CALAMAR

WATER RESOURCES MANAGEMENT

Measuring and forecasting rainfall using radar hydrometeorology

THE STANDARD FOR ANALYSIS AND DECISION-MAKING

”

Water is the driving force of all nature.

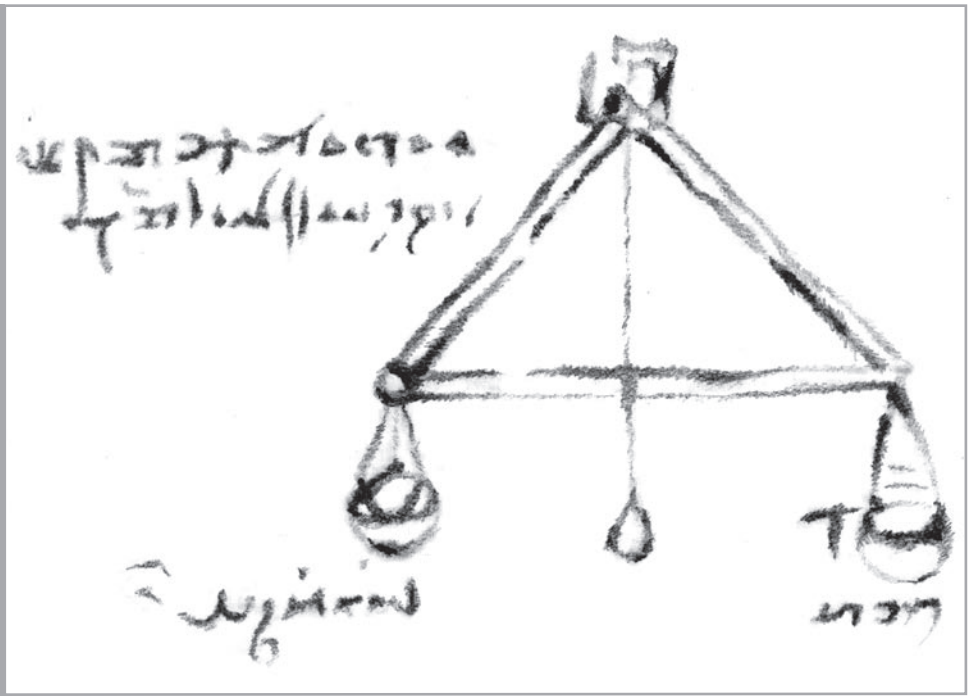
Leonardo da Vinci | Artist and inventor, visionary and engineer

KISTERS

Pioneering Technologies.

Hygrometer

In the late 15th century Leonardo da Vinci gave a first accurate explanation of the hydrologic cycle, including evaporation and precipitation. With his hygrometer he determined atmospheric humidity by measuring the imbalance caused by the absorption of moisture by the cotton wool, on one scale, which, when dry, is equal to the weight on the other side on the scale. It was one of his many observations methods for hydrologic phenomena with which he put his natural scientific obsession into practice: “It is necessary for us … to commence with experience and from this to proceed to investigate the reason.”



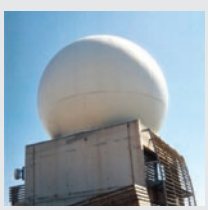
Measurement - forecast-based decision-making - analysis

We have developed the CALAMAR system to provide real-time measurement and short-term forecasting of rainfall on each square kilometer of a given area covered by radar hydrometeorology.

CALAMAR is a genuine decision-making tool; combined with probabilistic (risk indicator) or deterministic (rainfall flow) models. CALAMAR enables forecasting of rainstorms which is sufficiently accurate to allow time to act in-field.

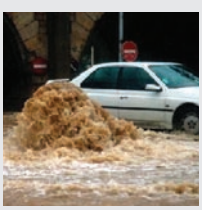
In off-line mode, CALAMAR enables a rainfall event to be reconstructed: with the aid of deterministic hydrological and hydraulic modeling: this enables the causes of any difficulties to be identified and corrected, providing better environmental protection.

