Assessing various approaches for flash flood forecasting in the Yzeron periurban catchment (150 km2) south-east Lyon, France

Isabelle Braud, Pascal Breil, P. Javelle, N. Pejalovic, S Guerin

Assessing various approaches for flash flood forecasting in the Yzeron periurban catchment (150 km²) south-east Lyon, France

HS4.1/AS4.35/GM9.11/NH1.10
Flash floods and associated hydro-geomorphic processes: observation, modelling and warning
Poster A.242

Isabelle Braud (1), Pascal Breil (1), Pierre Javelle (2), Nikola Pejakovic (1), Stéphane Guérin (3)

(1) Irstea, UR HHLY, Villeurbanne, France (isabelle.braud@irstea.fr), (2) Irstea, UR RECOVER, Aix-en Provence, France (3) SAGYRC, Grézieu la Varenne, France

1. CONTEXT AND OBJECTIVES

Context:

- A periurban catchment prone to damaging flash floods downstream, with a few hours response time
- A prevention and management plan of flooding, including the set up of a flood forecasting system

Objectives:

- Propose a simple forecasting system based on available data analysis (thresholds)
- Assess the relevance of the new French flash flood warning system based on the AIGA method in the catchment

2. STUDY AREA AND DATA (Fig. 1)

Study catchment:

- Yzeron catchment, south-east France, close to Lyon city
- Increase of urbanization from downstream since the 1970s
- Combined sewer systems with sewer overflow devices

Available data

- Rain gauges: 3 from Lyon Metropole (6 min) 6 from Irstea (variable time step)
- Radar rain gauges reanalysis from Météo-France (1996-2015), 1 km², 1 hour resolution
- SAFRAN reanalysis, 8x8 km², 1 hour resolution
- Discharge: 2 gauges from DREAL, 4 from Irstea, variable time step
- Dates of problematic events that led to over flooding

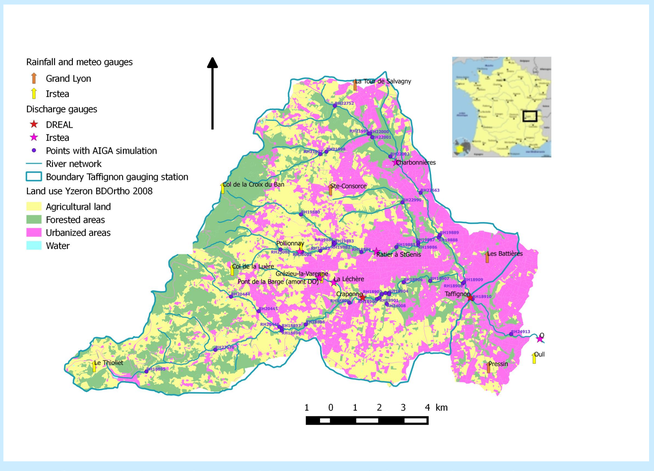

Figure 1: Location and land use of the study catchment. Location of the rain gauges and discharge stations. Location of the points where AIGA discharge was simulated

Acknowledgements:
This work was conducted with the support of: Sagyrc. Yzeron data are collected within OTHU.

3. DATA ANALYSIS

- Extraction of rainfall events from radar data plus associated discharge (Fig. 2)
- Selection of events with rainfall amount > 20 mm + 4 additional events kept in the analysis (217 events)
- Computation of rainfall amount, maximum hourly intensity, initial discharge, rainfall amount over the 5, 10, 30 previous days and peak discharge
- Statistical analyses using 1/ Factorial Analysis of Mixed Data; 2/ Classification and Regression Tree (CART) using *FactoMineR* and *rpart* R packages

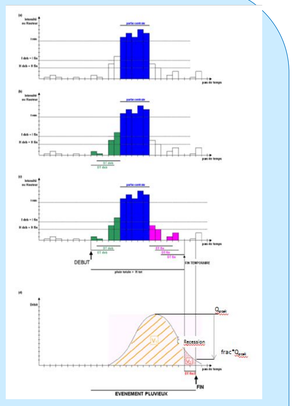

Figure 2: Event extraction method (adapted from Morena, 2004)

4. EVALUATION OF THE AIGA METHOD

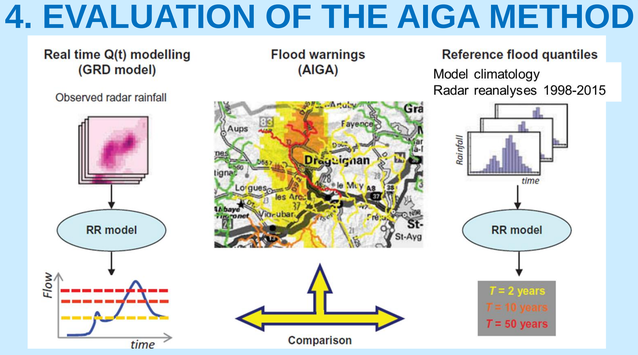

Figure 4 : Principles of the AIGA method.

