

## Monitoring and Early Warning System for the landslide in Borrano - Civitella del Tronto (Teramo)



In February 2017, in the Municipality of Civitella del Tronto, and more precisely in the division of Borrano has been reactivated by an **extensive landslide phenomenon** which affected large areas of the territory .

Plausible causes of this phenomenon date back to a series of **hydrogeological instabilities** related to geotechnical and lithological characteristics of the outcropping formations, as well as to geological-structural evolution of this area and to an unorthodox rainwater regulation. This phenomenon has **worsened after the last earthquake** and it is still evolving at a very high speed of about 40-50 mm/year.

This scenario involves a serious risk for public safety: emergency situations could result from the likely possibility that future rainfall events may jeopardize and further deteriorate the situation. After an in-depth study of the phenomenon, the Regional Civil Protection has ordered the implementation of a monitoring and early warning system dedicated to this kind of instability. This was possible thanks to the funds dedicated to the "earthquake crater". (Decreto Legge n. 189 del 18/10/2016 e Ordinanza Capo Protezione Civile n. 388 del 26/8/2016).

### Summary

**Location:** Borrano, Civitella del Tronto (TE)

**Conclusion:** 2018

**Focus:** Geological and hydrogeological risk

**Challenges:**

- Hydrogeological instabilities
- Extensive landslide phenomenon
- Guarantee public safety

**CAE solutions:**

- Full-scale and modern "turnkey" monitoring and early warning system
- WSN technology (Wireless Sensor Network)
- Chain inclinometers, piezometric sensors, surface clinometers and crack width gauges
- Mhaster station
- Duplex communication system

## FEATURES

After performing a feasibility study, CAE provided the Abruzzo Region with a **full-scale and modern "turnkey" monitoring and early warning system** that can be upgraded and modified at any time in a simple and fast way, without interfering with the functioning of the "Mesh" network, in order to adapt it to any possible future necessities that may occur during the monitoring of the phenomenon.

The system uses self-configuring **wireless networks thanks to the WSN technology (Wireless Sensor Network)**. Thanks to the use of solar panels and buffer batteries, each element of the system is **self-functioning from an energetic point of view**.

This system allows us to associate the evolution of the instability with the rainfalls on site; at this purpose, we can distinguish three phases:

- **Normality:** no intense rainfalls or landslide movements have been detected;
- **Pre-alarm:** rainfalls exceed a determined threshold of intensity. The number of safety measures increases, the headquarters can send a warning notification;
- **Alarm:** the movements of geological sensors (significant inclinations) involve sending alert notifications via vocal synthesis message, SMS and FAX.

The system will guarantee **maximum reliability** both in terms of data availability, allowing us to intervene in extremely rapid times in case of anomalies, and in real-time warning: when the conditions of the system change and the pluviometric and geotechnical alert thresholds are exceeded, the system communicate via vocal messages, SMS or e-mails, with the competent Authorities.



## COMPOSITION

More in detail, the system composition. In order to monitor the micro-movements deeply in the soil, we use chain **inclinometers** located in holes at a depth up to 80 m. Moreover, holes with **piezometric sensors** are created and equipped for measure of the water level in the soil, as a forerunner for the reactivation of the instability.

As for surface movements, we use surface **clinometers** and crack width gauges. Both sensors are used to evaluate the good conditions of the monitored structures.

While monitoring soil movements, the system is equipped with a **Mhaster station** that uses the meteorological data already available in the Municipality of Civitella del Tronto, thanks to the recent installation of the monitoring system located in Ponzano, a few kilometres away.

The **real time early warning features** are possible thanks to the automatic diagnostic functionalities and its duplex communication system (a **GPRS/UMTS modem** and a **UHF band radio device**); this system sends the collected data both to the Municipal Operative Centre and the Functional Centre of the Civil Protection System.

In addition to traditional hardware and software devices, CAE provides the competent Authorities with a **valid decision support**, thanks to a **data visualisation service** that uses a **WEB platform** which is 24h mobile-accessible from an internet browser.