Operational implementation of the AIGA method for qualification of intense rainfall and flood forecasting on unmonitored rivers

Partnership:

- Hydrological research: INRAE, Hydris-hydrologie
- Radar rainfall estimation: Météo-France
- Real-time implementation : Météo-France, French ministry of Environment
- Funding: European Union, French Ministry of Environment, Région Sud Provence-Alpes-Côte d'Azur, Météo-France, INRAE

The AIGA method in a few words

OBJECTIVES: to better assess the severity of heavy rainfall and anticipate flash floods in ungauged rivers.

METHOD: use of real-time radar rainfall, of a rainfall-runoff model and of thresholds values to assess in real-time whether the observed rainfall and simulated runoffs are unusual, with the results expressed in return periods (fig. 1).

DELIVERABLES:

- Maps showing in real time, at a 1 km² spatial resolution, the observed rainfall return period estimated thanks to a comparison with distributed threshold values, this comparison being made for different rainfall durations.
- Runoff modelisation, for any river outlet (with watershed bigger than 10 km²), using the real-time radar rainfall data.
- Map showing in real time, and for any river, the return periods of these simulated runoffs, thanks to a comparison with threshold values.

BENEFITS:

- Identification at a fine spatial scale of the most severe rainfall, expressed in return periods.
- Flood anticipation thanks to the immediate transformation of observed rainfall into flow, thus saving time compared to the natural process.
- Flood modelisation for all rivers, including ungauged rivers.
- Identification of the river sections where the most sever flood hazards are likely to occur.

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Real-time implementations

The AIGA method is used on a national scale in:

- the APIC system, operated by Météo-France, which synthesises at the municipal level the AIGA return period grids estimated for the observed radar rainfall;
- the Vigicrues Flash tool, operated by the French ministry of Environment and designed to anticipate flash flood on ungauged rivers, it synthesises at the municipal level the AIGA return periods estimated for the simulated runoffs;
- the "Sécurité Civile" web service operated by Météo-France for the French crisis management services, which displays AIGA rainfall return period grids and AIGA runoff return period maps.