Measurement and forecasting



Decision-making

Post-event analysis



CALAMAR is geared to stakeholders who have to deal with situations which are significantly affected by rainfall in both built-up and rural areas:

- Flood Forecasting Agencies
- Local government officials with responsibility for flood risk management
- Managers of sanitation and/or natural waterways:
  - Real-time management of network infrastructures
  - Permanent diagnostic reporting for urban sanitation networks
  - Assistance in planning network maintenance operations
- Engineers responsible for drafting or finalizing the hydraulic model for a sanitation network and/or a watershed‘s rainfall-flow model
- Hydrologists wishing to improve a measurement network.

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Real-time measurement

Input data:

- Hydrometeorological data from radar,
- Electronic data reporting from rain gauges deployed in an area of between 400sq/km and 1000sq/km.

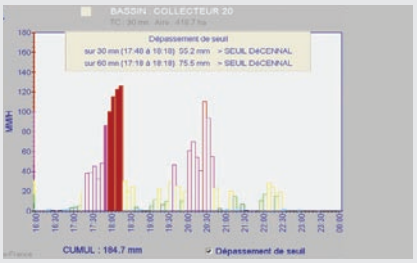
CALAMAR enables rainfall in a given area to be measured every 5 minutes in 1sq/km pixels or for any watershed within the area.
The collated data may be displayed in a number of ways:

Tables:

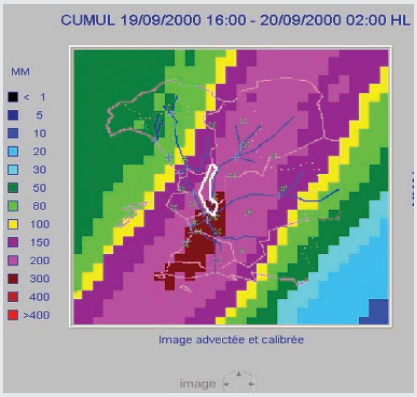
- *.txt, *.pre and *.grid files, etc.: rainfall data that can be used in hydrological and hydraulic modeling.

Graphs:

- Hyetograph showing rainfall for a given watershed or pixel



- Real-time or cumulative animated spatial representation of rainfall



Real-time forecasting

Forecasting provides expected rainfall on the basis of initial data in 5-minute increments for periods up to 2-3 hours ahead.

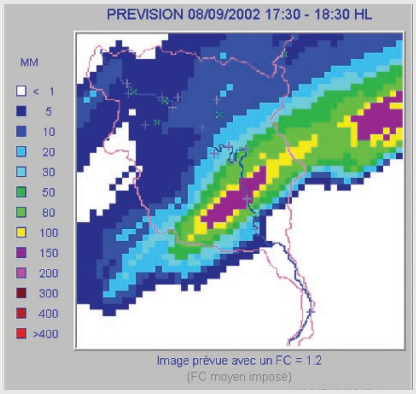
Forecast reliability is ensured by the supply of data from rain gauges located around the area in question.
The collated data can be displayed in a number of ways:

Tables:

- Cumulative forecast rainfall for pre-defined watersheds with a reliability index.
- The time at which a rainfall threshold will be exceeded, with a pre-determined warning period of up to three hours (risk indicator)

Graphs:

- Cumulative forecast rainfall for pre-defined watersheds with a reliability index.



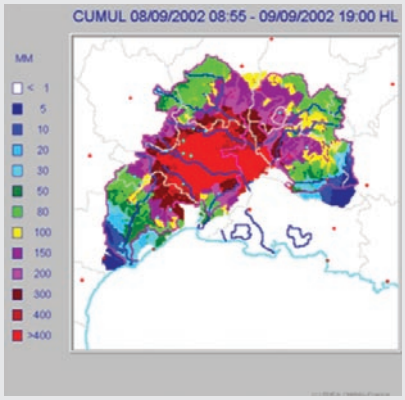
Offline mode reconstruction.

CALAMAR enables a rainfall event to be reconstructed using

- Hydrometeorological data histories from radar,
- Rain gauge network data (electronically or otherwise transmitted) even with differing time increments.

This enables the following:

- Improved understanding of consequences (submersion or non-submersion, pollution of the natural environment due to sanitation network overflows, etc.)
- Permanent diagnostic reporting for urban sanitation networks,
- Adding to and/or validating rainfall data,
- Adjusting rainfall-flow and hydraulic models,
- Simulating the impact of actual events on planned developments to optimize dimensioning
- Replaying historic rainfall data to test the reliability of a flood alert system or real-time management of sanitation infrastructure.



