

Orekan (Navarre Regional Government)

Early warning system to reduce flood risk

The Autonomous Region of Navarre, located in northern Spain, has a **surface area of over 10,000 km² and a population of approximately 680,000**, concentrated mainly in the Pamplona metropolitan area. It has a **highly complex hydrological system, as it is divided between the Ebro River basin, which covers approximately 90% of the region, and the Cantabrian basin**, characterized by short, fast-responding basins. This combination, along with variable rainfall patterns and diverse topography, makes Navarre particularly **vulnerable to flash floods**.

To address this risk, **the Navarre Regional Government, through Orekan (Navarre Environmental Management), operates a state-of-the-art hydrometeorological infrastructure** covering the entire region. Navarre's early warning system draws on **over 150 active rainfall stations**, as well as an additional **80 flow-measuring stations**, managed by various public agencies, which continuously monitor the hydrometeorological parameters affecting the region's major waterways. This network is complemented by **AEMET (the Spanish State Meteorological Agency) weather radars** and a set of forecasting models that provide updated information every six hours on expected precipitation, all of which are **integrated into a single digital platform**.

The Navarre Regional Government and Orekan have committed to upgrading their early warning system through the Xylem Vue platform, in response to the increasing frequency and intensity of extreme weather events, which have recently caused major human and material damage. The project, supported by European LIFE-IP NAdapta-CC funds, aims to strengthen anticipation and coordination capabilities by providing real-time information on changes in the severity levels of Municipal Flood Risk Action Plans (PAMRIs by their Spanish acronym), to support decision-making by Civil Protection services and local governments.

Challenges

Orekan and the Navarre Regional Government needed to **significantly improve flood risk forecasting and operational management in a region with highly diverse basins**, where large, slow-response rivers coexist with numerous torrential floods associated with fast-response sub-basins, capable of causing flash floods in just one or two hours. In this context, **it was critical to reduce warning times and provide Civil Protection services with a comprehensive, reliable overview of flood events that was easy to interpret and was based on observed data and predictive capabilities**, so that preventive measures could be activated well in advance.



Project highlights

- Regionalized early warning system to address flood risk.
- Real-time integration of hydrometeorological networks
- Single platform for monitoring, forecasting, and alert generation.
- Anticipation of flash floods and integration of PAMRIs

The territorial deployment of municipal emergency response systems was particularly important. In Navarre, **51 municipalities have PAMRIs**. This meant that warnings had to be adapted to local conditions, aligning thresholds, severity levels, scenarios, and messages with specific municipal procedures. The challenge was not merely to issue warnings, but to **ensure that alerts reached the appropriate regional and municipal decision-makers in a timely, targeted manner**, allowing for real-time visualization of the evolution of severity levels defined in the PAMRIs as established thresholds were exceeded. The aim was to support Civil Protection decision-making, improve coordination between different levels of government, and enable municipal decision-makers to activate local emergency response measures at an early stage.

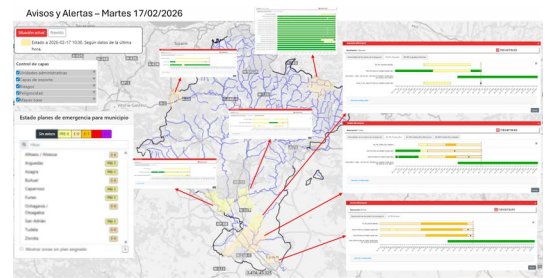
These challenges were compounded by the **need to integrate hydrometeorological information from multiple networks and entities into a single operational environment**, ensuring data quality, interoperability, and service continuity, and transforming the combination of real-time observation and modeling into clear alerts and actions. At the same time, the system had to evolve continuously to adapt to increasingly demanding events, adding **improvements in predictive capability, greater flexibility in parameterization by expert users, and more effective notification channels** that would strengthen both institutional responses and public risk communication.

Solution

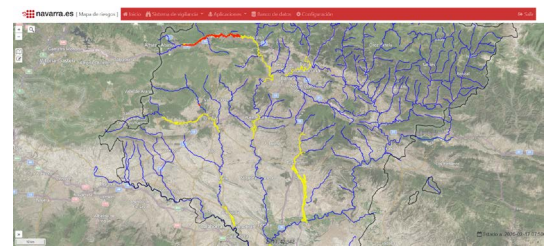
Orekan has responded to these challenges—with the support of the Navarre Regional Government—**by implementing and developing the Navarre Early Warning System based on the Xylem Vue platform's Early Warning System (EWS) application**, which has been configured and customized to meet the region's specific needs.

