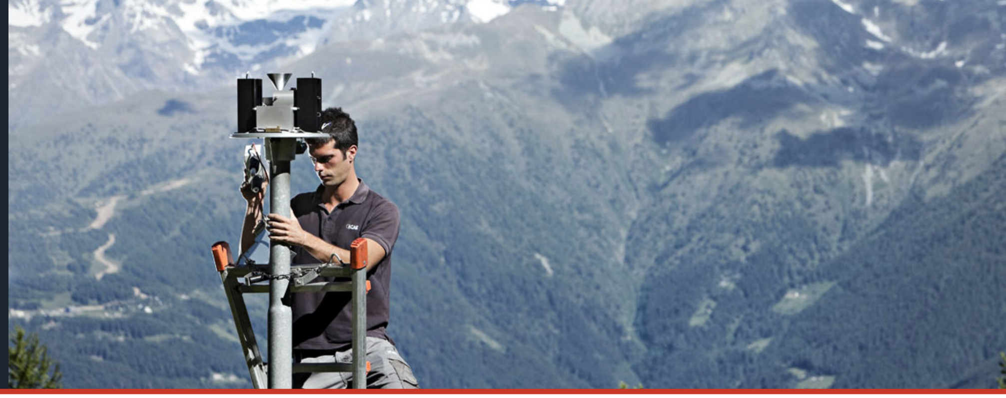
innovation for a safer world.

CAE MAGAZINE
E.V. - November 2017



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Editorial

Back from the Meteorological Technology World Expo held in Amsterdam last October, that has been a unique opportunity to see and touch first-hand the latest measurement and analysis technologies, we go on talking about technology.

CAE is born by working in the field of hydrometeorology, but today it is crucial to find a solution to face different kinds of extreme events, which unfortunately are becoming more and more frequent every day, and our company has been ready for several years to meet this kind of needs.

We will report the words of Guido Bernardi, CAE Business Development Manager, who will explain the importance of multi-hazard systems, a single technology that helps tackle drought, forest fires, landslides and floods. All the damages caused by these phenomena can be better reduced if we receive real-time information from the territory. Being able to use one single field infrastructure, the same transmission tools and the same IT equipment to handle all these measurements, calculations and information simplifies pretty much our task.

This issue will also talk specifically about the technology used to reduce the risk of hydrogeological instability. In particular, we will report the intervention of Geologist Simone Colonnelli at RemTech: "The use of the Wireless Sensor Network aiming at Emergency Management and Risk Reduction in instability scenarios: application examples, strong points and future perspectives." To find out more about this topic, we will also report an application case that will tell us more about the use of the monitoring and alert system at Castelnuovo di Campli.

Finally, we will discuss the rigorous tests to which the 0-35 m LPR radar hydrometer has been subjected. Apart from having passed the various tests internally and obtained EC and FCC certifications, the product has also been subjected to further tests in order to certify its accuracy under real conditions and at the Hydraulic Engineering Laboratory of the University of Bologna.

Enjoy your reading!

Tests certify the accuracy of the LPR Radar Hydrometer

Edited by Patrizia Calzolari

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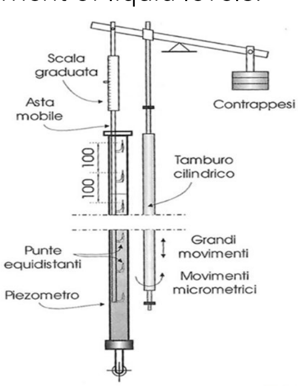
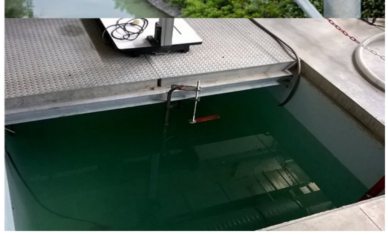
CAE philosophy has always been to do things at our best. For 40 years, quality has been our first priority and, in this regard, the tests to which our equipment is subjected are never enough. For this reason, apart from having passed the various tests internally and obtained EC and FCC certifications, the LPR Radar Hydrometer has also been subjected to further tests in order to certify its accuracy and precision as far as the measurement of liquid levels.