The AIGA method (Javelle et al., 2016) and its evaluation:

- A simple rainfall-runoff model is fed with radar / rain gauges reanalyses and the simulated discharge climatology is used to compute quantiles that are used as warning thresholds (Fig. 3 right). In real time the model is run using radar rainfall (Fig. 3 left). Warnings are issued if thresholds are exceeded (Fig. 3, middle)
- Evaluation: used of the simulated climatology in the Yzeron catchment and comparison of simulated warning levels with the known dates of overflow

6. CONCLUSIONS AND PERSPECTIVES

- Data analysis shows that monitoring rainfall amount and antecedent soil moisture is interesting for putting authorities on alert
- Performance of the AIGA method is satisfactory – but should be evaluated further when real time radar data will be used
- Lead time values must also be assessed
- On going work: evaluation of the global (GRP) and semi-distributed (TGR) flood forecasting models

5. RESULTS

Three configurations favorable to floods revealed by data analysis

- Significant differences of explaining variables between flooding and non-flooding dates (Fig. 4)
- Catchment rainfall amount, initial discharge q_{beg}, antecedent 30d-rainfall, max intensity most important splitting variables in CART analysis (Fig. 5)
- 3 clusters with flooding dates (Fig. 5): C6: high rainfall amount, wet conditions; C5: high rainfall amount, higher intensity, drier conditions; C3: Moderate rainfall amount, very wet conditions

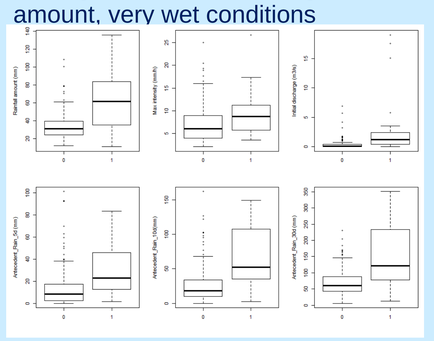

Figure 4: Boxplot of explaining variables for non-flooding (0) and flooding (1) dates. Differences are significant, p<0.001

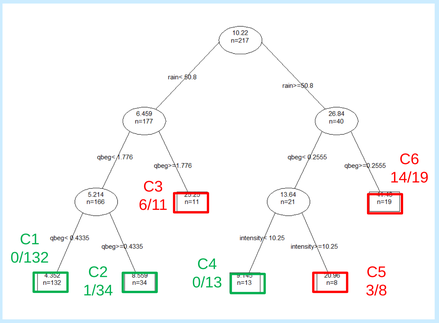

Figure 5: CART analysis results. Clusters with problematic events are in red and we give the rate of problematic events in each class

Evaluation of the AIGA method (1997-2015 period)

- The 9 flooding dates on the study period are detected with exceedance of the 5 year return threshold, except 2 dates
- Two examples of results provided in Figures 6 and 7

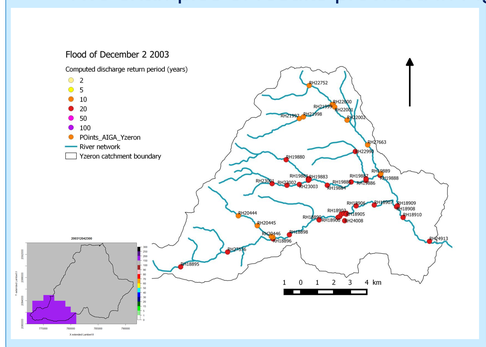

Figure 6: Event of December 2003, catchment rainfall:136 mm, 10 and 20 year return period thresholds exceeded. Bottom left: map of accumulated rainfall

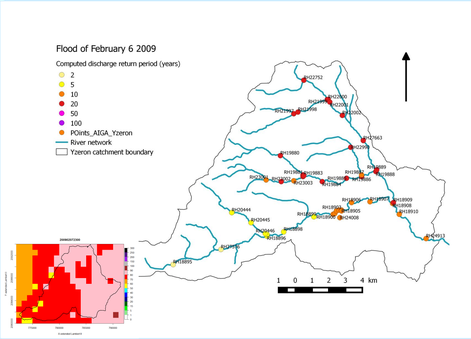

Figure 7: Event of February 2009, catchment rainfall 77 mm, 5, 10 and 20 year return period thresholds exceeded, largest threshold with higher cumulated rainfall. Bottom left: map of accumulated rainfall

References:
Javelle, P., Organde, D., Demargne, J., Saint-Martin, C., De Saint-Aubin, C., Garandeau, L., Janet, B. - 2016. Setting up a French national flash flood warning system for ungauged catchments based on the AIGA method in FLOODrisk 2016 - 3rd European Conference on Flood Risk Management. 2016. Lyon – France, https://doi.org/10.1051/e3sconf/20160718010
Morena, F., 2004. Modélisation hydrologique distribuée en milieu urbanisé. Représentation des processus de production et développement du modèle URBS, Institut National Polytechnique de Grenoble, Grenoble, 256 pp.