innovation for a safer world.

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Peru: monitoring and managing water resources of seven dams

"Peru Integrated Water Resources Management in Ten Basins Project – IWRM" is a project funded by the World Bank to strengthen the capacity of targeted water resources management related institutions to plan, monitor and manage water resources at the national level and in selected river basins in Peru.
Within the framework of this project, the Consortium of CAE and its local partner has signed the contract with the National Water Authority of Peru – ANA *(Autoridad Nacional del Agua)* for the **Supply, Installation and Commissioning of the Water level sensor for the Reservoir, Rain gauge and Data transmission system via GOES Satellite.** The contract aims at guaranteeing an adequate monitoring and safety management of seven prioritized dams, including Poechos, San Lorenzo, Tinajones, Gallito Ciego, Condoroma, El Frayle and Pasto Grande dam.
The selected dams, which are considered enormously important for storage and regulation of flows for irrigation and consequently for their economic importance for the Country, deserve special attention with regard to their monitoring and maintenance.
The contract involves the "turnkey" supply of **7 automatic dam monitoring stations**. Autonomous from the main power supply, these stations will be powered by a solar panel and backup battery. Each station will be equipped with CAE state-of-the-art technology:

- **COMPACT PLUS Datalogger**: based on embedded **Linux operating system** and equipped with an interactive **web server** on board;
- **PG2 Rain gauge**: tipping bucket rain gauge with measuring range **up to 1200 mm/h.** Classified as **Class A** according to the new **UNI EN 17277:2020** standard;

- **WLR/L Water level sensor**: based on radar technology;
- **ACTI-LINK Communication device**: dedicated to remote activation of monitoring and alert system components;
- **GOES Satellite Transmitter**;
- etc.

The data acquired at the stations will be sent to the main **ANA Data Center** by means of **GOES satellite transmitters**. CAE will be responsible for the installation, configuration and start-up of all the equipment of the GOES satellite data transmission system, which will communicate with the ANA Satellite Earth Station.

CAE's Consortium will provide a **complete range of services** such as civil works, installation, system integration, commissioning and training, etc.

This is the second project for dam monitoring of CAE abroad. Last year, CAE completed the **Monitoring and Early Warning System for Jinvali dam** in Georgia. The project gained the satisfaction from the client "Georgian Water and Power" - GWP (Click here for further information). ■

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CAE wins the leaderboard of HydrometLATAM Virtual 2021

Due to the COVID-19 pandemic, many events and exhibitions in the hydrometeorological sector have been cancelled or postponed. But even in these uncertain times, CAE keeps moving forward with several digital initiatives, among which **HydrometLATAMVirtual 2021** - a 100% online event for weather, water and climate professionals in **Latin America**.

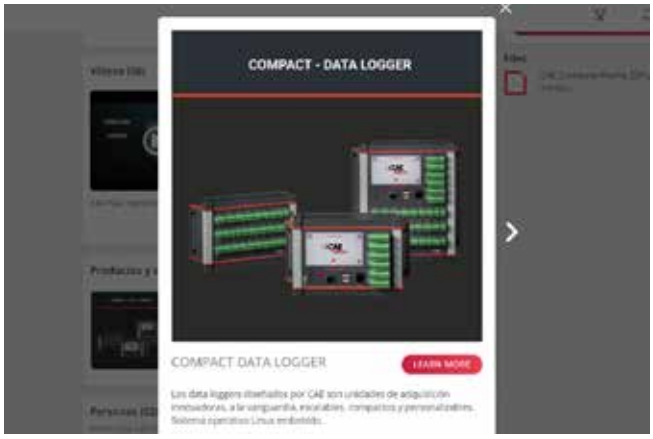
HydrometLATAM Virtual 2021, held from **March 16 to 18**, is the first of its kind in Latin America and hosted more than **858 participants** from the region's **National Meteorological and Hydrological Services (NHMS)**, governments, NGOs, experts from the private sector, academia, etc. While travelling is still severely restricted, the event brought together an audience from different countries into a unique **virtual platform** and helped develop a common understanding between public and private sector in terms of their priorities and partnership needs.

