Including the assessment of external vulnerability to flooding in the AIGA method - A step forward an integrated chain of flood warnings

C. Saint-Martin, C. Fouchier, P. Javelle, J. Douvinet, F. Vinet

Including the assessment of external vulnerability to flooding in the AIGA method

A step forward an integrated chain of flood warnings

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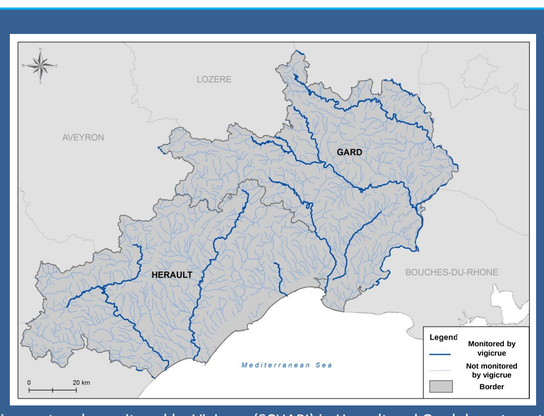
In the end of 2014, flash floods caused 14 deaths in the South of France. This disastrous record underlines the need to develop flash flood forecasting systems at a local scale and especially for ungauged basins densely populated.

Introduction to the AIGA method



River network monitored by Vigicrue (SCHAPI) in Herault and Gard departments
C. Saint-Martin (2015), *source : SCHAPI (2015); IGN (2012); BNBV (2013)*

Since 2006, the SCHAPI, the French national service in charge of flood forecasting, has developed an efficient real-time monitoring system for floods throughout France called Vigicrue (http://www.vigicrues.gouv.fr/). This service provides localised information on the severity of a flood but only for 22.700 out of the 120.000 kilometres of the French stream network so far. Consequently, a large part of the French territory does not benefit from a flood warning system.

To cope with this issue, Irstea and Meteo-France have developed an alternative warning system for ungauged basins called AIGA (Adaptation d'Information Géographique pour l'Alerte en Crue). It is based on a simple distributed hydrological model running at a 1km² resolution using radar rainfall information (Javelle, Demargne, Defrance, Pansu, & Arnaud, 2014). The warnings, produced every 15 minutes, result of the comparison of these real time flow simulations with statistical thresholds obtained from a regional flood frequency analysis (SHYREG).

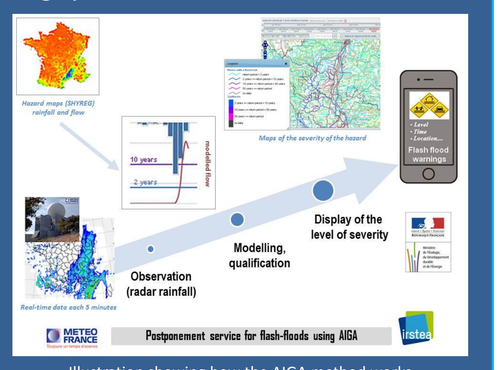


Illustration showing how the AIGA method works
P. Arnaud (2015), *copyright: IRSTEA (2015); Meteo-France (2015)*

Issues and objectives

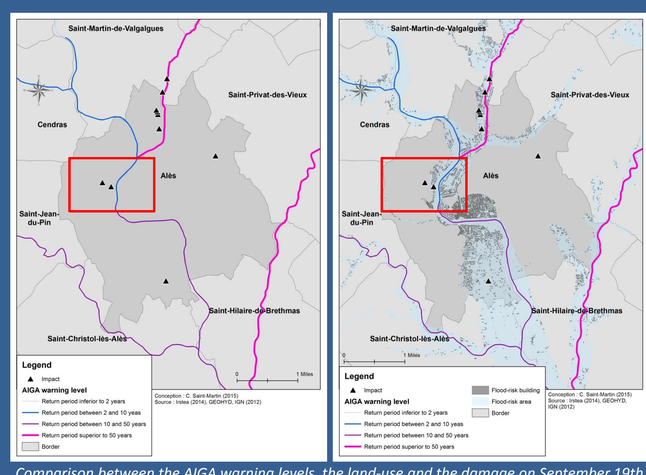
AIGA only focuses on the hazard level and doesn't take into account the stakes at risk in the studied areas. Therefore, it cannot assess what will be the potential damages. For example, if we compare AIGA warning levels and observed damages during the Sept. 2014 flood around Ales, some lags can be observed.

