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Comparison Between Flooded Areas and Flood-Risk Areas. Case of Var Department (France)

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Esposito Christophe, Jean-Louis Ballais, and Chave Sylvain

Abstract

June 15 and 16th, 2010, heavy rainfall strikes the department of the Var and provoked numerous floods. The French Ministry of Ecology, Sustainable Development and Energy decided to launch studies in order to define the flood extension. The aim of this paper is to compare these limits of the flood-risk area and that of the 2010 flooded zone. Studies have shown that Hydrogeomorphological mapping appears as being the best method to define the flood-risk area for such an event. But it was not carried out everywhere.

Keywords

Mapping of the flood-risk area • Flooded area • Millenary flood • France • Var department

154.1 Introduction

In the Var department, rainfalls of June 15th 2010 have produced important floods mainly in the Argens watershed. Several people died and there were considerable damage. Several informations exist about the demarcation of liable to flooding areas before the flood by the "Atlas des Zones Inondables" (AZI) realized with hydrogeomorphological method, by mapping of flood hazard in the "Plans de Prévention des Risques d'Inondation" (PPRI), by the limits of layers on geological maps (Fz) and by the limit given by the "Extraction des Zones d'ECOulements" (Exzeco). The flooded zone limits have been compared with them.

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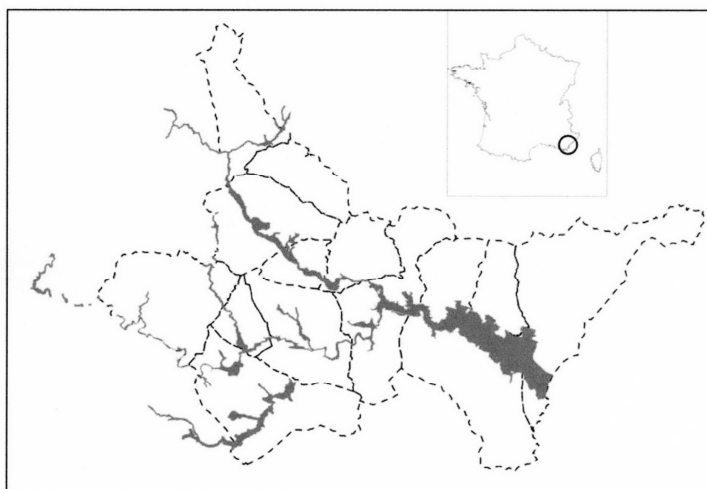
154.2 Limit of Flooded Areas

A survey of high water marks locating and of mapping of the Nartuby and Argens rivers flood envelope has been performed by research units in 13 municipalities (Fig. 154.1).

154.3 Limit of Flood-Risk Areas

Comparison have been performed on four liable to flooding areas mapping types. The AZI lean on the valleys geomorphological interpretation (Masson et al. 1996; Ballais et al. 2011). This method is able to determine the envelope of liable flood zones in the case of rare or exceptional flood. Up to now, the PPRI (MATE, MEDD 1999) have only been approved for three municipalities (Vidauban, Draguignan, Trans-en-Provence). The geological formations are given by the BD Charm-50. Recents alluviums Fz have been used. At last, the "Exzeco method" elaborated by the CÉTÉ Méditerranée (Pons et al. 2011) modelizes filling of talwegs with a given water height.

Fig. 154.1 Boundaries of the flooded area (in grey) within the studied area (municipality in dotted lines)



154.4 Method for the Analysis of Overflows

154.4.1 Numeric Methodology

Two papers present this method (Chave 2002; Esposito 2003). An overflow polygon is a sector that shows an over-shooting of the liable to flood zones limit by the flooded area. A data processing allows calculation of the over-shooting linear named contact linear (Lc) that forms, for each polygon, the over-shooting of the liable to flood area by the flooded area.