The virtual event encouraged the interaction between the participants by providing a leaderboard game through the platform. And after the 3-day symposium, **CAE's International Sales Team won first place with 4.300 points**, becoming the most dynamic participant of HydrometLATAM Virtual 2021.

From Physical to Virtual:

The global pandemic has a significant impact on business and our everyday way of life, but in another hands, it accelerates digitalization and business networking innovation. "*Going virtual not only allows us all to continue to operate during the pandemic, but we can also reduce the cost of our operations - in financial and environmental terms*", said the International Networking Agency **Varysian**.

Thanks to the **revolutionary online platform**, HydrometLATAM Virtual 2021 represented the place for constructive conversation and debate around building resilient hydromet infrastructure, improving data, developing partnerships, working with



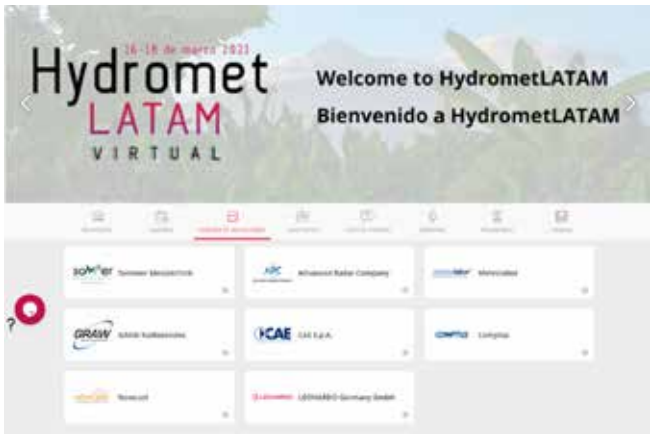
stakeholders and understanding the current key themes promoted by the WMO, including Public-Private Engagement (PPE).

The platform interface is very **user-friendly** and **easy to navigate**, even for the first-time user experience. The platform provided many relationship-oriented features including conversation, round-table discussions, one-on-one meetings and a networking lounge.

The event was the chance for the global hydromet community to join webinars held by the most relevant speakers coming from **WMO**, National Meteorological and Hydrological Services of countries such as **Chile, Peru, Argentina, Brazil**, etc.

CAE's Solutions Centre

By means of a "virtual booth" feature called Solutions centre, CAE showcased the latest range of hydromet technologies and services to mitigate the impact of natural events.



CAE's Solutions Centre was visited by nearly **300** attendees. In only 3 days, the introduction video of CAE prepared for HydrometLATAM Virtual 2021 got more than 100 views from all around the world and once again confirmed the success of this 100%-online event.

For whoever missed the 3-day Summit, the platform will be accessible for 2 weeks after the event. For more information, click here. ■

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Val d'Aosta - Free surface channels and innovative monitoring systems

The main mission of the Compagnia Valdostana delle Acque (CVA) is the production of clean energy, while sustainability is its tangible commitment to the well-being of people and the environment. This company transforms the power of water, sun and wind into 2.9 billion kWh per year, preserving the territory and the natural ecosystem.

Among the company's main assets, there are canalizations and **hydroelectric power plants** managed and designed to use and enhance water resources in mountain areas, as a result of an unbreakable bond between man and water from which the electricity arriving in our homes is generated. This relationship, rich of history, culture and mutual respect, and which for some years has also involved CAE, combines the generation of energy with the constant protection of the Alpine environment.

The monitoring systems, aimed at keeping the water level under control along the channels conveying the resource to the hydroelectric power plants, were installed on two specific plants: "Chavonne" and "Hône 2".

The Chavonne run-of-the-river power plant went into operation in 1922. Unlike what would be expected, it is not located near the riverbed, but halfway up the slope in order to discharge the swirled waters into the derivation channel of the Grand Eyvia power plant, for the benefit of the latter and the Aymavilles plant. The Chavonne power plant derives its waters from the Grand Eyvia, to which the waters of the Nomenon and,

subsequently, those of the side valley of the Savarais are added, through a long tunnel. The Chavonne plant produces renewable hydroelectric energy and is capable of delivering 7 m^3 per second to the 5 Pelton turbines installed, reaching a total power of 27 MW altogether.

