



Monitoring Mother Nature's Forces

by Elena Piantelli

The Messina region is considered one of Sicily's areas most vulnerable to natural disasters. As such, the communities in this northeast region have become all too familiar with "renewal" – the recovery after violent earthquakes, flooding, mudslides and landslides. Indeed, the community of San Fratello, a small village 90 kilometers (56 miles) west of Messina, is still trying to regain its footing three years after a disastrous landslide forced almost half the population of 4,500 residents from their homes. The implementation, however, of an advanced

surface monitoring system is providing authorities with the ground intelligence they need to not only help avoid the disastrous element of surprise, it may help to stem the slide as well.

According to ISPRA (Italy's Institute for Environmental Protection and Research), a significant contributing factor to the landslide was rainfall. About 105 mm of rain fell over the area in the eight days prior to the destruction, overwhelming the existing drainage system and putting the hillside village at serious risk.

On 13 February 2010, a landslide was triggered in Riana, a district in San Fratello. The two-kilometer-





■ Monitoring network with GPS baselines (red and yellow lines) and total station observations (pink lines).

wide (1.2 miles) phenomenon descended across the area for about two days, swallowing homes, damaging important monuments such as the San Nicola church, destroying principal roads and causing extensive damage to the districts of San Benedetto and Stazzone.

The day after the landslide stopped, the authorities with the Regional Civil Protection (RCP) of Sicily initiated plans to take a proactive approach to disaster preparedness. The plan would lead to a sophisticated, real-time, surface monitoring system that not only maintains a continual read on the stability of the terrain, it may help authorities manage Mother Nature's forces.

Setting a New Preparedness Standard

To adequately design a monitoring system, authorities first needed to study and observe the region's terrain to truly understand its movements, and consequently, its vulnerabilities. For two years, surveyors and engineers recorded and analyzed measurements from geotechnical and topographic instruments. Based on this comprehensive study, they determined an automated, integrated surface monitoring system would be the most effective, first-alert approach for its emergency preparedness plan.

In August 2012, the RCP issued a request for proposal for such a system, and in September 2012, it awarded Leica Geosystems with the design, development and installation of the integrated monitoring solution.

Operational since January 2013, the topographic monitoring system combines both GPS and TPS technology, along with advanced software tools, to provide a precise picture of the village's surface in near-real time.

Eight Leica GMX901 GPS receivers sit on buildings and drainage wells located in the landslide area. These compact, single frequency sensors monitor the high risk zone, acquiring position data every second, enabling them to record the smallest of movements.

Completing the automated control network are two double frequency GMX902 GPS stations, which are specifically designed to provide precise correction data to the single-frequency GPS receivers.

Each GPS station is powered by 220V and/or by a solar panel, and is connected to a cabinet equipped with protected electric cables and a buffer battery.

The communication among the stations and the master unit station, which houses the management software, is guaranteed by a wireless LAN 5 GHz device. The continuous GPS readings are collected by the Leica GNSS Spider software, which is installed on a dedicated PC on site. The software manages the individual GPS sensors, automatically calculates the baseline and sends the information to the RCP.

The Deformation Data Stream

The automated management of the GPS receivers and the data analysis tools are maintained by the RCP's control center, which is based in the city of Palermo, about 140km (87 mi) from San Fratello. The centralized control center has a network of computers to receive the GPS and other supplemental data, and it has specialized data analysis software to enable the RCP to study the data provided by the different instruments.

Although the frequency of the baseline calculation depends on the RCP's specific needs, at present, the automated monitoring system provides measurement data every hour. RCP personnel can access the system at any time to consult the measurements and modify acquisition parameters, thanks to the remote control features of the solution and an opportune remote control software.

In addition to the automated GPS monitoring system, 50 prisms are permanently set on buildings for routine measurement by a Leica TS30 automatic total station. Using a network of six measurement pillars, a surveyor positions the total station to perform an automatic measuring cycle, surveying each prism point, and enabling users to produce a topographic analysis of the measurement data.

Measurements and surveys are made on a monthly basis but the frequency can change according to specific requests based on the stability of the area or changing environmental and climatic conditions, which are considered hazardous.

Strategies to Stabilize Subsidence

All of the information gathered by the system is promptly delivered to the Office for Civil Protection so the data can be validated and integrated into the emergency plan. By having accurate, near-real time data, authorities have been able to identify and implement strategies to improve San Fratello's infra-



■ GPS Monitoring Station

structure, such as installing new drainage wells and constructing other support structures, mitigating the town's risk of severe damage from future natural disasters.

It is likely that landslides will descend on San Fratello again, but by flooding the area with their own network of technology, authorities may now have the means to turn the event into an exercise in "preparedness" rather than "disaster." And that may give comfort to both the residents and the authorities charged with trying to protect them. ■

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