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CAE MAGAZINE
n.19 · *February 2021*

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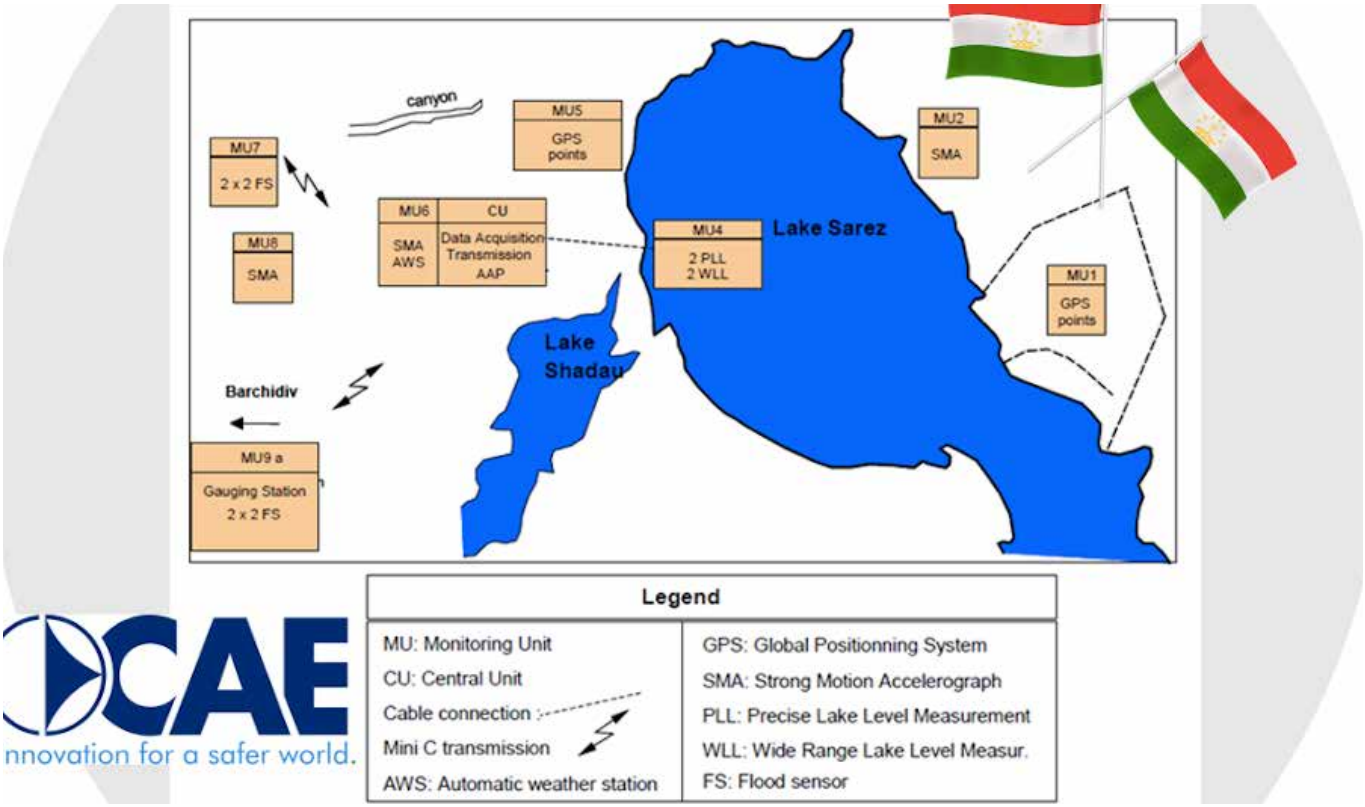
Tajikistan: Sarez Lake monitoring and early warning systems (EWS)

Sarez Lake is located in the Rushon District of the Gorno-Badakhshan province, Tajikistan. The lake was created by a massive landslide triggered by a high intensity earthquake in 1911. The landslide created the **Usoi Dam** (650m high), the **highest dam** in the world, either natural or man-made. The lake that formed behind the dam initially rose at a rate of approximately 75m/year and drowned the village of Sarez, after which it was named. The lake has no natural outlet and as a result there is concern that the failure of the rubble heap dam would have a significant impact of the habitants who live directly downstream of the natural Usoi Dam.