The run-of-the-river hydroelectric plant of Hône 2, located in the homonymous municipality, is characterized by a 12,830 meter long derivation channel, built halfway up the slope following the contour lines of the steep sides of the Ayasse stream valley. Some sections of the channel were built in a tunnel to overcome the precipices of rock and, at the same time, to protect it from landslides and avalanches. The plant uses the energy of the water coming from the streams of the catchment basin. During the winter, the waters released by the Miserin and Vercoce lakes are added. The hydroelectric power plant is equipped with three Pelton turbines with a flow rate of 2 m^3 per second. This equipment guarantees the plant a total power of 11 MW.

The correct functioning of these two plants is closely related to the good health of the approximately 30 kilometres of free surface and partially covered channels which flow from and towards the plants. CVA has always paid a lot of attention precisely to these infrastructures, with significant and continuous investments, as well as monitoring and maintenance programs. CAE's contribution is aimed at strengthening these activities, with the preparation of near real-time hydrometric monitoring

spots along these channels. In this perspective, the company considered essential to have an adequate volume of data on water levels in the channels along their entire path.

Between November 2018 and November 2019, for each intervention site the following activities were carried out:

- specific operational surveys to verify installation conditions;
- communication tests with **CAE ACTI-Link** radio modules, wireless technology, as well as the automatic stations provided;
- check of **UMTS/GPRS signal**, to allow remote viewing and transmission of data to the Control Centre located on the regional territory.

Both for the Hône 2 intake channel and the Chavonne channels, all required adjustments were carried out following the above-mentioned tests, and the piezometers were installed during the maintenance and emptying procedures of the channel.

Altogether, for these two projects the following equipment was therefore installed:

- n. **33 measurement spots**, for the acquisition of the **water level** through piezometric measurements using **PLM10 sensors** and **ACTI-Link modules** for **wireless** connection of the measurement spots, as well as the intake structure and the Control Centre;
- n. **4 Mhaster datalogger acquisition stations** with solar panel and backup batteries, two for each plant, capable of **wireless** connection to each of the measurement spots.

Completing the technological monitoring equip-

ment provided by CAE to CVA, there are also 2 automatic thermo-pluviometric stations, installed near Poignon and Fenille.

The CVA **Acquisition Centre** collects data via **routers** through the use of **DATALIFE software**, for the acquisition, management, communication and interaction via GPRS between the various components of the monitoring system provided by CAE.

The **displaying** of the collected data is available on site on the **station's LCD screen** or remotely via the **Web Server** installed on each data-logger, as well as remotely and on an aggregated basis via **AEGIS**, a web based software which is accessible and compatible with the most common browsers upon authentication and which allows the **geo-spatial representation of the information from the monitoring and early warning system**. DATASCAPE also operates in the same control unit for Open data sharing with standard interfaces based on Web Server with RESTful technology.

Completing the set of specific software for the monitoring systems, there are also tools for setting thresholds for each individual measurement spot, through a specific section of the website included in the Mhaster station. Data can in fact be collected in order to analyse **trends** and ensure that the **water level** is below a certain threshold. If the pre-established **threshold** is exceeded, signals can be triggered via notification or SMS.
Moreover, **2 workstations** are also provided for data acquisition and display, one in Châtillon at the CVA Civil Engineering offices, and the other one in Chavonne at the hydroelectric power plant.
From December 1st, 2020, CAE has been carrying out **maintenance on the hydro-meteorological stations** located in the high mountains in the Autonomous Region of Valle d'Aosta.
In this regard, CVA chose CAE not only for the unquestioned quality of its equipment, but also because it has already tested our company's efficiency in corrective and preventive maintenance, as well as for the guaranteed 24/7 assistance we offer with specialized technicians, both from remote and on field.
To keep the system going in the best possible way and to limit malfunctions, CAE offers 12 months warranty, including materials and labour force for all failures caused by manufacturing or installation faults. ■

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“Sensor integration” for a safer world: the results achieved by CAE and Fondazione Politecnico

CAE specializes in warning systems capable of mitigating risk by activating local alarms or reporting more or less impending dangers to the relevant authorities. The integration of these local systems with networks that are better distributed from a geographical point of view, such as those relating to the Decentralized Functional Centres of the Regions, implies a great added value for all levels involved.

