Flash flood in an urban area – How to cope with policy rules and scientific recommendations?

Devastating flash floods are occurring at regular intervals worldwide with dramatic impacts on populations, critical infrastructures, assets and environment. Floods are recognised to be the most important natural hazard in Europe, and flood risk management (from prevention to response and recovery) is a critical component of public safety and quality of life, not just for dealing with the severe damage caused by floods, but also for their important social impacts. During the last 50 years important efforts to improve flood warning systems have been carried out by the scientific, institutional and administrative sectors, as well as by engineering practice.

Flash floods are floods generally caused by storm events occurring in a short period of time. In the context of policy, e.g. the EU directive on assessment and management of flood risks (Directive 2007/60/EC), "flood" is the temporary covering by water of land not normally covered by it and the term "flash flood" designates those floods showing a rapid response, with water levels rising in the drainage network within minutes to a few hours after the rain event, leaving extremely short lead times for warnings. Flood policy requirements imply that risks are identified (taking into account vulnerability characteristics of each river basin) and that flood risk mapping are set and made available to operational decision-makers and to the public. Based on these flood risk maps, action programmes are being defined for managing the risks, i.e. prevention actions, surveillance, structural measures, and preparedness to ensure that responses will be as fast and efficient as possible. The overall goal of policies, either from a flood management perspective (EU Flood Directive) or from a civil protection perspective (EU Civil Protection Mechanism, Sendai Framework for Action), is to improve the resilience of people, urban environment, critical infrastructures, assets and of the environment.

Flash Floods are localized phenomena that occur in watersheds of a few hundred square kilometres or less, with response times of a few hours or less. Such basins respond rapidly to intense rainfall because of steep slopes and impermeable surfaces, saturated soils, or because of human- (i.e., urbanization and deforestation) or fire induced alterations to the natural drainage. The high rainfall intensities generating these events, the specific terrain characteristics giving rise to very fast hydrological responses and the high variability in space and time of both rain and land surface, are the main features of flash floods and also the main cause of their extreme complexity. The main reason for a lack of effective advancement in reducing their impact is most probably related to the fact that flash flood events are very complex phenomena, which are rarely observed at a given locality with the proper instrumentation, their main characteristic being surprisingly rapid onset with very little warning. There is very little time to react once the causative event is observed. The same could be argued about tornadoes, however the reality is that forecasting and warning systems, as well as public preparedness for reducing casualties from tornadoes have very much improved in comparison to flash floods and debris flow events.

Where they are in place, the tools that flash floods forecasting and warning centres are really using in real-time operation are very far from what could be deployed with the present knowledge and the available methodologies (even in Europe). The main reason is that these centres are usually confined to using their own networks of data, or because the data collection and processing systems are obsolete or not adapted to the real needs, but also because their systems have not been designed as real operational decision support systems. Hence, they usually do not have access to the latest technologies and advancements in knowledge, and very often face a lack of well-trained technicians. It is therefore easy to recognise that there is an important gap between what we know and could do, and what is available in reality for the operational forecasting centres (usually National Hydro-Meteorological Services or governmental emergency agencies), and also for utility companies affected by flash floods and debris flows. Filling this gap is one of the first steps to efficiently improve the preparedness and the risk management in flash flood events, and it is one of the most important challenges for the practitioners involved. One major challenge is that serious advances can only be reached through joining the efforts of meteorologists and hydrologists, i.e. through a multidisciplinary approach which is rarely in place operationally. In this context, how to introduce uncertainties associated with rainfall measurements and forecasting (the main input to the computational systems capable of anticipating these events) is critical, as well as those associated with the hydrological models themselves. This should be done in a comprehensive way that should help operational agencies to take into account such uncertainties in their decisions (with the help of experts): not just the expected values of the flows, but also the probabilities associated with the different scenarios conditioned on what is observed at a given moment.

The case study will focus on a real event that occurred in October 2015 in the city of Nice (France). Based on the above, two groups representing on the one hand policy decision-makers and, on the other hand, scientists will have to study how they would have tackled the event in time, from the first warning received until the event itself. **<u>The fact</u>: Violent storms (forecasted by Meteorological Services) on the 3rd October 2015 have led to heavy rainfall in the Var river basin, leading to flash floods that have caused the death of 20 persons.**

In two groups (policy and scientists) and group discussions, examine what are the management decisions to be taken in the light of available scientific knowledge, based on the following information:

Time - 1 Day: Meterological forecasts the day before the event indicate the likely occurrence of violent storms associated to heavy rains the following day (3rd October). Stormy winds of 80 to 90 km/h are observed, and warnings are being made about flood risk in rivers located along the coastline, including the Var River and tributaries.

3rd October, 14h00: Exceptional rainfall are observed in the coastal area between Antibes and the city of Nice, i.e. 80 to 120 mm in 2 h, which is equivalent to 2 months of precipitations

3rd October, 17h00: The meteorological station of Nice reports a precipitation rate of 74 mm in 1 h which is a record not observed since at least 20 years.

3rd October, 18h: The Var River level is rapidly rising while strong winds at the coast generate high waves, including in the area of the river mouths, thus disturbing the discharges to the sea

3rd October, 19h: Torrential rain leads to flash floods in the Var River and its tributaries as well as debris flows, owing to strong winds, the airport traffic is interrupted

3rd October, 20h: Lower parts of the city are exceptionally flooded, leading to flooding of parking and tunnels, closing of highways, the railway traffic is interrupted.

3rd October, 22h: Flash floods from a tributary of the Var River leads to rapidly increasing flooding in lower parts of the coastal area, leading to 20 casualties, among which 3 elderly people in a home near Antibes, 12 people drown in their cars and 5 in parking of their building.

Some elements of group discussions:

What issues does science advisors need to consider in support decisions

- Group 1 - Decision-making (policy)
  Select the Policy Authority to chair the discussion and choose a rapporteur
  - What preparatory measures (political considerations) are discussed in the light of policy-based flood risk management?
  - What key actions / political processes can you identify, including identification of stakeholders?
  - What are the key challenges / pressures / constraints you can think of?
  - How will you decide which knowledge-based recommendations to take into account to take sound decisions?

- Group 2 - Communication of complex science
  Select a Chief Scientific Advisors to chair the discussion and choose a rapporteur
  - What are the key messages to be given to the regional/local policy-makers and authorities over the time prior to the event and during the event?
  - How should messages be presented and how do you engage policy-makers to take the scientific advices into account in their decisions?
  - What recommendations can be given in terms of warning, alerts to the population, identification of most risky areas and related disaster reduction measures?
  - Are there limits to the science advice (e.g. in the light of the management-related policy framework)?

FEEDBACK FROM GROUP DISCUSSIONS

Chair / Rapporteurs will speak on behalf of each group, and possible questions will be asked by the other group, in order to reach a consensus for decisions to be taken.