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CALAMAR solution: key advantages

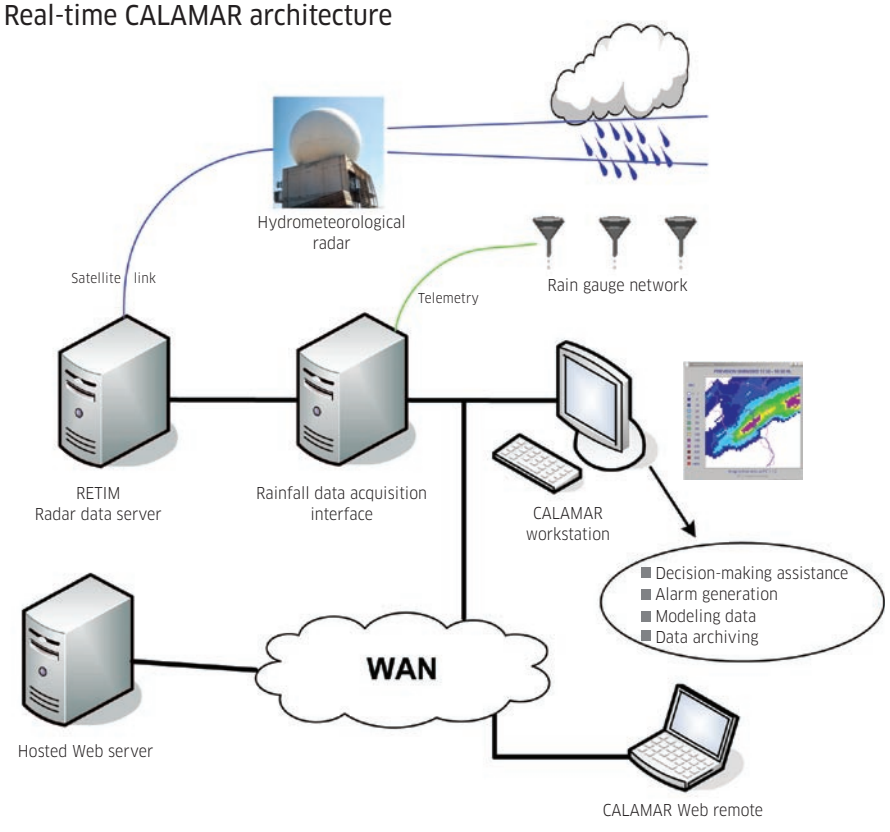
- **Precision:** radar data calibrated using rainfall data from homogeneous zones,
- **Reliability:** system chosen by flood prevention agencies in the most exposed Mediterranean regions.
- **Security:** redundancy of radar data acquisition resources, detection of faulty rain gauges,
- **Transparency:** the procedure was patented in 1992; it is thus clearly described and has been the subject of many publications.
- **Geared to operational requirements:** CALAMAR forecasting enables sufficient anticipation of events to allow operational personnel time to respond (1-3 hours).
- **Many references** in France (Flood Forecasting Agencies, Towns and Urban Districts, Departments, etc) and in the USA.

Real-time CALAMAR architecture

- Météo France RETIM 2000 station receives hydrometeorological data from radar
- Front-end interface collects rain gauge data every 5 minutes in the event of rainfall
- CALAMAR station carries out the calculations (rainfall measurements and forecasting) and provides graphic and dynamic display of events
- Hosted web server archives CALAMAR station data output and makes it available to remote users

Calamar was developed by RHEA, a member of the KISTERS group.

Real-time CALAMAR architecture



The discovery of the submarine.

The desire to be able to dive for longer than inhaled breath allows is just as old as the desire to fly. Until the 16th century, this was only be possible using a snorkel, and the snorkel only allowed a diving depth of up to 30 cm, after which it became life threatening due to the "air trapping" effect. It was Leonardo da Vinci who gave the theoretical push towards the development of modern submarines with his one-man diving boat. His sketches, which show a hull with a projecting command tower, are amazingly similar to today's submarines.

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