innovation for a safer world.

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INDEX

4560 m asl: Capanna Margherita the highest observatory in Europe

At the over-century-old Capanna Margherita observatory, the highest in Europe, an automatic station supplied by CAE to ARPA Piemonte has been operating since 2002. For the video, click here. **High mountains** are particularly sensitive to **environmental transformations** resulting from ongoing **climate change**: even small **temperature** variations cause the **snow**, **ice** and permafrost distribution to rebalance, which in turn affects the **stability** of **slopes** and rock faces at high altitudes. Measuring meteorological parameters in these situations is also aimed at studying the cryosphere and mid-troposphere.

In Italy, and more precisely at **Capanna Margherita** on Punta Gnifetti, we have the **highest physical-meteorological observatory in Europe**, which houses the **second-highest meteorological station in Europe** on its roof at **4,560 m above sea level**. The station was **installed in 2002 by CAE for Arpa Piemonte** and is equipped with a precision **barometer**, **thermometer**, **anemometer** and two **radiometers** to measure global radiation and UV radiation. These sen-

sors are designed and built in such a way that they can withstand **extreme weather conditions**, such as those found at high altitudes.

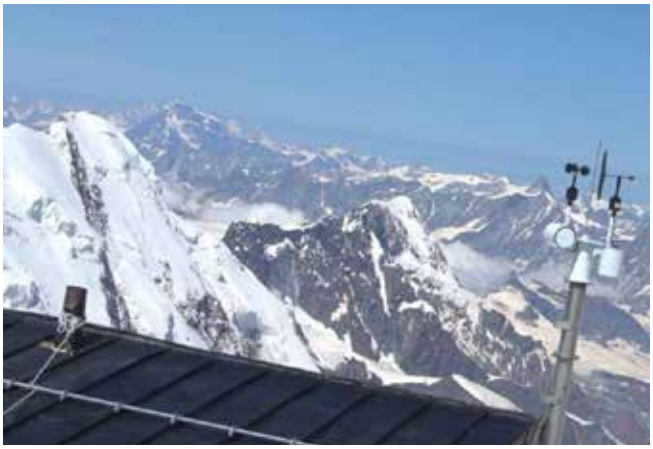
The data recorded by the station is representative of weather conditions on a synoptic scale. Thanks to the high acquisition frequency, the data recorded at Capanna Margherita is a useful tool for studying the interaction between air masses and the Alpine chain, and some particular phenomena that these interactions can lead to, such as foehn events.

Since 2002, data from the weather station has been recorded all year round and shows a **clear upward temperatures trend**, especially in 2023, the first period in which Tmin > 0 °C was recorded, a condition that lasted from 4 to 8 September 2023.

TRIVIA

Capanna Margherita was inaugurated in September 1893 in the presence of Queen Margherita of Savoy, and then entirely renovated in 1980. It is of great historical importance from a scientific-meteorological point of view, as meteorological has been collected there during the summer months since the early 20th century.

Source: ARPA Piedmont https://www.arpa.piemonte.it/scheda-informativa/capanna-margherita-losservatorio-fisico-meteorologico-piu-alto-deuropa



Capanna Margherita, the highest observatory in Europe and the second-highest meteorological station in Europe. For the video, click here.

Video of the station installation at Capanna Margherita in 2002, click here. ■

BACK TO INDEX

Water and agriculture in Greece: 6 new automatic stations

CAE is supporting a leading Greek company by supplying it with 6 weather stations, which can be managed on the move and that implement warning schemes.
The stations are part of a larger agro-meteorological project in which the data collected will feed dedicated irrigation software to better manage crops while safeguarding water reserves. The stations will be installed in the municipalities of Livadeia, Veria and Eordaia, and will be equipped with:
Compact Plus datalogger;
PG10 rain gauge, the heated version in 3 cases;
THS thermo-hygrometer;
Barometer;
Radiometer.

Each station will be powered by a **solar panel and battery**, will record **data** in **.csv** format and then send it via **ftp** to the server desired by the customer, thanks to the mobile communication system with which each station is equipped.
The CompactPlus data logger is designed for easy **reading and handling in any operating situation**. In addition to sending the data acquired in a standard format at scheduled times to an FTP server provided by the customer so that a simplified first-level control centre can be created, the datalogger is equipped with a **public website** subject to authentication, so that the datalogger can be managed (display, configuration, export) “on the move”. Moreover, a GUI is available: a graphic in-

terface on the LCD graphic display of the datalogger, to manage it directly on site.

The CAEtech CompactPlus datalogger can also be programmed to implement **warning schemes**. Specifically, complex alarm conditions can be based on various data types (sampled data, logged data and diagnostic data). After detecting an alarm condition, **a sequence of preset operations can be performed automatically, such as sending a warning message** and changing the operating scenario, i.e. changing the times for measuring, recording and transmitting sensor data in order to have **more data in a warning condition**, as well as **being able to independently take specific actions such as turning on a traffic light or lowering a barrier.**■

BACK TO INDEX

Innovation: testing is underway on the local warning for very small basins, where buried rivers and streams are a danger

We have already had the opportunity to explain how important monitoring small basins is today, as they go from dry to flooded in a matter of hours, if not tens of minutes, leaving little time for the authorities to intervene and manage the emergency. The short time frame of a possible flood is compounded by the fact that, in Italy, we have made massive use of river burying in past decades. In many cases today, these works are not large enough to drain the water that arrives from the increasingly frequent extreme, localized and high intensity events.