In order to strengthen its offer and provide increasingly effective solutions, suitable for specific risk scenarios, CAE has decided to invest in research and to involve the “Fondazione Politecnico” in the ambitious project entitled “L-Link2, a research project aimed at strengthening the management of local emergency activities”.

In terms of product, the aim of the project was to make available ***market ready*** models integrating data from multiple sensors of different classes. That is why two computational products have been developed: “Smart Slope”, related to the trigger thresholds of superficial gravitational instability, and “Smart Channel”, related to real-time control of the operation of free surface channels.

The working group of the Polytechnic of Milan, coordinated by Prof. Giovanni Menduni as research manager and including Eng. Ilaria Boschini, Eng. Federica Zambrini and Eng. Manuel Bertulessi, was involved both in the studying and in the field phases for almost two years. In order to test the solutions to be developed, the team also worked on real application cases. Particularly, the team used data and information kindly granted for research purposes by the Società Valdostana delle Acque (Water Company of Valle d’Aosta) and the Region of Valle d’Aosta.

One of the innovative elements of the whole project was the use of the ***sensor integration*** logic

scheme; its application and evolution can reach levels where an intelligent system, equipped with different sensors, can interact and operate in an unknown environment and in ongoing evolution without any human control. Where the space of action is not known in advance, the sensors can investigate and continuously update the model of the surrounding environment. This is a relatively recent subject and in the last few years there has been growing interest in the synergistic use of multiple sensors in order to increase the capabilities and possibilities of intelligent machines and systems.

The intake channels connected to hydroelectric plants are often installed on inaccessible slopes, characterized by critical hydrogeological conditions and at altitudes that could become inaccessible in the winter. Therefore, surveillance of this kind of critical infrastructure is difficult and remote monitoring is required. The need for monitoring this type of linear infrastructure is an emerging topic and a product called "Smart Channel" has been developed from the research project.

The conceptualization of the channel is entrusted to a varied motion model integrated with the complete De Saint-Venant equations, according to an implicit scheme. This issue is addressed through the ad hoc development of a specific calculation code. The output of the mathematical model, implemented with adequate boundary conditions, provides knowledge of the normal operating state of the channel and, therefore, allows to evaluate the deviation from the actual operating state by comparing it with the data acquired by the instrumentation.

Therefore, ***data integration*** allows the operator to obtain a decision-making support tool for the plant control. This system allows to identify and localize structural problems of the channel, such as breakages and landslides of the bank, or the presence of foreign bodies obstructing the flow. The operator can then decide if and how to intervene, assessing the danger of the anomaly, as far as production is concerned, and the possible development of risk scenarios in the area. Let's consider, for example, a leakage of the channel which can lead to the imbibition of the slope downstream of the channel itself and, consequently, to a surface landslide.

The "Smart Slope" product, as it has been conceived, is capable of providing information regarding the safety of people, buildings, infrastructures and therefore it is undoubtedly useful in the field of civil protection and in the management of critical infrastructures. The integration of the spatialized hourly rainfall data on a statistical surface with a mesh of dimensions equal to those of computation for the debris layer equilibrium model allows to obtain a system capable of predicting the evolution of soil saturation in areas that are particularly subject to gravitational phenomena of the surface layers.

"Smart Slope" allows to assess the predisposition to trigger surface phenomena related to the rainfall recorded by the measuring instruments installed near the area. The product includes a consulting body for problem analysis, a set of sensors and the related transmission system, the acquisition of geometric/topographical data to support the model and a customization of the software for the examined case, as well as the customization of the display dashboard.

The instrument is particularly suitable for mountain areas characterized by steep slopes and not too high altitudes, where gravitational instability of the debris layer is a strongly present phenomenon. ■

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Umbria, a future-oriented region

It was back in 1639 when, in the **Monastery of San Pietro in Perugia**, Father Benedetto Castelli, according to the monastic "ora et labora" (pray and work) rule and enlightened by the teachings of Galileo Galilei, designed and conceived the first meteorological station with a **rain gauge** system: a sort of "pot" for collecting and measuring rainwater. Afterwards, the Father himself also performed interesting studies on water flows, that is, on the quantity of water that a river can carry.