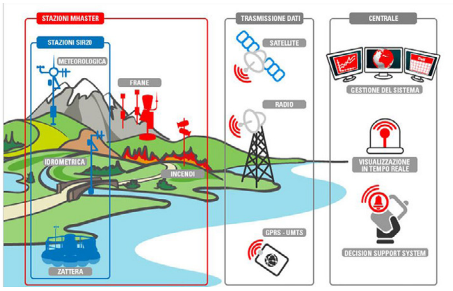
The radar hydrometer was compared to the primary system of the Hydraulic Engineering Laboratory of the University of Bologna as far as the measurement of liquid levels. The test environment consists of a calibration tank which can be filled at variable levels and equipped with a hydrometer with a multiple point rated accuracy equal to a tenth of a millimetre. Compared to other types of tests, this one has the advantage of being performed in a controlled environment, as a laboratory, but in the most realistic context possible. Actually, the instrument measured the water level and not the distance from ideal perfectly reflecting surfaces; moreover, there were reflecting obstacles in the surrounding environment. For this reason, compared to the tests normally performed on other producers' equipment, the test to which the LPR has been subjected can certainly give more realistic results.

This activity was aimed at assessing the precision and accuracy of the radar hydrometer, that is to say the measurement of random and systematic errors. The more the individual values measured under repeatability conditions are focused on the average value of the series of measurements performed, the more the measure is accurate. Accuracy, on the contrary, expresses the absence of systematic errors in the measurement process.

The results obtained essentially confirmed what the sensor data sheet stated, and showed even better performances as far as the accuracy; as a matter of fact, the standard deviation of the radar measurements performed at 2, 4, 5 and 6 metres has always been less than 1 mm (for more information, write to sales@cae.it).

In the laboratory, it was not possible to test the equipment at more than 6 metres in height; therefore CAE technicians

have integrated the tests with some field tests, under real conditions, by positioning a platform (telescopic crane) beside a lake. The tests were designed to verify the declared maximum distance of the measurement range, both in the ETSI certified version and in the FCC certified version, as well as to assess the accuracy of the sensor in terms of repeatability of the measurement. According to what emerged from the laboratory test, the results highlighted the excellent performance of the LPR, in this case also on the entire measurement range (0.5 ÷ 35 m). ■



Climate is changing. Guido Bernardi tells us how Multi-Hazard Systems allow us to optimize investments in prevention

Guido Bernardi Business Development Manager

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Why has CAE invested in "multi-hazard" technologies?
We wanted to think about the needs of Italian public authorities and to give them the opportunity to turn their investments in prevention more effective. Studies published by the World Meteorological Organization prove that the average savings produced by 1 Euro invested in the risk prevention connected to extreme meteorological conditions rage between 4 and 36 Euros during the following years, depending on the affected territory and the methodology of accounting. Apart from these economic savings, we should add an increased security for the citizens, which is important as much as it is difficult to monetize.

With the MHA technologies (Multi-Hazard System), any investment planned by a public authority in order to reduce "flood risk", which is the most common risk associated with meteorological conditions, has a positive effect on the reduction of other risks, too. Since one of the main skills of our company has always been the ability to create real-time monitoring systems for those phenomena that are traditionally associated with hydrological and meteorological fields, extending the scope of our activity to "landslides", "forest fires" and "quality of the water resource" has been a natural evolution. In times of straightened circumstances for our public authorities, investing in multi-function technologies is an important opportunity.

A single technology that helps tackle drought, forest fires, landslides and floods: how is it possible?
Locating a fire when its dimensions are still reduced, and therefore having the possibility to extinguish it with modest efforts, is now possible due to the use of high definition thermal cameras, as well as to the implementation of the appropriate algorithms. The more you are able to know in real time the meteorological conditions of an area affected by a fire, the more the prediction of how the fire front could expand in the following hours after its detection is accurate: temperature and humidity of air and soil, atmospheric pressure, rainfall and, above all, wind direction and speed. Even before the fire starts and is detected, when we are still in a phase of prevention and non-emergency management, these data provide a set of "risk indicators" that describe the probability of a combustion and the relevant danger.