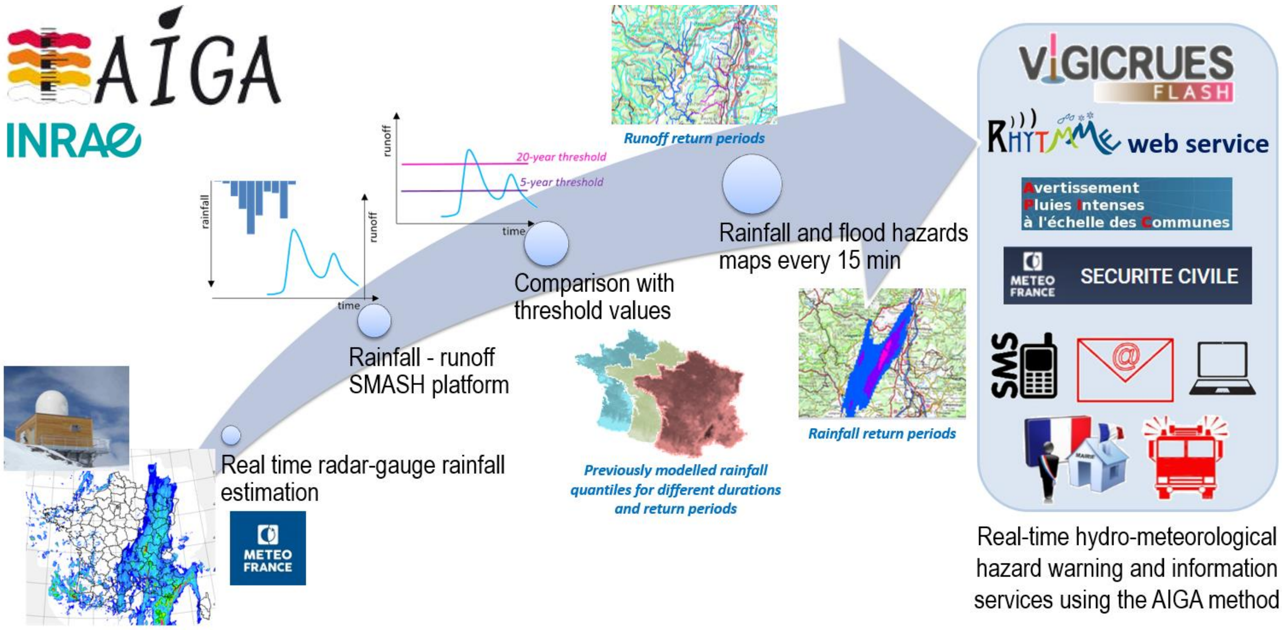
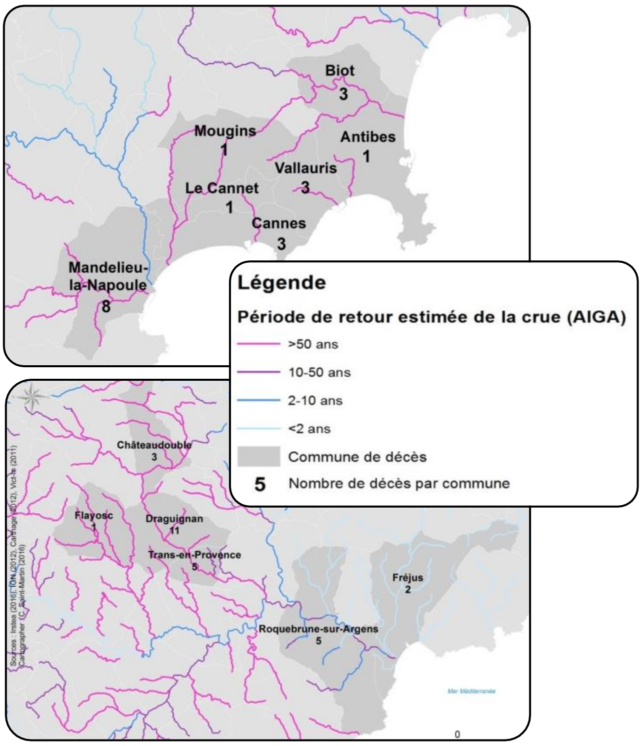


Figure 1: schematic diagram of the AIGA method.

The method is also used at a regional scale in the Provence-Alpes-Côte d'Azur area (south-eastern France), via the RHYTMME web service developed by INRAE and Météo-France.



Method performances

- In ungauged watersheds, the method correctly identifies floods affected areas (fig. 2).
- On average, over 700 French instrumented rivers:
  - 60% of the simulated frequent flow threshold exceedances are correct,
  - the AIGA method is more effective than a warning method based on rainfall information alone.

Figure 2: maximum return periods estimated for the AIGA modelled flows for the events of 2015-10-03 (top) and 2010-06-15 (bottom) and number of casualties.

On-going research and development at INRAE

- Improvement of the statistical rainfall and discharge statistical databases used for the definition of the method's thresholds values.
- Development and improvement of a distributed continuous hydrological model (fig. 3) implemented on the Spatially-distributed Modelling and Assimilation for Hydrology (SMASH) platform:
  - 1-km resolution and 15-minutes time step,
  - cell-to-cell routing modelisation,
  - use of variational calibration schemes,
  - new functions development to account for more hydrologic processes (e.g. snow component for mountainous catchments),
  - comparison with other models (Marine, CREST, GR4H, …)
  - adaptation to finer spatial resolutions,
  - account for vulnerability, to anticipate risks (and not only natural hazards).

