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Early warning system (EWS) in City of Užice, Serbia

The City of Užice experienced **several historical floods** and suffered great damage from **torrential precipitation** and floods over the last 10 years. Located at the confluence of different basins representing a direct threat to the population, the implementation of an **Early Warning System (EWS)** is of primary importance for the City of Užice, to ensure the flood defense of the entire catchment area of the Skrapež river and of Požega and other cities downstream of the river Zapadna Morava.

Within the framework of the **Municipal Disaster Risk Reduction Project (MDRRP)** in Serbia, the **Procurement and Installation of the Equipment for Early Warning System in City of Užice** financed by Swiss Government on a grant basis has been entrusted to the Consortium composed by CAE and its historical serbian partner.

The Early Warning System consists of different types of automatic stations: **hydrological, meteorological, climatological** and **precipitation** stations.



All the supplied equipment will be cutting-edge, resistant to external atmospheric conditions, easy to operate and fulfilling all WMO requirements, such as the **MHASTER** Datalogger, the **THS** Air temperature and relative humidity sensor and the **ULM30/N** Snow Depth Sensor.

Considering that for the City of Užice, the flood early warning system must be an independent system, the Consortium will provide a specialized software package which will be installed on dedicated servers in Užice and connected to all stations in the territory. The package is composed of the powerful **DATALIFE** - SW for **system management and control**, **AEgis** – new web-based SW for **data visualization**, **PatrolME** – SW for **automatic remote alarm 24/7**, etc.

By installing such software, Užice will gain decision making priority over other municipalities and cities

in the Zapadna Morava basin, that is, it will become the Regional Center for Flood Waves Monitoring for this basin. Other municipalities and cities will be able, in the future, to connect to the same system.

The system will be composed of:

- 1 meteorological station;
- 3 climatological stations;
- 3 precipitation stations;
- 3 hydrological stations;
- specialized software package: system management and control, data visualization, remote alarm.

The CAE's Consortium will provide not only the equipment for MDRRP - Early warning system, but also high value-added services, such as construction works, installation, commissioning, calibration of EWS as well as staff training and warranty service. ■

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Interoperability beyond all limits: Compact Dataloggers



Compact line's products are **compact, open and customizable** and use the most popular scripting languages, such as Python, C, Shell Script, etc. These products are equipped with an on-board web server guaranteeing maximum interoperability.

Its powerful hardware is based on a **Linux embedded** operating system (Kernel 4) which guarantees flexibility and user-friendly graphic interface and, at the same time, is able to manage very complex algorithms, such as those necessary for alert functions.

Moreover, thanks to its **low consumption, small size, modularity and scalability at the hardware, software and installation level**, it meets the needs of different application scenarios: from local

warning systems, to large distributed monitoring networks, up to the creation of Multi-HAZard Systems (**MHAS**).

At the Hardware level, Compact is divided into 3 modules:

- **Compact**: digital acquisition unit;
- **Compact Plus**: acquisition unit for analogue and digital sensors;
- **Plus**: expansion for analogue and digital sensors.

CompactPlus has more than 50 inputs/outputs; connecting several modules together, in wired or wireless mode by means of serial remote control devices such as **ACTI-Link**, it is possible to meet a virtually unlimited range of needs. ■

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PG4i, a “Made in Italy” solution appreciated all over the world



PG4i are autonomous rain gauges with a collection surface of 400 cm² which, thanks to an integrated 3G modem, are able to measure, locally record and autonomously send data relating not only to **accumulated rainfall**, but also to its **intensity per minute** to an FTP server, all without any connection to an external datalogger.

This new stand-alone sensor, designed to facilitate a distributed, high-density monitoring of rain measuring points, was born in 2019. In order to verify the functionality and robustness of the first prototypes, CAE has launched a structured campaign to test them. Some organizations, including Italian universities and administrations which are particularly active in the field of rain measurement, have

made agreements with our company and participated in the test campaign.

The **Consortium for Parma's Land Reclamation** is one of the organizations that carried out these first tests. It is also thanks to the resulting technical contributions that the PG4i project has gradually improved, becoming therefore a finished product. Among the first to adopt the innovative instrument, were not only the Consortium itself, but also several other administrations in Italy and abroad, which have kindly provided the pictures accompanying this article.

The new PG4i have found wide application both in the monitoring network of the Hydro-meteorological Institute of the Republic of **Serbia**, and in the



local Early Warning system of the **City of Belgrade**. The stand-alone sensor has proven to work well also in the **Maldives islands**, in completely different environmental conditions than in the Balkans, and where it provides information to the Maldives Meteorological Service network.

Thanks to the efficient on-board controlling electronics, the intensity of rain, calculated by the instrument on the basis of the tilting of the balance, indicates the **real intensity** of rain for each minute, expressed in mm/h and with a final resolution of 0.1 mm/h.

The **maximum error** of our products, in their standard version, **remains below 3% up to 350 mm/h, below 5% between 350 and 500 mm/h, and below 10% between 500 and 600 mm/h.**

At customer's request, it is possible to select even more performing products, as they all are "Made in CAE".

Overcoming one of the limits of weighing rain gauges, PG4i rain gauges measure with precision from

the first minute following the detected phenomenon and are therefore especially suitable for timely measurement of rainstorms.

PG4i rain gauges produced by CAE are compliant to **"Class A"** according to the **UNI EN 17277:2020 standard** and therefore are the best available on the market for such equipment.

