# Is 'flood risk management' identical to 'flood disaster management'?

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***Abstract***

*Related to natural hazards and, in particular, floods, the term 'risk' is defined in numerous ways and is often confused with the term 'disaster'. This article describes the Flemish flood risk methodology as an approach to tackle flood risks, which are defined as combinations of hazards and vulnerabilities. Furthermore, the relationship between the Flemish flood methodology and the integrated approach (economic damage, human health, ecology and cultural heritage) from the EU Floods Directive, is given. Finally, the concept of the flood risk management cycle and its components is compared with the management of flood disasters.*

**Keywords:** *flood risk management, risk assessment, European Floods Directive, flood disaster management*

## 1. Introduction

Flood hazards are the most common and destructive of all natural disasters. Each year, flood disasters cause tremendous losses and social disruption world-wide. In recent years, risk-based approaches have received increasing attention as means to 'manage' flood hazards. In day to day language, the term 'risk' is often used as a synonym for probability or chance. This should not be a surprise since the denotation of the term often varies with the sector in which it is applied (e.g. in legal professions, insurance, natural disaster research communities, cultural heritage researchers, etc.) (Coste, 2001). Yet, even in a flood context alone, numerous definitions for flood risk have been suggested. In their 'Language of Risk'-Report, Samuels and Gouldby (2009, p. 21) recommend to employ the term flood risk as "*the probability multiplied by the consequence in which the multiplication is to be understood as including the combination across all floods*". The definition of a disaster is even more vague. In the glossary of the UN International strategy for Disaster Reduction (UN-ISDR, s.d.) 'a disaster' is defined as "*a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources*".

The definitions of 'flood risk' and 'disaster' indicate that, although related to each other, both terms are no synonyms. Lumbroso (2007) differentiates risk from disaster in terms of impact. Whereas risk refers to *any* consequence that can be measured, a disaster denotes a large or even catastrophic event. Hence, both terms ask for a different way of management. This paper presents an overview of the functioning and the requirements of flood risk and flood disaster management, with specific attention to the state-of-the-art in Flanders (Belgium). In Belgium water management, including flood risk management is a responsibility of the regions (Flanders, Wallonia and Brussels) for the larger rivers and of the provinces and municipalities for the smaller river courses. Crisis management and disaster handling is done by the commander of fire brigade and/or the major for smaller events. As soon as more than one municipality is affected, the province governor in charge of the coordination and when more than one province is affected by flooding this is the Minister of the Interior. Formally there's no role for the regional authorities when up scaling the crisis management. However in practice the regional water managers are members emergency centres on provincial or federal level. Since they are imperative to flood risk management, flood risk calculations are discussed in the next Section.

## 2. Flood risk calculations

A recent overview of the flood risk calculation methodology for Flanders can be found in Kellens *et al.* (2008) and Deckers *et al.* (2009). The scheme (cfr. Figure 1) in Kellens *et al.* (2008) elucidates the type of data that is needed to calculate flood risks.

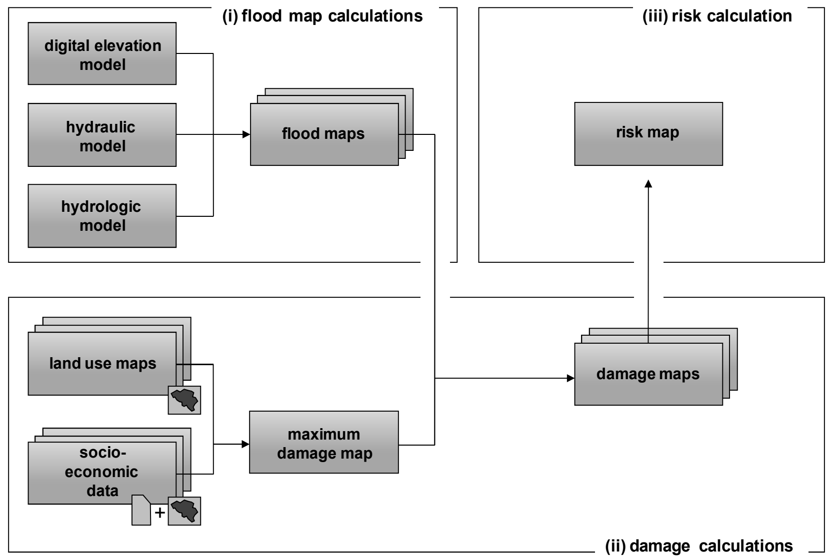


**Figure 1** Derivation scheme of flood risk mapping in Flanders (Kellens *et al.*, 2008)

It is beyond the scope of this paper to discuss the hydrodynamic software that is needful to create flood maps. However, their importance should not be neglected, since detailed flood maps, indicating the flood extent, the water depth and (where relevant) flow velocity and rising velocity, are essential to produce meaningful calculations on the consequences of flooding.