Within the framework of the **Lake Sarez Risk Mitigation Project (LSRMP)**, CAE and its local partner will be responsible for **a complete replacement** of the current monitoring and Early Warning System (EWS), established between 2003 and 2006, as it is approaching the end of its design life. The new monitoring and EWS is expected to protect the 17 villages located along the Murgab



river and the Bartang river and **reduce the vulnerability of the population** to natural disasters, including the **potential outburst** of Lake Sarez.

The contract scope includes the **supply, installation, and commissioning of the monitoring and EWS** that will enable real time and reliable monitoring of Sarez Lake's right and left banks, as well as upstream and downstream rivers for data gathering, Early Warning System activation and communications with required units.

The approach to the early warning and monitoring system was based on **triggering effects** and the concatenation of possible triggering events for the Usoi Dam and the Sarez Lake, respectively. The main triggering events considered were a right bank slide, an **earthquake** affecting the dam or causing an **increase in water level** in the lake, the dam overtopping by a wave due to either a **significant landslide** into the lake proper or a glacial lake outburst above the lake, and the internal disturbance of the dam. Since the 2000-2006 analysis, it has been noted that a left bank slide area in the lake has been documented as a primary concern. Most of the triggering events are not mutually exclusive. The **triggering events** to be monitored in the contract:

- Right bank slide;
- Left bank slide;
- Earthquakes;
- Lake Sarez level;
- Community EWS;
- EWS System, Communications and Data Centre (SCADA);
- Communication center at Sarez Lake and at Dushanbe.

The Sarez Lake monitoring and EWS will be composed of:

- **n.4 GPS points**: to be used for manual observations for the both right and the left bank slide;
- **n.3 strong Motion Accelerometer (SMA)**: to monitor seismic activity relating to earthquakes;
- **n.2 Sarez Lake Level Measurements**: to monitor water level and wave height by means of submersible pressure sensor, connected to one

CAE Mhaster datalogger and solar power charging system;

- **n.1 automatic Weather Station (AWS)**: to monitor local weather conditions of Sarez Lake with a complete set of sensors including thermo-hydrometer THS, rain gauge PG2, snow depth sensor ULM30/N, wind speed and direction, solar radiation, and atmospheric pressure, etc.;
- **n.4 hydrological stations** above Lake Sarez and **n.2 hydrological stations** below the lake, managed by 6 Mhaster dataloggers;
- **n.30 siren alarm stations**: composed of five-meter tower with two manually-triggered sirens, solar power, charging system;
- **n.30 portable radio and Sat-phone**: for communication between Sarez Lake and Dushanbe Communications centers and downstream Community siren control centers;
- **n.1 EWS PC-based SCADA**: equipped with CAE software suite, including DATALIFE, AEGIS, PatrolME, etc. for collecting data from hydrological stations, Sarez Lake water level, SMA and trigger alerts to communication centres;
- **n.1 drone:** for Remote monitoring of sites in the lake proper and below the dam;
- **n.1 ADCP and n. 1 salt dilution technique equipment with Surveyors Level:** for Discharge measurements and direct water level readings.

In addition to the supply of the specialized equipment, CAE will provide a **full range of services** such as project design, system integration, equipment installation and commissioning, transport, testing as well as classroom and on-site technical training, etc.

CAE will continue to update you over the next few months about the project's developments. ■

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The Region of Apulia: new landslide and sink-hole phenomena monitoring systems

During 2020, despite the difficulties due to the COVID-19 pandemic, the administration of the Region of Apulia finalized an important public tender aimed at preventing geological and hydrogeological risk.
According to the resulting contract, signed in December, CAE has committed itself to supply the required technologies and perform the services aimed at instrumental monitoring of landslide phenomena, on an experimental basis. The whole project is for civil protection purposes and the activities are closely related to the forecasting measures performed by the Decentralized Functional Centre.
The project focuses on 3 landslide sites in the Daunia Sub-Apennine (Motta Montecorvino, San Marco La Catola and A16 Candela-Lacedonia freeway); 2 representative sites of rock landslides along the coast (Tor di Lupo and Torre dell'Orso); and 1 site affected by sink-hole phenomena (Laterza).
Among the preparatory works for the implementation of technologies and the correct interpretation of the data, there will also be fieldwork, such as surveys, geognostic surveys and installation of an inclinometer tube, as well as geotechnical laboratory tests.
The project involves the delivery and implementation of several technological solutions, to be integrated into a single platform equipped with specialized software. Particularly, in the 6 landslide sites considered altogether, the following equipment will be activated:

