Lessons learnt from a Mediterranean flood (Gard, September 2002)

Philippe Huet, Genevieve Baumont
Ministere de l'Ecologie et du Developpement Durable
Paris France

Abstract

This paper presents the lessons learnt from the severe floods occurred in South of France. A large number of scientists were involved in the review organized by the French Ministry in charge of environment. Data were collected and are available for future scientific works. The characteristics of the framework and the main results are presented and discussed in an integrated tool prospect.

1 Generalities

The sustainable development is partly based on an effective management of industrial and natural risks. Indeed, two kinds of scenarios have to be studied for the future, those that describe how to reach a sustainable development using positive criteria and those that describe undesired events and risks with the ways to avoid them.

These last scenarios are well known by the PSAM community: nuclear reactor fusion, chemical accident consequences, chronical pollution with health consequences can be described in a comprehensive way, using probabilistic studies in order to support decision making. Here, the non-desired event is the severe damages after torrential rains and the goal is to manage a sustainable development in the south of France. Can an integrated tool to govern and manage this kind of risk be developed? What are the finding and material available to discuss the feasibility?

To be submitted to severe floods is a typical characteristic of the Mediterranean coast because in autumn, a process occurs during which storms can produce intense long-lived rainfall over the mountain chains around the Mediterranean coast in Spain, Italy and France. Most of the vapor is drawn from warm Mediterranean water while their thermodynamic structure can be explained by the air mass characteristics, originating in north Africa and the Mediterranean basin itself. Such storms are recorded, mostly, every year, but, depending of the rain intensity and the characteristics of the air mass, floods can occur in small areas, but large and severe floods are relatively rare (that is the main point of the discussion). Futhermore, different kinds of phenomena occur simultaneously and they are very sudden (short delays and large uncertainties of prevision). Depending on the actions performed during the delay time, the gravity of consequences (death and economic damages) can be reduced. Preventive public information is an aspect to increase good

performance during crisis. For these reasons, an integrated tool could help to manage all the aspects of prevention and crisis management to assure sustainable development of the region.

Data collection and scientific analyses constitute an essential first phase for further full studies where Mediterranean characteristics would be taken into account.

2 Organization to manage the flood feedback

2.1 the framework

Few weeks after the catastrophic floods, the government decided to review all the aspects of this event. It was performed following the French habits and legal frameworks. But in addition, a lot of scientists were asked to support the process and the population and local collectivities invited to participate in the information collection and in the debates. This feedback exercise is very similar of the glaze crisis feedback in Quebec in 1998 (ref 4).

As usually done after such events, the French Ministry of Environment gave a mandate to high-level civil servants in order to:

- Characterize the events: level of rainwater, level of flow, level of streaming, mode of confluence (junction) of rivers, the role of the dams etc
- Identify the role of anthropogenic factors in the flood dynamic (urbanization, agriculture mode, territorial management -road and railways impact-,...)
- Examine the modes of warning and their efficiencies
- Elaborate recommendations for government to reinforce flooding management.

The mandated team met the local population, associations, mayors, and state services in order to collect information and to list the main questions, heard from public or from local authorities.

A group of scientists coming from different institutions has been called to answer the 30 gathered questions and indicated 1) for most of the questions, the most important scientific results coming from research which enlighten the problem 2), for several, the level of consensus or the aspects in debate, 3) for some of them the lack of data or information. This work was performed in a very short delay (6 months). It was not, of course, completely exhaustive and not presented in an academic way, but the findings were sufficient for giving scientific bases to the review.

In parallel, different crews performed some studies few months after the flood in Languedoc Roussillon region (LR). One of them had to determine, in one hand, the intensity and the extents of the rains, in the second hand, the depth, the extents and duration of flooding in the different river basins and, finally, to discuss the probability of such conditions. An other crew has to analyze economical aspects. The last one had to describe and discuss the warning system with a psycho-sociological approach (ref 3).

A final report (ref 1 and 2) presents all the results. They were shared with mayors and local people.

2.2 Discussion

Due to the lack of an institution that could centralize all the studies in this field[1] (for scientific aspects and for local administrations as well), the governance of flooding risk is not simple in France. In this review, it was necessary to collect data for different aspects of risk management which are distributed: meteorological aspects depend on the Ministry of Equipement, the hydrological aspects on the Ministry of Environnement, the crisis management on the Ministry of Interior security. The planification of urbanism, road and train building also depends on different administrations, deciding separately investment aspects. In these conditions, future work for an integrated tool in this area could only be organized with panel experts as presented in ref 5, with a strong coordination by the toolmaker.