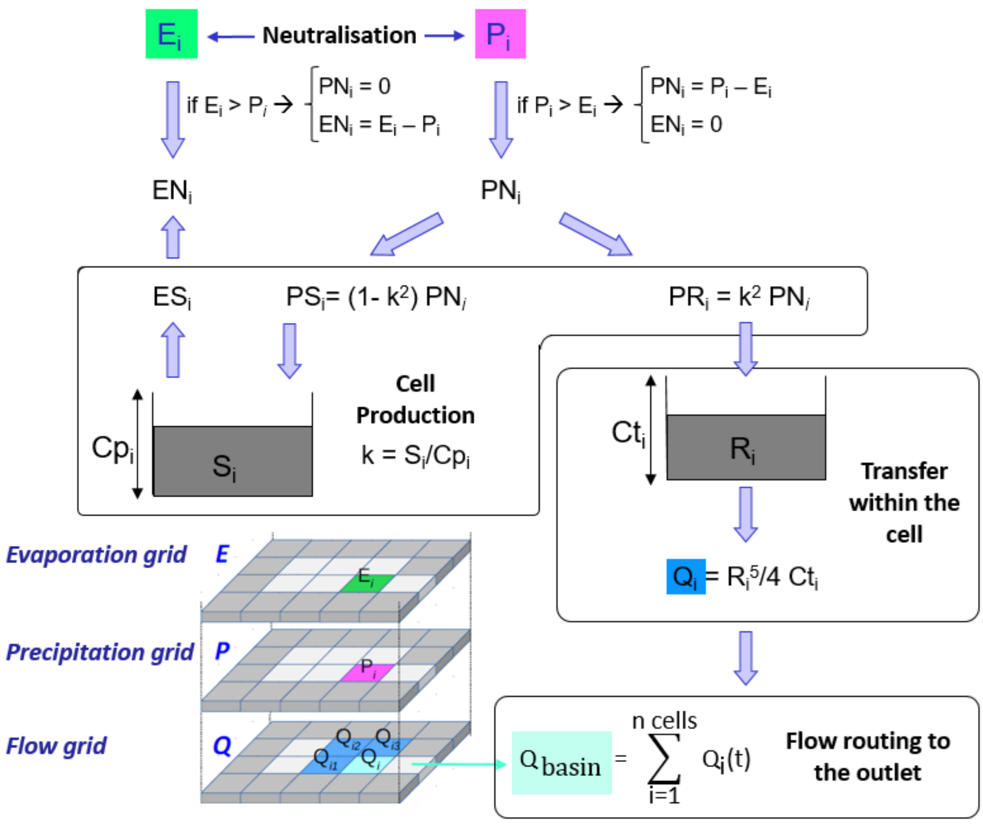


Figure 3: distributed continuous conceptual model as operated on the Spatially-distributed Modelling and ASsimilation for Hydrology (SMASH) platform for Vigicrues Flash.

Distributed model inputs, outputs, parameters and states (with an i-index): P, radar rainfall data; E, evapotranspiration; PN, net rainfall after rainfall – evapotranspiration neutralisation; EN, net evapotranspiration after rainfall – evapotranspiration neutralisation; Cp, capacity of the production store (model parameter); PS, part of rainfall directed to the production store; PR, part of rainfall directed to the transfer store; Q, runoff.

Aggregated model output: Q_{basin}, catchment runoff

Result: an integrated flood hazard management method

- Which will take into account the main components of flood hazards, from the rainfall hazards to vulnerability,
- Adapted to different management scales, thanks to its fine spatial resolution,
- Developed in relation with the different French flood management services, from local to national level, with the benefit of real-time implementation in operational tools and the end-users feedbacks.

Prospects: improvement of the rainfall runoff model

- Account for uncertainties,
- Account for and underground flows,
- Development of a flood impact model by accounting for vulnerability, thus enabling flood risk map production,
- Use of high-resolution precipitation nowcasts,
- Observed runoffs assimilation for real-time model correction,
- Use of flood damage data to assess the method performances on ungauged rivers.

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