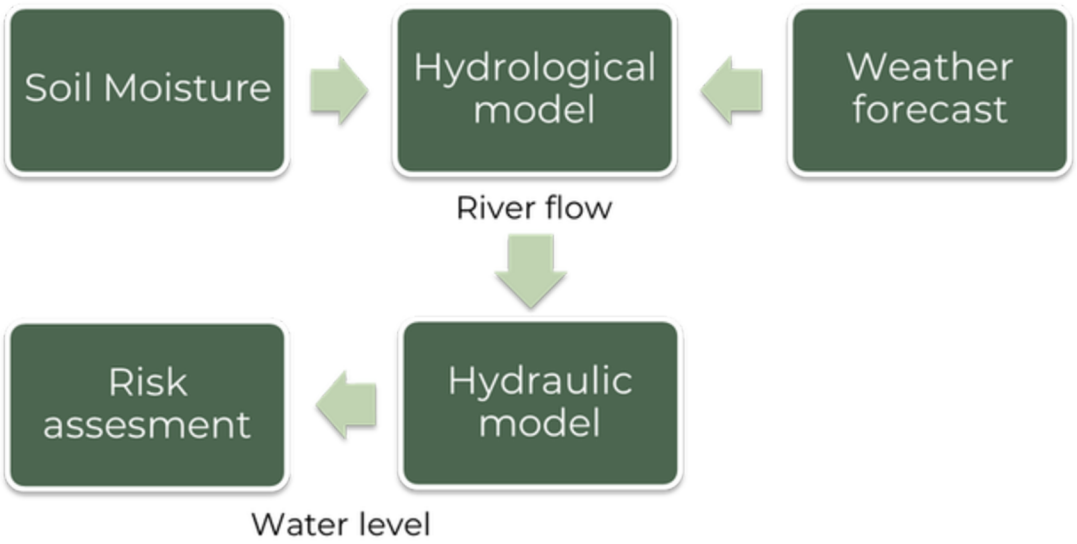






How it works?

Our early warning service integrates multidisciplinary knowledge to better represent the complexity of these phenomena. Below are the key steps.



1. Soil Monitoring: Soil Moisture Measurement

To determine if a flood is likely, we must first know how wet the ground is. If the soil is already soaked like a full sponge, it cannot absorb any more water. Consequently, the next rainfall will immediately flow over the surface and swell the river.

To capture this, we install one or more **Finapp** probes within the river basin. These probes measure soil moisture across a large area, deep underground, and in real time. This actual measured data is far more accurate than theoretical computer estimates, satellite imagery, or traditional single-point measurements (such as TDR probes).

Standard hydrological guidelines typically simplify soil conditions into three wetness levels, known as **AMC (Antecedent Moisture Condition)**, based solely on how much it rained over the last 5 days:

- **AMC I:** Dry soil (high water absorption capacity).
- **AMC II:** Moderately moist soil.
- **AMC III:** Completely saturated soil (cannot absorb any more water).

Finapp's technology overcomes this limitation. Instead of guessing or estimating the soil state, it measures the exact percentage of soil saturation. It achieves this by precisely calculating the **field capacity** (the soil's maximum water holding capacity) and the **wilting point** (when the soil is completely dry). This data drastically improves the reliability of the entire forecasting system.

2. Atmospheric Data: Weather Forecasts

Finapp uses highly precise, site-specific weather forecasts rather than generic regional ones. We apply a multi-model approach, combining several meteorological models to reduce the natural uncertainty inherent in any weather forecast .

The system analyzes predicted rainfall, snow-related variables (such as snowline elevation and snowmelt), and future soil moisture. This future soil moisture is calculated up to 72 hours in advance by merging current field observations with weather forecasts through proprietary Artificial Intelligence (AI) algorithms. Thanks to this integration, we can forecast incoming water volume with exceptional anticipation.