With the same meteorological information, integrated with the measurements of the hydrometric levels and the flow of the water courses, you can understand flood events and, therefore, manage them. Through an adequate modelling, it is possible to understand how a river flood will evolve. In other cases, when the phenomenon is particularly fast, as it occurs to some streams in case of particularly intense and concentrated rainfall, field equipment can be programmed to make decisions based on the events, with no need to wait for human intervention, which could come too late. This logic, integrated with locally-installed technologies, allows us to activate an alarm (traffic lights, sirens, barriers ...) in case of debris flows towards an inhabited area or a flooded subway in a urban area.

Many kinds of landslides can also be "observed" in real time in order to determine both its past and prospective evolution. We will need to integrate the already mentioned meteorological measurements with geotechnical ones, collected at the site affected by the instability. In this case, even more than in the previous ones, the information rarely allows the geologist to have a deterministic and definite prediction of how the phenomenon will evolve hour by hour, but it will be possible to evaluate the hazard of an instability in a given period. Once again, we will be able to make crucial decisions for the safety of the citizens.

Therefore, it seems clear that all the damages caused by these phenomena can be better reduced if we receive real-time information from the territory. Being able to use the same field infrastructure, the same transmission tools and the same IT equipment to handle all these measurements, calculations and information simplifies pretty much our task.

We often hear about "interoperability of technologies." What does this mean for CAE and how does it affect multi-hazard applications?

In the IT field, interoperability is the ability of a system or IT product to cooperate and to exchange information or services with other systems. For CAE, it is an irreplaceable characteristic of the systems we offer. Applying physical interfaces and standard protocols, implementing widespread data recording formats, and massive implementation of web-based technologies are all designed to promote interoperability with third-party technologies.

There are many advantages that this approach guarantees to our clients. First of all, a system offered by CAE can always integrate technological components, such as already existing sensors produced by any other manufacturer. If a public authority uses MHA technologies, virtually it does not waste any of the investments it has previously made, and it is sure that the new implemented technologies will result from the integration of the best solutions on the market.

Moreover, interoperability as a wider concept guarantees a very high degree of flexibility in the architecture of monitoring and alert systems. Several organizations and bodies, such as Regional Functional Centres, municipal authorities, University Departments, and maybe even National Parks, are often involved in the management of a critical scenario. In such cases, it is crucial to make the collected data easily manageable by all the people involved. Some users may just need to check the data on a fixed location or mobile device, while others may need to integrate measures into an already existing database developed with their own technologies. Finally, someone may want to use the regional radio networks of the Civil Protection in order to increase the security and the reliability of the entire solution. Today, all this has become possible and easier thanks to interoperability.

Extending the scope of your activity to multi-hazard systems is an important step for your company. How did you prepare for this?

We have always structured our work in order to provide reliable solutions, that are especially effective in emergency situations, when meteorological conditions are more difficult. We have a department that intervenes remotely, as well as field technicians ready to move anywhere there is a system provided by our company, always 24 hours a day, 7 days a week, and 365 days a year. Even in the design and implementation of solutions we always pay attention to reliability and use technologies that are always independent from external power supply and equipped with transmission technologies that are, if possible, redundant and aimed at meeting the specific needs of our customers.

But this is not enough. Investments specifically aimed at expanding the scope of activity from the traditional "hydrometeorological" field to a "multi-hazard" one began in 2010, with a massive work on the development of the Wireless Sensor Network dedicated to landslides. Then, they continued with the launch of the "Mhas" technology in 2013, with its automatic Mhaster station, and are still continuing with many other innovations and news, that we also discuss here on this Magazine from time to time.

Since CAE's concept is to offer not just technology, but also a high added-value service, we are working hard on many other aspects: we have strengthened the team thanks to a staff specialized on specific topics; moreover, we are now equipped with specialized tools and have ongoing collaborations with companies, universities and research centres specialized in each target area. ■

Live from RemTech: "the use of the Wireless Sensor Network aiming at Emergency Management and Risk Reduction in instability scenarios: application examples, strong points and future perspectives" according to geologist Simone Colonnelli

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RemTech Esonda Expo

Ferrara Fiere Congressi
Ferrara, 20-22 Settembre 2017

REMTECHEXPO
CONVEGNI ESONDA

Giovedì, 21 Settembre 2017, 14:30 - 17:00

FRANE INDOTTE DA EVENTI NATURALI ESTREMI

I Sessione

Coordinatori:
Patrizia Ercoli *(Regione Emilia-Romagna),* ***Franco Violo*** *(CNG)*