For this reason, following the event that occurred in Genoa as far back as 2011, Michele Di Lorenzo, Federico Grazzini and Fausto Tomei, of Arpae Emilia-Romagna's Hydro-Meteo-Climatological Service, began working on creating a real-time forecast model, to be applied to flash flood warning systems that would issue warnings early enough to make people safe, for very small basins (<20 km2). Today, this model is implemented experimentally on the Ravone river in Bologna.

This is an innovative solution in that it is based on software running directly on the weather station's datalogger. It uses the rain and level data collected at various points, and a modelled index of the basin's capacity to retain water, which is updated every day by Arpae and acquired every morning from the datalogger via ftp, to forecast how high the level will rise in the minutes following the processing.

This system ensures maximum reactivity in disseminating the warning. Operationally, this is achieved with a CAEtech Compact data logger running the Linux operating system. It is designed to be powerful, low-power, open and even customer-programmable to meet even the most specific requirements.

The model used today is based on a relationship found by traditional statistical regression methods, but the system is ready to exploit the potential of artificial intelligence.

During the flood events of May 2023, when the level data relating to the Ravone in via del Chiu was not yet available, it became apparent that hydrometric data was available half an hour/an hour earlier than downstream, i.e. in the city.

This warning system will soon make it possible to issue warnings to citizens in danger before the event occurs.

As mentioned earlier, it is a model designed for the characteristics of very small basins. In order to extend its use to other scenarios, similar to that of the Ravone, a series of statistical analyses must be carried out on the historical data available for

the area of interest, after which the key parameters must be calibrated. In this way, the model can be tested and provide reliable predictions in any basin of the same type.

For the in-depth study applied to the May 2023 flood case, click here.
For the interview with Federico Grazzini by Il Sole 24 Ore, click here.■

BACK TO INDEX

The Citizens' Observatory continues to grow: it is the turn of the Adige

Under the agreement with RFI (Italian Railway Network), the DAO (District Basin Authority of the Eastern Alps), has called a tender to implement measure M43 "Citizens' Observatory" of the Flood Risk Management Plan (PGRA), for **overflow management in the Adige river basin**, in particular for the catchment areas within the Veneto Region, including Fibbio, Marcellise, Mezzane, Illasi, Prognolo, Tramigna and Chiampo-Alpone.

CAE is the leader of the temporary consortium formed with Softlab, Conit and Zetagroup, which won the tender that involves creating a **monitoring system** by installing and completing a remote network for measuring **hydrological and hydraulic** variables, as well as a dedicated **IT platform** to **store and process data from the network and citizens, and integrate them with the hydraulic models** of the Adige river basin.

The project is complex and includes several interconnected components that make up the system as a whole, namely:

1. a **system for measuring hydrological and hydraulic variables on the ground**, consisting of a remote **hydro-meteorological monitoring network**, **flow rate measurements and instrument-based section surveys** to characterize **run-off scales** where required;
2. an **IT platform serving the Observatory**, consisting of:

- a multi-basin **DAO modelling system** to collect heterogeneous flood data from external providers, manage flood forecast modelling chains,

and provide data export and display services;

- a **web- and mobile-accessible platform** to support decision-making, provided by DAO, in order to:
  - > make flood data accessible to those involved in the Observatory's activities;
  - > improve communication exchange among decision-makers and citizens, who will no longer be just recipients of news and communications;
  - > improve communication exchange among decision-makers and rescuers;
- a **cloud environment** to host the multi-basin DAO modelling system as well as the web and mobile platform;

3. **training and involvement services for citizens and schools** to disseminate the initiative and train citizens and students in the area of interest.

In particular, CAE will be responsible for the supply, installation and subsequent maintenance of the environmental monitoring network, which will use high-quality technologies such as: CompactPlus data loggers, WLR radar hydrometers, PG2R heated rain gauges and THS thermometers... and will be composed as follows:

- 9 stations equipped with wireless hydrometer, surface velocity radar to measure water flow and hydrometric rod with QrCode panel;
- 14 stations equipped with a wireless hydrometer and hydrometric rod with QrCode panel;
- 7 weather stations;
- 15 stations for monitoring hydrometric levels by reading from a hydrometric rod equipped with a QrCode panel;
- 3 flood monitoring systems for road underpasses.

This project aims to improve the real-time flood monitoring system by integrating information

from predictive models (Early Warning System) and physical sensors with:

- use of **innovative measurement sensors**, which can **also be used directly by citizens**;
- **training of citizens** and implementation of actions locally to keep them involved.

To find out about the other Observatory projects carried out by CAE, click the following links: Brenta-Bacchiglione, Tagliamento 1 and Tagliamento 2, Piave, Miane and Alleghe. ■

BACK TO INDEX

The Lazio region's hydro-meteorological monitoring network tested

The Lazio region, through the company LazioCrea, has in the past equipped itself with a digital radio communication system for the 118 Health Emergency and Civil Protection services. All 231 existing stations have been upgraded to transmit data via this existing network, in addition to the mobile network.

The measuring stations are currently equipped with the modern **CompactPlus** data logger, **DMR terminals and a cellular module**, andhave been integrated into a new **radio network to complement the existing regional microwave network**. For details of the network composition, click here.

Following successful testing, the maintenance and support period starts for the entire hydro-meteorological monitoring system and the IT system needed to provide the operational reliability, ro-

bustness and continuity required by the Regional Functional Centre. In fact, the Lazio Region Civil Protection monitors ongoing meteorological and hydrological phenomena and assesses the risks they pose, in order to coordinate emergency interventions, disseminate warning messages, arrange for operational interventions, and archive and process the data for purposes relating to climatological analyses and dissemination of data to the public. ■

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