3. Water Volume Calculation: The Hydrological Model

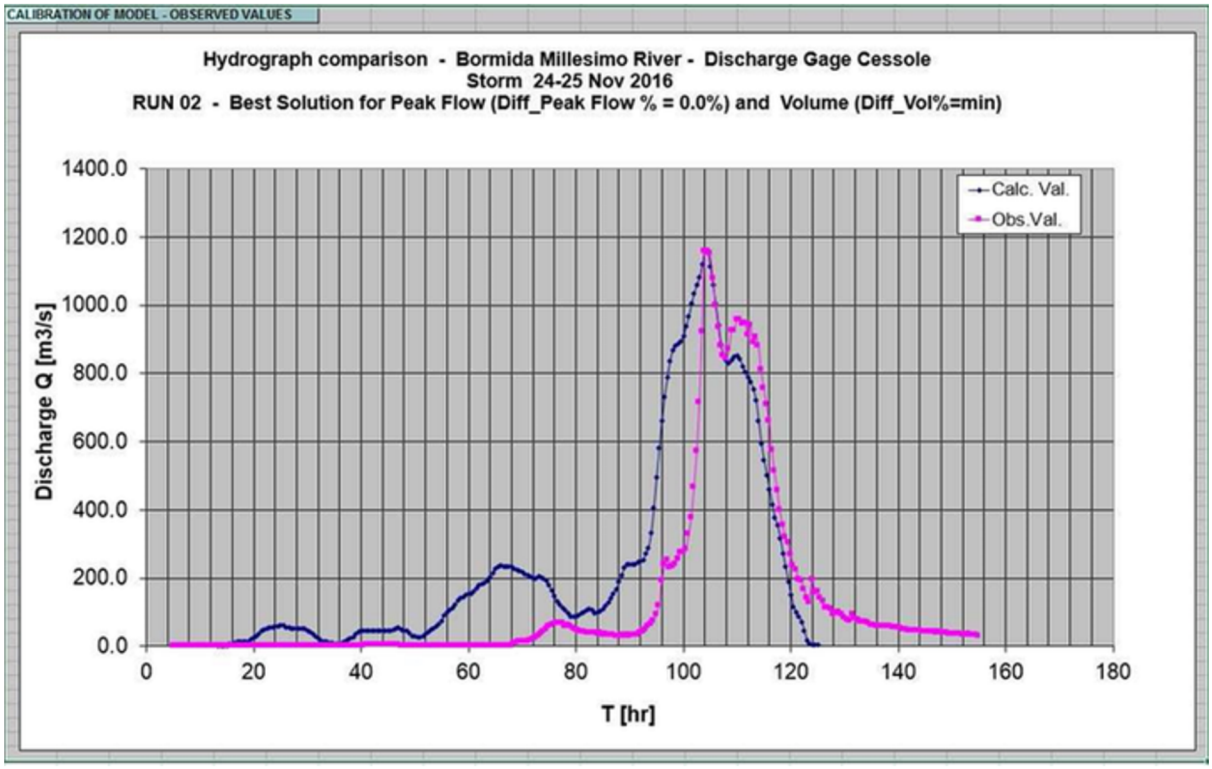


Figure 1. Calibration of the Fin4Floods Model: Difference Between Observed and Calculated Flood Wave

Finapp's proprietary hydrological model simulates how the water cycle behaves across the landscape to calculate the final output: **river discharge** (the volume of water flowing through the river per second).

The model operates in two main steps:

1. **Calculating losses (SCS Curve Number method):** The model estimates how much rainwater is absorbed by the ground and how much becomes surface runoff.
2. **Simulating the flood wave (Clark or SCS Hydrograph):** The model calculates how long it takes for runoff water to travel across the land and reach the river. It determines the **time of concentration Tc** (the basin's reaction speed) and **storage attenuation** (how much the peak of the flood wave is naturally flattened or dampened along the way).