Introduzione alla Sessione
Michele TORSELLO, *#italiasicura Struttura di missione contro il dissesto idrogeologico della Presidenza del C.d.M.*

Keynote Lecture: Previsione e monitoraggio di eventi franosi ad alto rischio
Nicola CASAGLI, *Università di Firenze - UNESCO Chair on prevention and sustainable management of geo-hydrological hazards*

Interventi di messa in sicurezza di infrastrutture strategiche danneggiate da disastri naturali
Ginevra BERETTA, *ANAS SpA*

Comportamento osservato delle dighe in occasione di terremoti storici
Rosella CARUANA, *ENEL Produzione / ITCOLD Comitato Nazionale Italiano per le Grandi Dighe*

Configurazione di scenari di esposizione al rischio idrogeologico attraverso metodologie quantitative
Pasquale VERSACE, *Università della Calabria - Consorzio Interuniversitario per l'idrologia*

Effetti del sisma sui sistemi idrogeologici
Marco MATERAZZI, *CNG - Università di Camerino,* ***Silvia FABBROCINI***, *CNG - Università di Napoli*

Le colate di detrito durante i nubifragi dei bacini montani di Parma 2014 e Piacenza 2015
Giovanni TRUFFELLI, *Regione Emilia-Romagna - OGER,* ***Alessandro CORSINI***, *Univ. di Modena e Reggio Emilia*

INTERVENTI DAL CALL FOR PAPER COMITATI SCIENTIFICI E COMITATO REMTECH EXPO

Applicazioni della Interferometria terrestre per il monitoraggio delle frane
Paolo PAPESCHI, *Boviar*

L'utilizzo dei Wireless Sensor Network nella gestione delle emergenze e nella riduzione del rischio in scenari di dissesto: esempi applicativi, punti di forza e prospettive future
Simone COLONNELLI, *CAE SpA*

Aerofotogrammetria ad alta risoluzione mediante impiego di droni
Angelo GHIRELLI, *Studio DRYOS*

Utilizzo dei palancolati per la prevenzione del dissesto idrogeologico
Matteo SAVRIE', *Elto*

VISITA ALL'ESPOSIZIONE

On Thursday, September 21st, Simone Colonnelli, Geologist and CAE Project Manager, spoke at the Esonda conference "Landslides caused by extreme natural events", at the RemTech Expo. His intervention was about "The use of the Wireless Sensor Network aiming at Emergency Management and Risk Reduction in instability scenarios: application examples, strong points and future perspectives."

The first WSN used to monitor landslides was created by CAE in 2010 inside an experimentation project carried out together with the University of Bologna. Today, thanks to further developments, that technique has been consolidated and has allowed CAE to install almost 200 knots all over Italy.

Each WSN monitoring network is part of a wider system that, apart from the field sensor network, includes:

• a main station, located outside the moving area, performing the coordination and acquisition of the field sensor network, that can integrate weather sensors, if necessary;

• one or more communication systems;

• headquarters where to check the network and display the data;

• an alarm system, if necessary.

The CAE wireless knots, that are called W-points, can be connected to various sensors located in the area to be monitored. Each knot controls the processes of sampling, registration and first elaboration of the data and it is equipped with 3 analog inputs, that can be augmented up to 12, and 2 digital input/output. Each W-Point is self-sufficient from an energy point of view and presents an average endurance of more than 10 months thanks to its pack of batteries, or a virtually unlimited endurance thanks to the Solar Pack.

All the geotechnical sensors that are commonly used in the field of landslide monitoring (for example: piezometers, inclinometers, extensometers, and so on...) can be interfaced to the W-Points. Moreover, these sensors can be supported by a RTK GPS monitoring system in order to control any possible deformation of the surface.

Apart from the characteristics of the hardware, the main strengths of this solution are its functioning logics. Particularly, we are talking about "multi-hop" systems where there is no need to configure in advance the communication paths among the various knots, because they configure automatically and dynamically, as the system is not submitted to any hierarchy among the knots. This allows us to easily modify the geometrical structure of the field network and to adjust it to the evolution of the instability, without the need to intervene in the «software» configuration, by simply moving the W-Point to where it is more necessary and, therefore, following how the emergency evolves. Moreover, the fact that the network can keep configuring itself allows the system to survive to any possible malfunction, if it has been designed with the appropriate redundancy.