- 6 complete automatic weather stations, connected to the control centre via GPRS, capable of managing the collection of measurements from a significant number of geotechnical sensors;
- 2 robotic total stations for topographic surveys, also connected to the control centre via GPRS;

- 19 GNSS receivers, of which 7 Masters and 12 Rovers, connected via GPRS to the control centre and in ubiquity with the industrial PCs installed on site.

Among the strengths of CAE, in addition to previous experiences in the management of this diversified set of techniques and technologies, there is the ability to automate geotechnical monitoring, both remotely and in real time, thanks to the extensive use of wireless devices. Specifically, in addition to integrating a large number of weather sensors including the PG10 rain gauge and the THS thermo-hygrometer, the aforementioned 6 automatic stations implement short and medium range radios (W-Point and Acti-Link) and thus become the centralizers able to manage:

- 9 automatic deep inclinometer chains;
- 36 piezometric cells;
- 22 biaxial clinometers for blocks/buildings;
- 22 wire extensometers for buildings with short range;
- 4 level measuring containers.

The automatic stations, equipped with Mhaster dataloggers and therefore characterized by programmability, openness and interoperability, are also equipped with an anti-theft alarm, as well as a theft detection system for solar panels.

The **Control Centre** is based in Modugno and will be equipped with a complete suite of specialized software, capable of managing all the proposed solutions. Among these software, some will be provided in OpenSource mode, complete with source code, while others will allow mobile access to data.

The Region of Apulia will therefore have almost 2 years of continuous services including **installation, monitoring, start-up and technical assistance**. This period will be followed by a 12-month **maintenance** which will be both **preventive** (with 2 visits per year for calibration and setting of the devices), and **corrective in case of need**.

As always, the service is "turnkey" and includes 24/7 remote maintenance and assistance, remote control with help desk and, in case of short-term, urgent interventions, there will be an on-site operator trained by the company. Manual inclinometer reading service is also provided for the entire period, with a frequency of 6 measurements per year. ■

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Maintenance and technological adaptation of the hydro-meteorological network of Piedmont

The weather and hydrometric monitoring network managed by ARPA Piedmont plays a strategic role in the control of the water balance and in the monitoring of the buildup of Po river's floods; it includes over 400 measuring stations to which weather and hydrometric sensors are usually connected, but also sensors for measurement of snow depth, water and gamma radiation parameters. The stations are equipped with UHF transceivers and are polled by the control centre of Turin through a chain of repeaters.

CAE has won the tender for the **renewal of the maintenance service**, which is essential for keeping the network perfectly efficient, as well as for the **technological adaptation of the stations and the connected transmission system**.

The company shares the strategic importance that ARPA Piedmont has given to the **UHF band radio communication network**, as it can be considered the only alternative capable of guaranteeing the **reliability** necessary for a monitoring and warning system for the purposes of civil protection. For this reason, CAE has always invested in this technology and has offered a transmission system with a high level of standardization and innovation, thanks to a cutting-edge product: **RCS RÆVO radio**. This product will not only allow the **reduction of the polling cycle from 30 to 15 minutes**, but it will also allow us to activate scenarios that require a **more frequent acquisition of**

data, in case of temporary needs due, for example, to hydro-meteorological emergencies.

Being a product of the **CAEtech** line, the **RCS RÆVO radio** is characterized by the use of **diagnostic** elements and by **high levels** of **standardization**; in fact, it allows **interoperability** with products of third-party manufacturers, thanks also to the compatibility with modern **IoT** protocols.