PG4i are particularly easy to maintain due to their self-emptying tilting technology and redundant reeds. They can report possible malfunctions before they cause the interruption of the measurements thanks to innovative built-in diagnostics aiming at checking:

- the clogging of the funnel that conveys the water to the moving parts;
- the correct angle of the instrument mouth with respect to the ground: "electronic bubble level";
- the correct functioning of the sensing elements (reeds) counting the movements of the moving parts;
- the good condition of the tilting and moving parts.



Thanks to the **low consumption, standard batteries** guarantee **uninterrupted operation** for very long periods of time and, at the same time, highly simplify installation operations. PG4i do not require solar panels or mains electric power supply.

PG4i are **simple and intuitive**: you just have to insert batteries and register on the website <http://support.cae.it> to start receiving data.

Rain gauges can also be customized and **configured** via **web** or **locally** by physically connecting to the tool.

Customizations include:

- FTP service;
- 3G connection service;
- mode and frequency of sending data.

In 2020, **UNI EN 17277:2020 standard** became part of the European regulations for the sector. A result of the experience gained by the Meteorological Service of the Italian Air Force and the

University of Genoa in the context of the World Meteorological Organization (WMO), it represents the first European reference for defining the performance of data collecting rain gauges.

In order to carry out and certify an effective and correct calibration of its rain gauges according to this standard, CAE was the first to produce an "automatic" **calibration machine** for data collecting rain gauges, which incorporates what the UNI EN ISO 10012: 2004 standard specifies.

It is therefore possible to check and calibrate the rain gauge with constant flows at various rain intensities, as required by the standard. This device allows CAE to certify the rain gauges placed on the market (with a specific calibration certificate), guaranteeing its customers the certainty of purchasing a certified product of high quality, precision and reliability. ■

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CAEtech rain gauges: maximum accuracy up to 800 mm/h intensity



Since 2012, CAE has been among the first companies to equip itself with procedures and facilities to certify all rain gauges within its production in Class A, according to the requirements of the Italian standard which, at the time, regulated the certification of accuracy of rain gauges with special reference to the measurement of rainfall intensity.

Today, following the example of what has already been achieved in Italy, the European standard UNI EN 17277: 2020 was established. The different accuracy classes to which the various instruments can be certified remain substantially identical: there still are 3 reference classes which are called A, B and C.

The methods for certifying sensors in the various

classes are similar, albeit slightly stricter in the European version. The company is proud to announce that all our rain gauges can be certified in Class A according to the new standard too, where the maximum errors in the measurement of intensity on a 1 minute scale are less than or equal to $\pm 3\%$. In the same period, thanks to modifications carried out on the equipment used and the redefinition of test procedures, the actual operating ranges have been verified and extended for all the rain gauges produced by CAEtech, with the relative error values. The strict tests performed show that the rain gauges of the PG10 line and those of the PG2 line, with a collection surface of 1000 cm² and 200 cm², guarantee a maximum error below 3% of the mea-

surement, up to 800 mm/h and 700 mm/h of rainfall intensity respectively.

The innovative **PG4i** stand-alone rain gauges, with a collection surface of 400 cm² and resolution up to 0.1 mm, guarantee an error of less than 3% of the measurement up to 350 mm/h of rainfall intensity.

The tests performed have also shown that, since the products are “Made in CAE” and can be customized and selected on request, it will be possible to meet any requests for instruments with even greater range and performance. ■

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Landslide monitoring system maintenance in Lombardy



The Geological Monitoring Centre (CMG) of ARPA Lombardy in Sondrio has launched a tender, won by CAE, for the biannual maintenance of the geological monitoring network spread throughout the Lombardy Region. The implemented solutions make extensive use of wireless technology, partially installed by CAE itself during Armogeo project. Since 2015 and through **Armogeo project**, the Geological Monitoring Centre (CMG) of ARPA Lombardy has been monitoring over 31 of the main landslides in Lombardy, many of which 24/7 and in real time. The basic technologies of these systems include clinometers, inclinometric chains, piezometers and many other sensors connected to automatic stations via local systems of redundant wireless knots: the now consolidated **WSN (Wireless Sensor Network) technology based on W-Master and W-Point**.

This extensive network, which also includes 22 au-



omatic weather and hydrometric stations, provides ARPA and the relevant bodies with important data useful to monitor the evolution of water and hydrogeological instability phenomena, as well as to support the **decision-making of the institutions responsible for the management of the civil protection alert procedures** in case of landslides.

CAE will therefore carry out planned preventive maintenance and timely corrective and updating



interventions, verifying the functionality of the transmission and acquisition devices, replacing or adjusting any wearing component, ensuring the correct functioning and continuity of transmission of geological monitoring data, as well as providing an annual satellite back-up of data acquired via GSM/GPRS and radio.

For a more careful monitoring of **ultrasonic snow depth sensors** and **rain gauges**, the installation of 10 additional cameras is also planned, in addition to the maintenance of the existing ones, which will be remotely controlled as usual by the CMG through the ARPA network.

Finally, in addition to the ordinary and extraordinary unlimited maintenance of the entire network, if the Region of Lombardy deems it appropriate, there will be the possibility of further implement the network with new WSN W-Master and W-Point monitoring stations with **open and interoperable technologies** to ensure maximum integration.

With this project, the first of its kind in Italy and in Europe, the CMG has created **the largest integrated and redundant regional remote sensing network for landslide monitoring** which participates in ensuring the safety of Lombard citizens, by sharing data with the competent authorities. ■

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Managing Editor: Guido Bernardi

Editor-in-Chief: Enrico Paolini

Editorial Staff: Simone Colonnelli, Riccardo Galvani, Tran Thu Trang, Virginia Samorini, Emanuela Pedrini

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