It was also thanks to the collaboration with Father Castelli that Galileo came up with the invention of the thermometer and the enunciation of the principle of mechanics. Another pivotal event was the invention of the barometer by Torricelli, one of Father Castelli's disciples.

Much later, in 1983, the Water Resources and Hydraulic Risk Service of the Regional Hydrographic Service of Umbria was among the very first bodies in Italy that started the installation of an automatic hydrometeorological monitoring network with real-time operation, integrating therefore the activities of the National Hydrographic and Oceanographic Service.

CAE, which was the at the centerstage of the upgrade taking place in the early 1980s, has now proudly won the tender for the three-year **ordinary and extraordinary maintenance**, as well as the works for the expansion of the environmental monitoring network for civil protection purposes.

More specifically, during the maintenance period all system components will be substantially upgra-

ded: sensors and automatic field stations, equipment and transmission network, software, servers and clients.

In 106 automatic remote measurement **stations**, in addition to the renewal of solar panels, the existing dataloggers will be replaced with the innovative and performing **Compact Plus** dataloggers, which are programmable, user-friendly and powerful thanks to the openness of their software and the use of standard protocols.

As far as the replacement of **sensors**, there will be adaptations for:

- **water level sensors**, from ultrasonic to ultra-modern **WLR/L radars**;
- **rain gauges**, replaced by **PG10 and PG10/R** with Zero Breakdown Technology;
- **snow gauges**, replaced by modern CAEtech **UL-M30/N**;
- **existing thermometers and hygrometers**, replaced by the more efficient **THS thermo-hygrometers**;
- radiometers;
- **anemometers**, replaced by **DV20/VV20**;
- new image modules.

At the end of the expected upgrade, all the remote measurement stations will be equipped with both the RCS RÆVO radio and a module capable of using the existing mobile networks. The dual transmission system will guarantee the maximum reliability, allowing full access to the field equipment. However, it is thanks to the new radio designed by CAE that the network will be able to significantly evolve in terms of acquisition speed and protocol standardization. In fact, in addition to being extremely performing, the new device will transmit messages processed with several protocols, among which standard IP ones, such as CoAP, that will be implemented in the Regional system of Umbria.

At each measurement station, on the 11 repeaters of the regional system and at the Perugia power stations, the radio transmission modules will therefore be replaced with new **RCS RÆVO** radio modules.

At the regional headquarters of **Perugia**, the construction of a new **primary network control centre** is also planned, based on a highly redundant 3-knots cluster server, on which a new generation of application SW will be installed, such as the powerful front-end **Datalife**, a potent tool for complete management of network stations and field repeaters, and **AEGIS**, a fully web-based platform for the cartographic and tabular analysis and display of the collected data.

Also at the client level, the CAE proposal provided for the supply of new high-performance **workstations** with high resolution **triple monitors**, new **dual-monitor notebooks** equipped with mobile routers and new **tablets** with the **DroidMAPS** app, capable of ensuring **interoperability** and full usability of data also **"on-the-go"** and outside the Perugia control centre .

In order to further increase system safety in all operating conditions, the CAE proposal will provide for the supply of a **second Disaster Recovery control centre**, to be installed in a geographical location separate from Perugia, that is the **Regional Functional Centre of Foligno**.

In normal operating conditions, this control centre, equipped with the same Datalife and AEGIS software as the primary centre, will constantly receive network monitoring data from Perugia and, in the event of a fault in the latter centre, will take over the management of the entire monitoring network, ensuring therefore continuity of service to all users connected to it.

The maintenance service offered is, as always, "turnkey", including precise guarantees on the availability of data in any weather situation and including 24/7 remote maintenance and assistance, with calibration and revision of the sensors at each scheduled or corrective maintenance intervention.

In this regard, the maintenance portal will also be updated: this is the tool through which all the activities carried out in the field and at the control centre are documented and available for consultation, in order to ensure the correct functioning of the equipment. ■

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