Indeed, damage can be observed at low warning levels. Conversely, at some high warning levels, no damage is reported.

The land-use seems to explain those latter discrepancies.

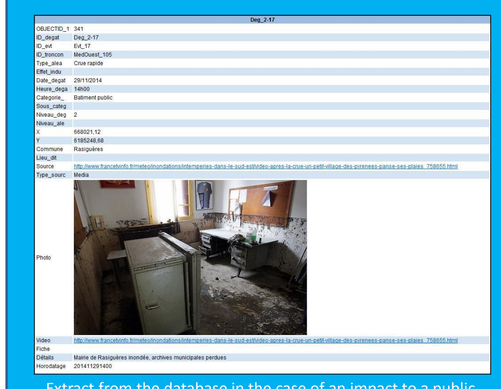
Therefore, to improve the efficiency of the AIGA method, it seems essential to :

- Develop an external vulnerability indicator in order to quantify the surrounding land-use,
- Develop an exhaustive damage database in order to validate the relevance of the approach.



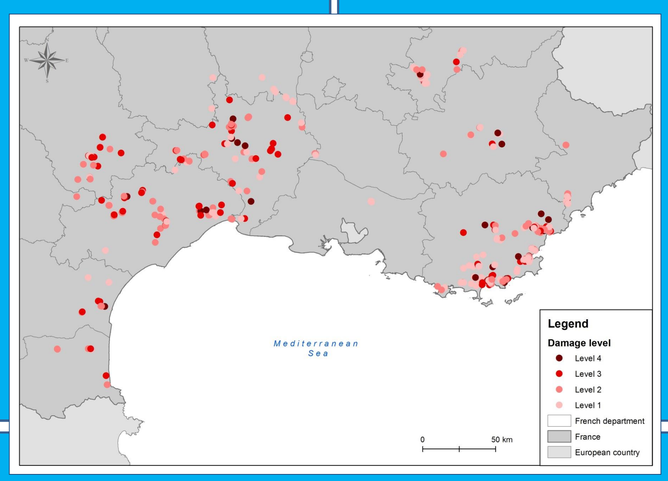
Comparison between the AIGA warning levels, the land-use and the damage on September 19th and 20th 2014 - C. Saint-Martin (2015), copyright: Irstea (2015)

Structure of the database



Extract from the database in the case of an impact to a public building on November 2014 - C. Saint-Martin (2014), *source : Irstea*

To offset the absence of a global database indexing the damage due to flash floods in South of France, we have undertaken to develop one. The data in this base come from multiple sources, namely the media, feedbacks of the local actors and social networks. Each impact is geolocalised, time-stamped and documented, ensuring data quality control. To enable a comparison, a simple scale has been implemented with four levels. For instance, in the event of a road impact, the level one refers to a small flooding enabling the vehicles to pass while the level four means that the road is unusable due to extensive damage.



Localisation and severity of the indexed impacts from 2011 to 2015
C. Saint-Martin (2015), *copyright: Irstea*

Link with the HyMeX Project

As HyMEX, Irstea is interested in the Mediterranean area. To validate the AIGA warnings, we collect information on the damage in a multiple way including directly on the field. To do so, we lead feedbacks by conducting surveys and taking flow measurements. The recent catastrophic floods at the end of the year 2014 have led Irstea to work together with the HyMeX project in the Gard and Herault departments. For the September floods alone, we collected 87 impacts.

Improving the number of data and the AIGA method may be a way for a better understanding of flash floods in Mediterranean regions.