Average amplitude (Am) corresponds to the height of a rectangle whose length is equivalent to the contact linear and surface is equivalent to the over-shooting polygon surface (Fig. 154.2). Significativity threshold is 25 m for AZI and PPRi and 50 m for Fz and Exceco.

154.4.2 Results of Process

Applying data processing allows to select 550 polygons for the Atlas des Zones Inondables, 103 polygons for risks maps of the PPRi, 421 polygons for Fz and 1611 polygons for Exceco (Table 154.1).

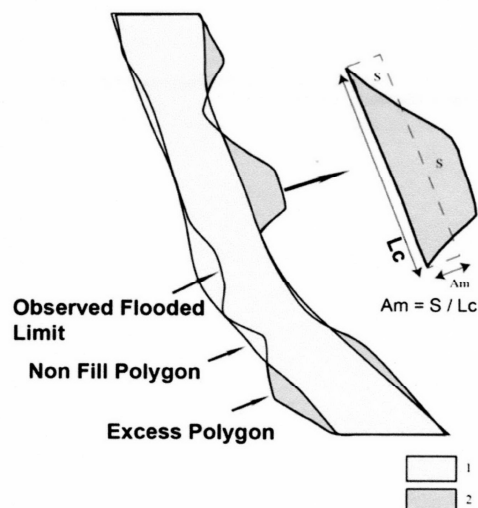


Fig. 154.2 Superposition of the limits and polygons of overflow zones and un-filled areas. (1 Liable to flood zone, 2 Flooded zone, S Surface of the polygon, Lc Contact linear, Am Average amplitude)

Table 154.1 Selection of overflow polygons

	Overflow polygon	Overflow polygon (Am > 25 m)	Overflow polygon after verification
AZI	550	71	21
Fz	421	124	30*
PPRi	103	20	18
Exzeco	1611	136	18*

154.5 Analysis of Overflows

This analysis is performed for each of the mappings (Esposito 2012). Using several informations, first analysis has been done for the overflow causes.

In the case of the AZI, the hydrogeomorphological envelope has been exceeded only a little more than 11 km. Only 4 %. 21 overflow polygons have been analyzed and the main excess cause is the high proportion of mapping mistakes (15 polygons). About the overflows beyond the liable to flood zone defined in the PPRi, 18 overflow polygons must have been analyzed. 15 from them are due to non recognition of the liable to flood zone. About the overflows beyond the liable to flood zone defined by the recent alluvium (Fz), 30 polygons must have been analyzed. They are shared out in 3 causes: mainly the absence of Fz in the thalwegs (16 cases), liable to flood zone or Fz mapping mistakes. The total excess percentage (Table 154.2) is only 3 % but the mean amplitude is at least 50 m. About the overflows beyond the liable to flood zone defined by the Exzeco method, 18 excess polygons must have been analyzed (10 % or 41 km) showing two causes: insufficient water height and Exzeco mapping mistakes.

154.6 Methodology for the Analysis of Non-filling and Filling

As well as for the overflow polygons, non-filling polygons have been analyzed. There are 513 polygons for the AZI, 94 polygons for the PPRi, 409 polygons for Fz and 1349 polygons for Exzeco (Table 154.3).

Table 154.2 Comparable linear between flooded zone and mapping for overflow

Mapping	AZI	PPRi	Fz	Exzeco
Total comparable linear (km)	305	55	413	424
Total comparable linear "flooded zone" (km)	338	55	334	338
Overflow linear (km)	11	17	13	41
Overflow proportion (%)	4	30	3	10

Table 154.3 Comparison between the flooded zone and the predictions concerning non-filling

Mapping	AZI	PPRi	Fz	Exzeco
Total Liable to Flood zone Linear (km)	305	55	413	424
Total Flooded zone Linear (km)	338	55	334	338
Non-fill Linear (km)	140	6	101	92
Non-fill Percentage (%)	46	11	24	22