As far as CAEtech products are concerned, for any intervention of evolutionary maintenance that may be required during the contract's duration, the main technologies used will be:

- **PG10 and PG10R rain gauges**
- **ULM30 ultrasonic water level sensor/snow depth sensor**
- **CompactPlus Datalogger**

Particularly, **CompactPlus** datalogger is a latest generation product, with Linux operating system, allowing maximum flexibility in the implementation and development of **customized applications**; in order to facilitate these customized applications, the datalogger integrates and makes available a command interpreter that can use a simple language like **Python**, while for standard applications it supports **plug 'n' play** connections of the main sensors on the market. A first level of **accessibility and interoperability** provided by the CompactPlus datalogger is represented by the **presence on board of a web server**, which allows us to provide a **website** for the **display, configuration and export** of the data collected by the datalogger itself.

This is not a regular maintenance contract, but a huge and cutting-edge technological upgrade of one of the most impressive Italian regional monitoring networks. ■

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Lazio Region: green light to the evolution of the remote measurement network

The activity carried out by the Department for Civil Protection of Lazio's Region is crucial: monitoring meteorological and hydrological phenomena in progress and assessing risks associated with them, in order to coordinate emergency interventions, make warning messages circulate, arrange operational interventions, as well as store and process the collected data for climatological analysis and spread data to the public. Therefore, aiming at real-time monitoring, the remote measurement system must meet needs of reliability, robustness and operational continuity in order to comply with relevant regulations and tasks of the Regional Functional Centre.

Lazio Region has **238 automatic remote measurement stations** on its territory. There are sensors to measure many different meteorological parameters (the main ones are: rainfall, level and flow rate of water courses): in fact, as many as 200 stations are equipped with rain gauges and the network operates, as a whole, with 82 hydrometers.

Moreover, a flow detection system has been implemented on 10 hydrometric stations based on the combined use of an ultrasonic hydrometric sensor and a doppler radar sensor for measuring surface speed.

Through LazioCrea Company, LazioRegion has recently equipped itself with a digital radio communication system, homogeneous in architecture and operation, subservient to the 118 Health Emergency and Civil Protection services. Aiming at efficiency and cost containment in the long term, the Regional Department for Civil Protection has decided to use this radio communication system as a communication channel for the data of the meteorological and hydropluviometric monitoring network. Then LazioCrea Company itself run the tender procedure awarded to CAE.

Among the advantages on which the chosen architecture is based is the **standardization of peripheral radio components**, compliant with the European DMR standard, which will ensure the Administration the possibility of having a **plurality of suppliers**. In fact, the renewal of some components of the regional monitoring system allows to achieve the **aim of making the aforementioned system open**, in other words free from an exclusively owned or little-known technology, thus facilitating competition between market operators that are able to carry out activities of supply, assistance and maintenance, as well as contain management costs.

Firstly, CAE **will draw up the final design**, including all possible adjustments and variations in the making, then it will move on to the important phase of the **evolutionary maintenance** of telecommunication technologies, peripheral stations and central software and hardware.

Secondly, the **new radio network will be built to integrate the already existing regional microwave network**. All stations will be equipped with **DMR terminals**, as well as a **cellular back-up module**. Consistently, the network infrastructure will be implemented with broadcasting systems based on Trunking **DMR Tier III radio technology** in **UHF band** for radio broadcasting to all peripheral stations. Finally, with the aim of ensuring the efficiency and effectiveness of the network, the **already existing regional trunking** will be used for transport connections between the various loudspeakers and the control centre, via **standard Ethernet Layer 2 IP links**.

The **radio modem** devices will allow **transparent communication** in terms of data flows in and out of each pair of radio modems. All the protocols used, from a physical to an application level, such as USB, Ethernet, IP, UDP and CoAP, are standard protocols widely documented in the literature, and framed in the ISO/OSI model as far as standardization is concerned.

The technical choice of the **UDP transport standard**, based on **IP** standards, will also allow us to **optimize data traffic and reduce latency times**. The system provided presents a **remarkable level of innovation** thanks to the use of the CoAP, a protocol belonging to the "**Internet of Things**" family. By choosing CAE offer the Administration will have the possibility to maximize its investment, as at the end of the adaptation works it will count on a forward-looking system, which communicates not only with devices within the same network, but also with any kind of device through the logic of the Internet.