3 Some data for the Risk Measure

The team recommends to study how to build a program on several years for preventing flooding and run-off risks in the Languedoc-Roussillon region. These studies have been developed in some countries or regions.

For example, it seems that the framework of the flooding governance and the characteristics of the flood risk in Netherland provides the necessary condition to develop such a tool. After recent disasters in Netherland (in Bijlmer, Enschede, Volendam), full risk assessments of existing risks in areas have been done for Betuwe, Tieler, Culemborger, Waarden (ref 6). The aim of such a work is to support societal debate on flood protection level. Beyond the existing data, some evolutions coming from different development scenarios (climate change, sea level rise, higher river discharges) could be introduced. So, the authors are using different parameters for their calculation where the risk measure is a mathematical function of the probability of an event (mostly breach modeling and flooding extension) and the consequences of that event (assessment of loss of life, evacuation cost and economic damages.). The following paragraphs discuss the data collected by the French team, facing with this kind of approach.

3.1 Meteorological and hydrological data and return period values

Of course, to discuss the probability of an event, it is necessary to describe it. And, it is not as evident as it appears at first sight. The two first important parameters are rainfall intensity (rate of rainfall) and duration. In a case of torrential rains as it occurs in Mediterranean regions, topography, soil conditions, and ground cover also play an important role to explain hydrological data and the flooding mode. They are influent factors. Furthermore, the damages are due to different events: river

[1] For comparison, Delft University of Technology centralizes a lot all studies in the flood domain

overflow, rivers overflow in confluence, dam rupture, sudden run-off, rising tide effect etc... Different phenomenas have to be taken into account following the concerned area.
So, the scientific group discusses a lot to define what parameters and which occurrence rate characterizes this event. So, as a result the following table presents some data.

Parameter	Intensity	Return period
Maximum of rain fall in a place	687 mm in 24 hours	40 years in the LR region
Area inside the isohyetal 200 mm	Very large area	80 years in the LR region
Area inside the isohyetal 300 mm	2/3 of the Gard departement-around 4000 km^2	140 years in the LR region
Area inside the isohyetal 400 mm	1800 km^2	
Area inside the isohyetal 600 mm	150 Km^2	
Total rainfall in the Gard, Vidourle and Cèze basins		> 100 years
Total rainfall in the Gardon d'Anduze basin		# 70 ans
Maximum Flow in the rivers	Estimated with different method, still in discussion	Still in discussion

Table 1. size and return period of some parameters.

So, the probability to be flooded in a place depends on many meteorological and/or hydrological parameters, which differs from one area to an other and may be dependant.

3.2 Historical data

The european programme SPHERE (ref 7) provides an analysis of the series of events in the south of France and in south of Europe. Historical data analysis provides a new approach of the return period discussion. In the figure below, scientists observe climate cycles recorded in the past. River "crisis" were observed during three periods: a) 1582-1632, with crest segment in 1592 and in 1606, b) 1768-1800, with crest segments in 1777 and 1791, c) 1833-1868, with crest segments in 1855. During these years, the period between two floods was very short.

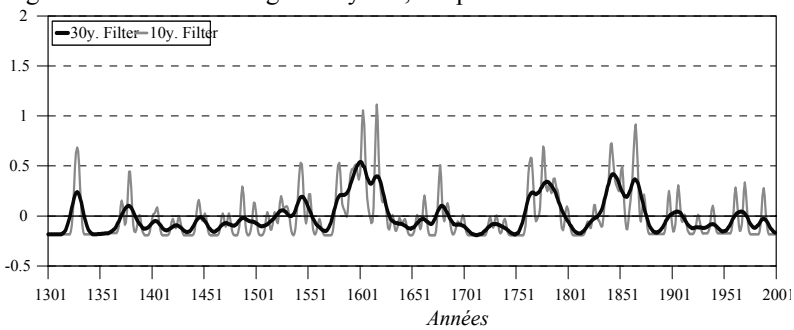

Figure 3 - Climatological analysis of flood frequency in Ter, Segre and Llobregat basins from 14th to 20th century (ref 8)

The conclusion of scientists is that the uncertainties on the figures are enormous due to the short series of recorded data, due to climate variations (see before) and due to possible climate change effects. In such conditions, it is better to decide that the probability of such extreme flood is important. This can reinforce the vigilance of people and motivate decision makers for improving prevention.