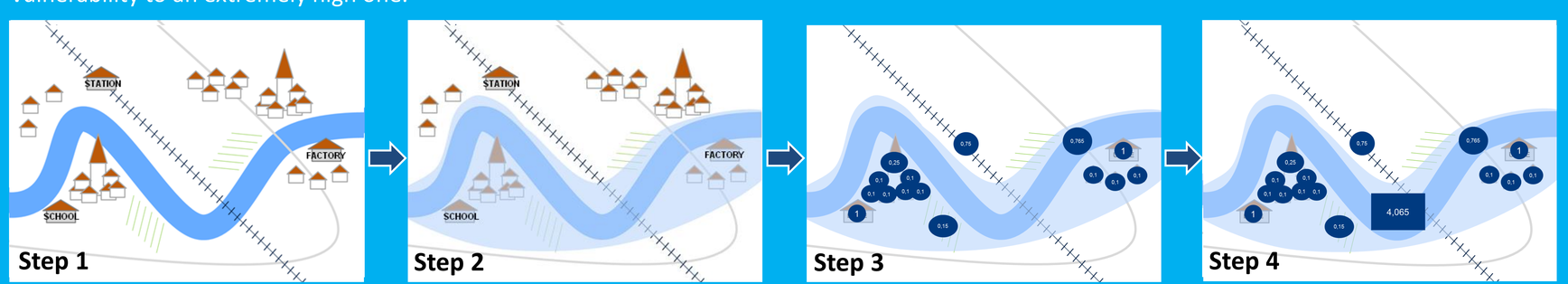
Witness mark of the flood of September 19-20, 2014, In Saint-Laurent-le-Minier (Herault) - *Source : C. Saint-Martin (Irstea, 2015)*

External vulnerability

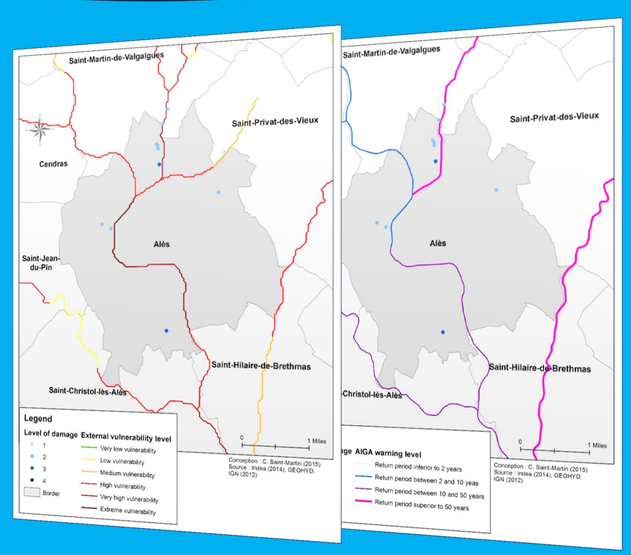
This term describes the tendency of a stake to be damaged considering the characteristics of its very own nature. For example a hospital is by its own nature more vulnerable than a supermarket (fragile equipment, people with reduced mobility, essential in times of crisis…)

Conception of an external vulnerability indicator (C. Saint-Martin, 2014)

To appreciate the external vulnerability of a flood-risk territory, an indicator has been implemented. It is based on the different types of stakes that may be damaged by a flood namely the networks, buildings and sites with a special function (school, hospital…). In order to develop a simple and easily reproducible index, we have intended to use easily accessible data. To do so, we have chosen to work with the data produced by the French national centre for geographic information (IGN) namely the BD Topo database. First, we select all the flood-risk stakes. Those stakes are localised in flood-prone areas called EAIP (Enveloppe approchée des inondations potentielles). The EAIP are drawn by combining historic floods, regulatory zoning and topographic information. Once those stakes selected and prioritized, we provide them with a value. This value is proportional to the consequences of their potential damage on the community. Finally, we aggregate those value per watershed to obtain a final value corresponding to the external vulnerability of the area surrounding a river. To make the treatment of this values easier, we convert them in an indicator. This indicator consists of six levels, from a very low vulnerability to an extremely high one.