At the end of the update, all **238 peripheral stations** will be equipped with modern **CompactPlus** datalogger. This new CAE product is based on a **Linux embedded operating system and a powerful integrated webserver**, in order to guarantee not only reliability, computing power and programmability, but also **interoperability and openness**. Many other components of the peripheral stations will be updated, including all battery and solar cell power systems, as well as **45 integrated webcams**.

Another valuable element of CAE's offer is the **ad hoc creation of an information system** to support CFR (Regional Functional Centre) staff, that is to say, the development of a **new computer infrastructure** which is fully compatible with the infrastructure platform made available by the Contracting Company. Software for: network management, data's displaying in cartographic, graphic and tabular form, managing alarms and processing historical series and records. It should be noted that almost all the proposed applications have a **web-based architecture**.

During this phase of technological updating, CAE will guarantee **assistance and maintenance of the various software and/or hardware components** of the existing **hydrometeorological monitoring system**, as they are gradually updated and until of successful testing.

After the successful testing and the placing into service of the new system, a **27-month assistance and maintenance period** will begin for the entire hydrometeorological monitoring system and computer system. In addition to providing strict intervention times for blocking malfunctions, this service also provides that CAE will take care of all restoration interventions resulting from exceptional causes, such as theft, robbery, fire, atmospheric events, earthquake, vandalism, accidental damage caused by third parties or animals, turmoil, riots, acts of terrorism and sabotage.

Moreover, a particularly important phase of the project is the one dedicated to **training** the personnel assigned to operate on the proposed hydrometeorological monitoring system; this training phase is essential to make the Administration more and more autonomous in managing the various functions.

During all the activities provided for in the contract, CAE is also responsible for **any disposal of the equipment/systems** currently in use, where requested by the contracting Company. ■

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FOCUS ON CAE | Celebrating the past to look into the future: the Franco Bertolani museum

CAE was born in 1977 from the will of four electronic telecommunications engineers and researchers of the Marconi Foundation, with a very specific purpose: providing public and private bodies with the most advanced technologies for monitoring the environmental risk caused by natural phenomena.
On the occasion of the 40th anniversary of CAE, we created a company museum named after one of its four founding partners: Engineer Franco Bertolani, who passed away in August 2016 and always wanted to dedicate a space to the exhibition of items that have made the history of CAE.
Actually, today CAE is the leading Italian company in many services such as design, construction and maintenance of systems and technologies for **multi-hazard monitoring and alert**.

CAE constantly invests in the development of reliable, innovative and interoperable technologies aiming at the protection of the territory for civil protection purposes.
CAE has never backed away in case of installations in significantly inhospitable environments, such as:

- Antarctica;
- K2;
- he Capanna Margherita on the top of Monte Rosa (at 4556 m a.s.l.);
- oil platforms.

CAE has always proved to be able to intervene professionally even during important emergency situations, such as:

- the flood in Valtellina (1987);
- the landslide in Sarno (1998);

- the threat of Lake Effimero on the municipality of Macugnaga (2002) etc.

The museum was thus created to guide visitors in the discovery of CAE, starting from the milestones that made it what it is.
A space of about 80 m^2 was therefore recreated, connected to the training room, which houses about forty historical items.
The evolution of CAE has seen the expansion of the sectors of intervention where it operates.
Starting from the hydrometeorological sector, the company also dealt with the management of gates, water quality monitoring, landslides, wildfires, up to multi-hazard systems capable of integrating all the different systems in a single one that includes alert functions, too.
The museum is set to retrace the essential milestones of these first 40 years: the challenges faced and the evolution of its products.

The exhibition showcases items including peripheral stations and hydrometers, software and the latest generation technologies, without neglecting the pieces made for the calibration of the instruments and to verify the real radio coverage in the field.
Finally, moving to the adjacent internal courtyard, which is also presented as an exhibition space, it is possible to take a look at the present of CAE: visitors will be able to observe some of the main latest generation products, suitable for monitoring different types of risk and thanks to which, today as in 1977, CAE is ready to face whatever challenges may arise with enthusiasm and therefore guarantee excellence of results.
A museum is certainly not enough to enclose and summarize 40 years of intense commitment and research, but it is certainly a good starting point to arouse the curiosity of our visitors. ■

CAE MAGAZINE

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https://www.cae.it/eng/magazine-hm-30.html?mId=81