All results are verified and validated within the industry-standard software environment, **HEC-HMS**, ensuring a highly precise distribution of soil values. Basic geographic parameters (such as soil impermeability and initial water losses) are enhanced by advanced parameters that allow the model to automatically calibrate itself.
While the system works best when focused on sections of the river equipped with official monitoring stations, it is flexible enough to calculate and forecast water flow at **any specific point** along the river's course.

4. System Optimization: Hydrological Model Calibration

To ensure that simulations are highly accurate, the model must be "trained" or calibrated. This is achieved through back-analysis: we look at historical data from past flood events, feed the model with the actual rainfall recorded back then, and verify if the model can accurately recreate the water levels observed during those real events.
This calibration is dynamic, constantly updating itself based on both past historical data and newly occurring events.

5. River Water Levels: The Hydraulic Model

Once the hydrological model has calculated how much water is heading toward the river (the discharge), the hydraulic model steps in to calculate the visible impact: the river's water level (the hydrometric height in meters).
To predict how high the water will rise, the model needs to know the exact shape of the riverbed. We reconstruct this channel and riverbank geometry by extracting cross-sections through two high-precision methods:

- **High-resolution digital elevation models (DEMs)** with a resolution of 1 meter or less or, if not available
- **Aerial drone surveys (Airborne LiDAR scanning)**, which can accurately map the riverbed even through dense vegetation along the riverbanks.

These geometric profiles, combined with **Manning's roughness coefficient** (a value indicating the friction or resistance to flow caused by concrete, stones, or trees), are fed into the hydraulic software **HEC-RAS**. HEC-RAS calculates the **rating curve**, which is the geometric law that links every specific water discharge volume to its exact corresponding water level height.

6. Safety Management: Risk Assessment

The final piece of the chain translates raw data into public safety. When forecasted river levels and flow rates exceed predefined safety limits (established by analyzing the history of that specific river), the system triggers four distinct **alert levels**:

- 🟢 **Ordinary**
- 🟡 **Low**
- 🟠 **Medium**
- 🔴 **High**

These safety thresholds and rating curves are not static; they are continually updated whenever a new significant flood occurs, making the system increasingly accurate over time.

Thus, the first early-warning service is born:



Soil Moisture integration

Large-scale, in-depth, real-time **soil moisture measurements and forecast**, combined with soil's saturation levels, improve the performance of hydrological models.

It **overcome current limitation of ACM** - Antecedent Moisture Condition- **increasing the Curve Number estimation** for better accuracy of the whole system



Site-specific

as it takes into account the specifics of the location, both in terms of defining alert thresholds and forecasting future conditions, both meteorological and related to soil saturation



Early warnings

Up to 3 days ahead risk assessment thanks to weather and Soil moisture forecast

Data Access

The early warning index is calculated in real-time and fully automatically.

By accessing our Fin4Earth portal, the customer can view a map showing markers that indicate each basin outlet where flood risk forecasts are provided.