Table 154.4 Comparable linear between flooded zone and flood-risk areas

Mapping	AZI	PPRi	Fz	Exzeco
Total comparable linear (km)	306	55	413	424
Total comparable linear flooded-zone (km)	338	55	334	338
Overflow linear (km)	11	17	13	41
Overflow percentage (%)	4	30	3	10
Non-fill linear (km)	141	6	101	92
Non-fill percentage (%)	46	11	24	22
Fill linear (km)	153	32	300	290
Fill percentage (%)	50	59	72	68

154.7 Non-filling/Filling/Overflow

Comparing liable to flood zone and flooded zone allows to show overflow and non-fill linears for each mapping. We can deduce the linear filled (Table 154.4).

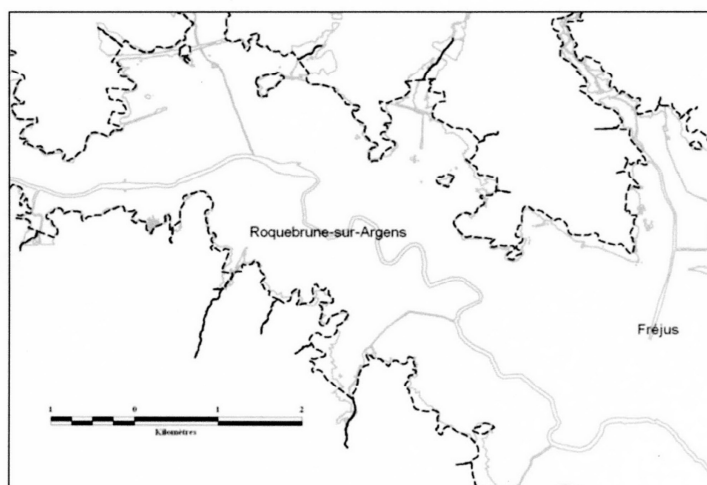
154.8 Analysis of the Rivers

The estimation of the 2010 June 15 flood return period in the surroundings of Draguignan (Lang et al. 2011) has been performed on five streams: Argens, Nartuby, Aille, Floriève

Table 154.5 Linear and percentage on stream with return period

	Stream	Argens	Nartuby	Aille	Floriève
Linear (km)	AZI	172.4	64.5	33.1	20
	Flooded Zone	169.7	64.2	26	19.5
	Non-fill	94.2	36.8	2.8	4.2
	Fill	76.2	26.7	22	15.7
	Overflow	1.9	0.9	8.3	0.1
Percentage (%)	Non-fill	54.6	57.1	8.5	21.2
	Fill	44.2	41.5	66.5	78.2
	Overflow	1.1	1.4	25	0.6
Return period (year)		100	250	500	>500

Fig. 154.3 Q 1000 flood (in grey) and the hydrogeomorphological mapping (in black)



and Réal. The return period is contained between 100 and 500 years (Table 154.5). The Réal is not concerned by our paper.

154.9 The 1000 Years Flood

By request of the Var DDTM, SAFEGE (2010) modeled the millenary flood on all the reaches of the streams. The limit of this flood is almost superimposed on the limit of the liable to flood zone as determined by the hydrogeomorphological method, at the scale of the Fig. 154.3.

154.10 Conclusion

The goal of this paper is to find a method or a set of methods that allow to rapidly and qualitatively determine the liable to flood zone on a given territory. So we have produced some quantitative elements that can support the argumentation of a method results in front of an event that can be qualified as exceptional. PPRi use only a 100 years period return flood, geological mapping provides recent alluviums only along the main streams and at a scale (1/50,000) very insufficient for flood risks, and Exzeco allows obtaining the whole flow axes. The hydrogeomorphological method that can be applied everywhere and whose mapping is efficient at least up to a 1/5,000 scale remains the best method to determining liable to flood zones. An association of these methods could

support mapping of liable to flood zones with a great care about the restitution scales. Nevertheless, hydrogeomorphological mapping allows to qualify an event whose period return is greater than 500 years.

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