3.3 Economical and psycho-sociological data

The feedback review highlights the cost of floods in the Languedoc Roussillon region : every year, the damages resulting of the small floods generated by autumn storms cost 150 M Euros in the LR region ; in 2002, the estimed cost of this severe flood is 1,2 milliard of Euros. The development cannot be sustainable is such an amount of money has to be spent to frequently. The study (Ledoux B. part in ref 2) assesses the nature and the cost of damage.
These data are important for an Economic Risk approach. For example, the authors of ref 6 suggest an Economic optimization in order to minimalize the Total Costs = Investments + Risk, in order to select the most efficient measures. The data collected in the feedback exercise will be very precious if such an approach is decided in the future.

The damage can also be reduced if the population is well informed, take pertinent decisions about their house or building site and materials, and are aware when the alert is given. This last point can also reduce the number of lost lives

The study of psycho-sociological aspects of the crisis is interesting to know objectively the various behaviors of the population. This study focuses on information flow (ref 3) in such an event was performed by a group of three researcher teams in order to identify 1) the information and signals mobilized by the population, the mayors, the companies and emergency services to determine their action to save life and values 2) the structure of information's channel 3) the lacking information to improve early warning.

Based on interviews and data reports, some chronological curves have been built in order to represent the society reactions. The limits of the preventive information and public participation in risk approach have been put in evidence. For example, the practices of risk management seen in ref 9 and 10 have not yet been tested in France. Such data are very close to those collected to perform the level 2 PSA (ref 9) to take into account crisis management and human factors aspects. The data analysis led to choose the “decision tree methodology” for building the tool and to weight the factors to discuss probability of good performance.

Conclusion

These different studies and the data collected should provide a sound basis for making a comprehensive framework using probabilistic risk assessment, in risk informed approach. They help to identify and documents, phenomena, factors, human behaviors. The aim should be the test, the prioritization and argumentation of

any realistic options existing to reduce flood damage and argument them. This could force experts to communicate together.

Of course, the complexity of the problem, the limitation of knowledge, the, uncertainties do not allow the use of existing PSA approaches directly. A lot of work and researches should be developed in this area. The Next research program "Risque decision Territoire (RDT) of the Ministry of Ecology and Sustainable Development (MEDD) should provide the opportunity to develop this type of work.

References

1. Synthesis of the lessons learnt and recommandations (in french language) : http://www.environnement.gouv.fr/infoprat/Publications/syntheses-ige/2003/media/crues_gard.pdf

2. Huet P. Duband D, Neppel J.L, Coeur D. Llasat C., Brun E, Benoit G. Ledoux B. Valarié P, Gresillon J.M. Baumont G. Inondations en Languedoc Roussillon du 9 et 10 septembre 2002, Quels enseignements un an après ? Documentation Française 2004, à paraître

3 Colbeau-Justin L, Cartier S, Ledoux B, et Wybo J.L, Etudes psycho-sociologiques concernant l'information et l'alerte pendant l'épisode extrême du 8 et 9 septembre 2002 (Crues du Gard et de l'Hérault) à paraître.

4. Sinclair Desgagné B. Retour d'expérience de la grande crise de la tempête de verglas, survenue du 5 au 9 janvier 1998 au Canada, Cahier du Programme Risques Collectifs et Situations de crises du CNRS

5. Pulkkinen U, Simola K. An expert panel approach to support risk informed decision making, VTT Automation, November 2000 STUK-YTO-TR172

6. Jonkman B.,Van Gelder P., Vrijling H. Flood risk calculated with different risk measures IHE Course on Probabilistic Design 2003 http://www.waterbouw.tudelft.nl/public/gelder/paper101c.ppt

7. Davoine P.A, Martin H., Trouillon A., Cœur D., Lang M., M. Bariendos, C. Llasat, Systematic, Palaeoflood and Historical data for the improvement of flood Risk Estimation, "SPHERE" Project

8. Llasat M.C., Barriendos M., Barrera A. & Rigo T. [2003] dans PHEFRA - Palaeofloods, Historical Data & Climatic Variability: Applications in Flood Risk Assessment, Proceedings of the International Workshop held at Barcelona, Spain, October 2002

9. G Baumont, F. Ménage, J.R Schneiter, A. Spurgin, A. Vogel. Method for quantifying human and organizational factors in accident management, using Decision Tree The HORAAM method. Reliability engineering & system safety, oct 2000, Elsevier.

10. http://www.srh.noaa.gov/lmrfc/education/safety.shtml#types

11. http://weathereye.kgan.com/cadet/flood/rules.html and http://www.environment-agency.gov.uk/subjects/flood/floodwarning

12. http://www.environnement.gouv.fr/actua/proposit/approsit.htm