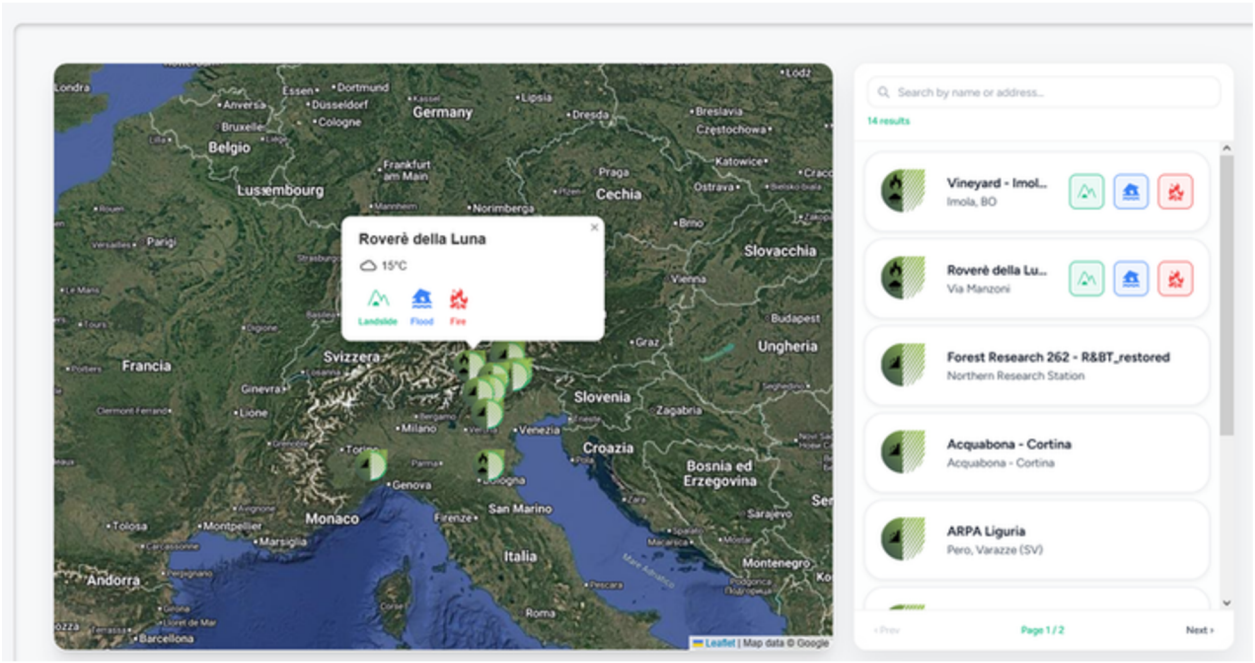


Figure 2. Fin4Earth Home page



By clicking on a marker of interest, the user is taken to a detailed page showing the **flood risk level** for the current day and the following two days, classified into four categories:

- **Low**
- **Medium**
- **High**
- **Critical**

The page also displays a soil moisture chart measured by the Finapp probe installed in the field, along with additional information on the ongoing conditions.