Collect the data — **Identify the flood-risk stakes** — **Assign a value to each stake** — **Aggregate the values by river section**



Comparison between the external vulnerability levels and the warnings for the flood of September, 17th 2014 - C. Saint-Martin (2015), *copyright: Irstea*

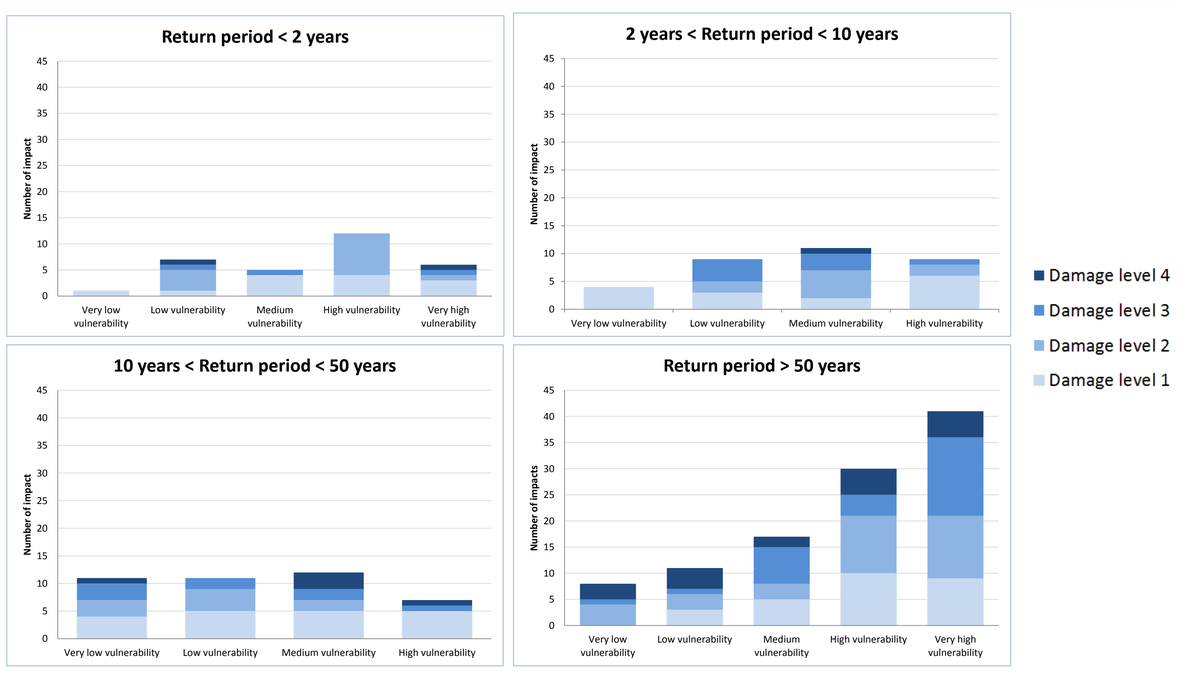
First results and perspectives

Each impact from the database is affiliated to a river due to its spatial localisation. Thus, for each impact we know the external vulnerability of the river which it refers as well as its maximum AIGA warning level during an event.

By combining all these latter data, we obtain the chart on the right. On this chart, we can observe a slight proportionality between the AIGA warning levels on one side and the severity of the impacts on the other side. Thought, the higher is the hydrological warning, the higher will be the severity of the impacts.

Furthermore, the severity of the impacts seems to be slightly connected to the external vulnerability level. Indeed, the more vulnerable is a river, the more it may be disposed to be severely damaged. As much as the results aren't perfect, they are still promising because they underline all the potentialities to undertake such crossovers.

By combining hydrological warnings, damage and external vulnerability, our goal is now to generate an impact model. During a flash flood, this model would be locally assessing the severity of damage in real-time. (*ongoing PhD thesis)*



Crossovers between damage, external vulnerability and hazard level (AIGA war,ings)
C. Saint-Martin (2014) – *sources : Irstea*

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