This intervention gave us the opportunity to introduce the audience of RemTech to some application cases, for example the ones connected to the installations carried out in many Municipalities inside the "crater" of the latest Italian earthquake, the monitoring system for the Panaro River expansion chamber, and the ongoing project for the construction of the landslide monitoring network of the Region of Lombardia, where for the first time in Italy we can see the construction of a unique, great integrated system for landslide monitoring (to know more about the above-mentioned projects, please visit our website). The flexibility of al these instruments allows us to easily and quickly adapt to different operational contexts, as well as to efficiently meet the various needs of the clients, that go from the monitoring of adverse situations from a logistic point of view, where traditional cable-lying works could be too complex or expensive, to the activation of monitoring and alarm systems aiming at public safety in emergency situations. Actually, WSNs can be useful not only to monitor landslides, but also to handle other kinds of scenarios connected to hydrogeological risk, allowing us to reduce the risk itself and to handle emergencies. ■

This intervention has been broadcast live on our Facebook page (click here) and now it is also available on YouTube at the following link (click here)

Photogallery

A Wireless Sensor Network (WSN) for the landslide in Castelnuovo di Campli (Teramo)

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Once more, we are talking about landslides. Last February, a landslide occurred in the Municipality of Castelnuovo di Campli, in the province of Teramo. Unlike the landslide occurred in Ponzano, which was translational, the landslide in Castelnuovo di Campli caused the slope along the stream Siccagno to collapse, with a front of approximately 80 meters. That was a sudden sinking resulting from the rainfall episodes occurred after the melting of the heavy snowfalls of the last period. Because of this landslide movement, a stretch of fence of a commercial area collapsed, as well as a medium-voltage cabinet of the national electric service (Enel) that was approximately 6 meters high, two garages and a stretch of municipal street of approximately 25 meters. This dramatic situation occurred just a few meters from some houses.

After performing a Feasibility Study, CAE provided the Region of Abruzzo with a full-scale and modern “turn-key” monitoring and alert system that uses self-configuring wireless networks thanks to the WSN technology (Wireless Sensor Network). The collapse of the above-mentioned Enel cabinet caused a blackout that left all the buildings of the area without electricity; therefore, in order to face any other similar situation and avoid any possible malfunction, every element in the supplied system is self-functioning from an energetic point of view; moreover, the use of solar panels and buffer batteries allows the system to self-function up to 30 days and more.

More in detail, as far as the composition of the system, in order to monitor the micro-movements occurring deeply in the soil, we used multipoint extensometers located in inclined holes along the ridge of the southern mountainside, specifically at 12 and 25 meters in depth. As far as the surface movements, we used clinometers that measure the inclination variations of the structures where they are fixed; in detail, they allow us to monitor the inclination variations both on a single axis and on two planes perpendicular to the surface where they are fixed.

While monitoring soil movements, the system is also equipped with a thermo-pluviometric Mhaster station that allows us to associate the evolution of the instability to the rainfalls on the spot; at this purpose, we can distinguish among 3 phases:

- normality: no intense rainfalls or landslide movements have been detected;
- pre-alarm: rainfalls exceed a determi-

ned threshold of intensity, therefore the number safety measures are increased and the headquarters can send a warning notification;

- alarm: the movement of the geological sensors (significant inclinations) involve the need to send alert notifications via vocal synthesis message, SMS and FAX.

This system must guarantee the maximum level of reliability in terms of:

- availability of data: this will allow the operators to intervene in an extremely short time, in case of anomalies;

- alert in real time: when the conditions of the system change and the pluviometric and geotechnical alert thresholds are exceeded, the system must communicate via vocal messages, SMS or e-mails, with the competent Authority.

All this is possible thanks to the automatic diagnostic functionalities of the system, as well as to its duplex communication system (a GPRS/UMTS modem and a UHF band radio device connected to the remote measuring radio network of the regional monitoring service); this system sends the collected data both to the Municipal Operative Centre and the Functional Centre of the Civil Protection System. In such situations, the availability of the collected data is essential; therefore, apart from the traditional hardware and software devices, CAE provides the competent Authorities with a valid support to decision making, thanks to a data visualisation service that uses a WEB platform which is 24h mobile-accessible from an internet browser.

CAE MAGAZINE

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