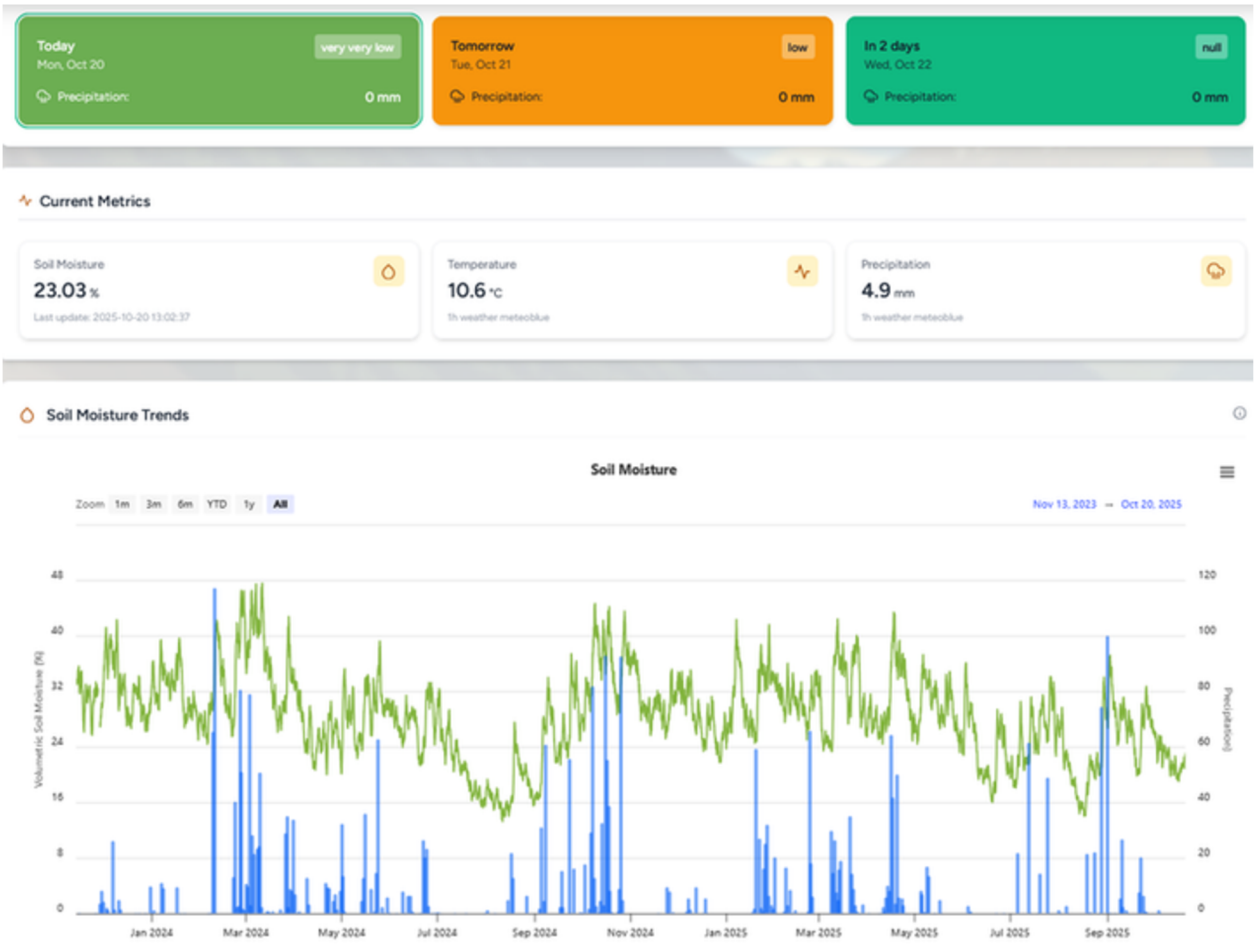


Figure 3. Fin4Flood site specific page

Comprasion with Existing Solutions

Warning Bulletins

The definition and subsequent calculation of hydrological and hydraulic risk, as described above, should be considered an evolution of the traditional alert bulletins issued by the relevant authorities.

First and foremost, the availability of soil saturation levels, representative on a large scale, is a key aspect for the most accurate definition of the early warning level. Secondly, the specific characteristics of each watercourse, where the Finapp probes are installed, are taken into account, rather than just the main rivers of a region.

	Finapp	Warning Bulletins
Minor watercourses	✓	✗
Quantitative assessment of soil moisture	✓	✗

Site-Specific Monitoring Systems

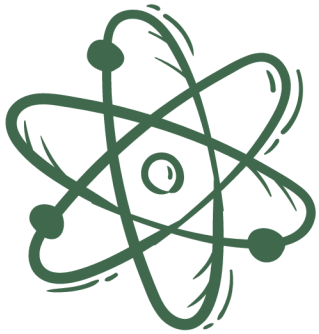
Traditional monitoring involves the installation of weather stations and hydrometers that provide real-time data on precipitation and flow rates. Precipitation thresholds or hydrometric levels can be established, beyond which specific warning thresholds are triggered.

However, these instruments are not capable of providing true early warning. This equipment measures the current state but cannot forecast future risks.

For this reason, Finapp's early warning system perfectly complements site monitoring, as it operates on a different timescale.

Learn More

What is CRNS Technology?



CRNS stands for Cosmic Ray Neutron Sensing, which refers to the detection of cosmic rays. Cosmic rays originate from deep space, and when they reach Earth's atmosphere, they generate a cascade of "secondary" particles, including fast neutrons.

Fast neutrons have the characteristic of primarily interacting with water molecules, specifically with the hydrogen they contain. When they come into contact with water in the soil, some of the fast neutrons are absorbed, and others are reflected back into the atmosphere, losing part of their initial energy. This process produces slow neutrons.