The core of the Early Warning System, capable of **generating automatic real-time alerts based on hydrometeorological thresholds**, is based on a hydrodynamic modeling service that simulates the hydrometeorological status of all elements of the water system in real time, enabling the assessment of risk scenarios and supporting decision-making. **The platform incorporates advanced GIS visualization, flood zone analysis, impact estimation, and a multi-channel alert system** that enables alerts to be tailored to different user profiles and administrative levels, as well as displaying changes in the emergency status of the integrated PAMRIs, whose operational management falls under the remit of Civil Protection through its own systems.

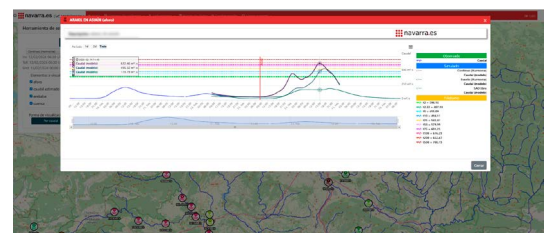
Navarre has strengthened its predictive capabilities through Xylem Vue EWS by incorporating new data sources, including additional sensors and medium-range probabilistic weather models such as the ECMWF's (European Centre for Medium-Range Weather Forecasts) IFS-ENS, as well as specific improvements to the **visualization of PAMRI severity levels**. Likewise, **the functionalities for configuring alerts, issuing warnings, and parameterizing models** have been expanded, incorporating differentiated user profiles and working with different hydrological response levels, from large basins to ravines with short runoff times.



Emergency plan monitoring



Flood risk map



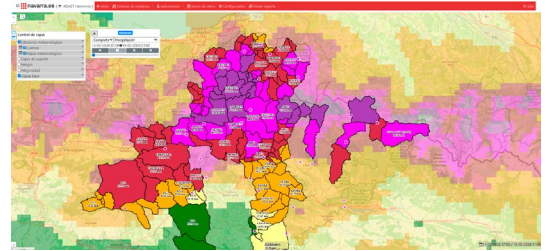
Hydrological forecasting

Results

Navarre's early warning system has taken a major step forward thanks to Xylem Vue's EWS application, building on the long-standing commitment of the Navarre Regional Government and Orekan to using the most advanced technologies for proactive, coordinated, and data-driven flood risk management. **The platform provides a consolidated, centralized environment that aggregates all relevant hydrometeorological data for the region in near real time**, enabling a more precise, shared understanding of risk events. It also brings together the different PAMRIs and provides real-time monitoring of how their severity levels evolve as defined thresholds are exceeded, so that agencies such as Civil Protection and local governments have a shared, up-to-date operational view throughout the event. From an operational standpoint, **the system has significantly improved the ability to forecast and issue flood warnings, reducing warning times and improving emergency service preparedness.**

Since the EWS was launched in 2021, it has operated 24/7 without interruption and has tracked 27 significant events, 16 of which caused damage. The system has demonstrated a robust ability to anticipate frontal rain events, providing up to 48 hours of accurate advance warning, and has strengthened the management of convective events, which are more difficult to predict. In January 2025, during the Arakil River flood, it detected the event three days in advance and issued the first alerts 12 hours before the peak, enabling a coordinated response by Civil Protection and the affected municipalities.

Xylem Vue EWS **has helped strengthen coordination among the various agencies involved in flood management and has increased the capacity to disseminate alerts** at both the technical and management levels, improving transparency and risk governance. At the same time, the platform is establishing itself as a **key tool for climate change adaptation**, designed for continuous adjustment to evolving climate risks, helping to reduce economic and social damage and to boost Navarre's territorial resilience to increasingly frequent extreme events.



Weather forecasting

“Including PAMRIs in robust early warning systems brings flood risk management capabilities closer to the municipal level, equipping local governments with operational tools to respond to episodes of heavy rainfall. It also improves readiness to respond to risks that could increase due to climate change.”



Luis Sanz Azcárate,
Technical Director of Orekan (Navarre
Environmental Management)