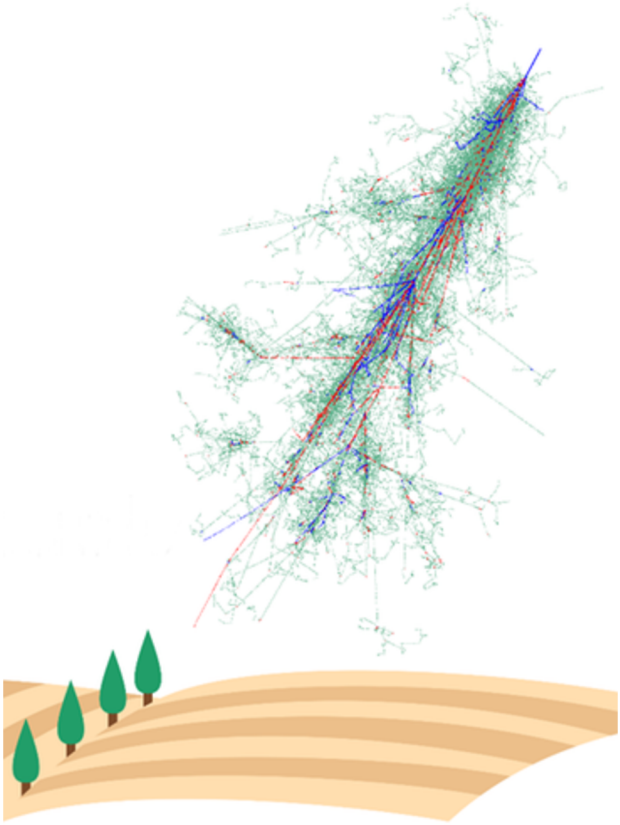


Figure 4. Cosmic rays hit the Earth's atmosphere and break into various particles, including fast neutrons.

The Cosmic Ray Neutron Sensing (CRNS) technology, based on the principles described above, is capable of measuring the water content in the soil.

A significant difference between the number of fast and slow neutrons indicates a large amount of water present in the soil, and vice versa. Since fast neutrons have enough energy to penetrate the soil for many centimeters, the data provided is representative of depth, not just the surface.

Similarly, because slow neutrons are spatially distributed and scatter over large distances in the air, it is possible to monitor water content over vast areas—approximately 5 hectares at sea level and under standard conditions, up to over 20 hectares at higher altitudes, where the rarer air allows the slow neutrons to travel further. The data obtained is interpreted as the average value across the entire described area.

The CRNS technology has been around for decades and has been validated by the scientific community over the past twenty years through numerous publications. The FAO – Food and Agriculture Organization of the United Nations – goes even further, stating that CRNS technology is currently the best available for practicing "smart agriculture."

Source: *https://www.iaea.org/sites/default/files/21/09/nuclear-science-and-technology-for-climate-adaptation-and-resilience.pdf*

Who We Are

Finapp is an innovative startup founded in 2019 as a spin-off from the University of Padova.

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The name of our company is an abbreviation of "Fisica Nucleare Applicata" (Applied Nuclear Physics), as the founding members were all professors and researchers in the Department of Nuclear Physics.

In the 2010s, the research team developed a probe capable of detecting radioactive sources from a great distance, to ensure security at airports, train stations, and other sensitive sites. This same technology was later applied in a completely new field, environmental sustainability: instead of detecting radioactive material, the focus shifted to measuring water.

Finapp invented a new way to measure water using cosmic rays. The CRNS (Cosmic Ray Neutron Sensing) probes patented by Finapp provide unique insights into the water content in soil and snow on a large scale, at depth, in real time, and without contact.

All of this is done using a lightweight, compact instrument that can be installed anywhere with no maintenance required.

In June 2023, Finapp won the European Innovation Council – EIC award.

European Innovation Council

In 2025, Finapp became a joint-stock company (SpA) to support its international growth and welcome new strategic partners.

The company has deployed over 300 probes across 20 countries, spanning all seven continents.