## 2.1. Digital Elevation Model

The Digital Elevation Model (DEM) plays a key role in the flood risk methodology. For Flanders, a DEM ("*DHM Vlaanderen*") was created on initiative of regional water management authorities together with the Flemish agency for geographic information (AGIV) between 2001 and 2004. It is based on laser scanning in rural areas with basically 1 point per 4 m² during recording. After filtering out buildings and vegetation, 1 point per 20 m² remains in the final Triangular Irregular Network (TIN) file. For urban areas, photogrammetric interpretation based on stereoscopic aerial photos is used, resulting in 1 point per 100 m². Additional break lines are added to compensate for the lower point density. This high density of elevation points is needed, as the topography is rather flat in a large part of the territory. The local variations have to be in the model to accurately delineate the flooded area. Local embankments or quarries not immediately included in the elevation model create over- or underestimation of the flood zone.

## 2.2. Land-use information

A detailed and uniform land-use map is an important prerequisite to perform flood risk calculations, since it determines what is damaged in case of flooding (De Maeyer *et al*., 2003). In the Flemish methodology, various land-use categories are distinguished (e.g., urban area, industrial area, infrastructure, crop land, pastures, etc.) and further subdivided according to their vulnerability level, which is related to the desired level of detail: a high level of thematic detail is needed where the damages are high or highly varying (e.g., built-up area, industry and infrastructure) and less where the (economic) damages are low (e.g., different types of pastures of nature areas). The vulnerability of the land-use categories is determined by various socio-economic data (e.g., replacement values).

With respect to spatial distribution and update frequency of land-use data, airborne and space borne data sets have been found promising in the past. Results from the FAME project showed that Landsat images, as compared to IKONOS (Willems *et al*., 2003), offered less thematic and spatial detail, but allowed to use interpretation keys for the entire territory of Flanders. Therefore, the CORINE Land Cover (which is based on Landsat imagery) was found most suitable in the early stages of the Flemish risk methodology. Recently, cadastral information is being employed to calculate the damage of individual houses and industrial sites resulting in a higher level of detail (Vanderkimpen *et al*., 2010).

It is important to note that the detailed methodology used in Flanders is currently not applicable on an international river basin. Each country collects socio-economic information differently and applies interpretation keys of land-use information in a (slightly) different way (e.g. Verwaest *et al.* (2008) for the countries along the North Sea coast). However, there is improvement in sight. As part of the AMICE project, the international catchment of the Meuse is used as a test case to develop overarching interpretations of the CORINE Land Cover in addition to the national and regional interpretations.

## 2.3. Flood risk calculation variables

The final stage comprises the combination of the flood maps (i.e., hazard maps) with the land-use maps (i.e., vulnerability maps). So-called stage-damage curves are often used to define a relation between the water depth (or another flood characteristic) and the expected damage for each specific land-use category. Many functions have been proposed in the past, either on theoretical grounds, or on empirical grounds (e.g. Van der Sande 2001, Kok *et al.* 2002, Penning-Rowsell *et al.* 2005). After the recent floods in Belgium (in November 2010 and in January 2011), it makes sense to set up an inquiry to calibrate the functions used in Flanders.

A specific issue regarding the applicability of stage-damage curves is the limited validity of the economic information. The same damage can be expressed as replacement values, or depreciated costs. Moreover, the same goods can have a different value due to taxes and insurance systems, making values and stage-damage functions not transferable to other countries automatically. These differences are worked out in the Interreg IIIb North Sea project SAFECoast (Verwaest *et al.* 2008) for countries in the North Sea Region.

As for land-use, these differences in water depth-damage relations make a comparison between different regions complex and the possibility exists that the uncertainties are dominant in people's perceptions, even when the conclusions are robust. Additional calculations with common stage-damage functions may be needed and the Joint Research Centre in Ispra (Italy) is elaborating such functions (Barredo & De Roo 2010).

In the final phase of the methodology, the set of damage maps is integrated into a single risk map (cf. Figure 1). Each damage map can be seen as a scenario to which a weight is attached, based on the scenario's return period. The Flemish methodology employs different corrections for these factors to compensate for the limited number of modelled flood maps. Whereas the damage maps represent the consequences for each scenario, the flood risk map expresses the average damage per year.

## 3. Flood Risk Management

Flood risk management comprises more than flood risk calculations. Figure 2 presents the Lumbroso framework for flood risk management, which is close to the terminology of the EU Directive on the assessment and management of flood risk (EU COM, 2007, further referred to as the "Floods Directive"). While The Floods Directive states that (Article 7 §3): "*Flood risk management plans shall address all aspects of flood risk management focusing on prevention, protection, preparedness, including flood forecasts and early warning systems",* Lumbroso (2007) did not implement "protection" in his framework. However, this phase can be located between the prevention and preparation phases.

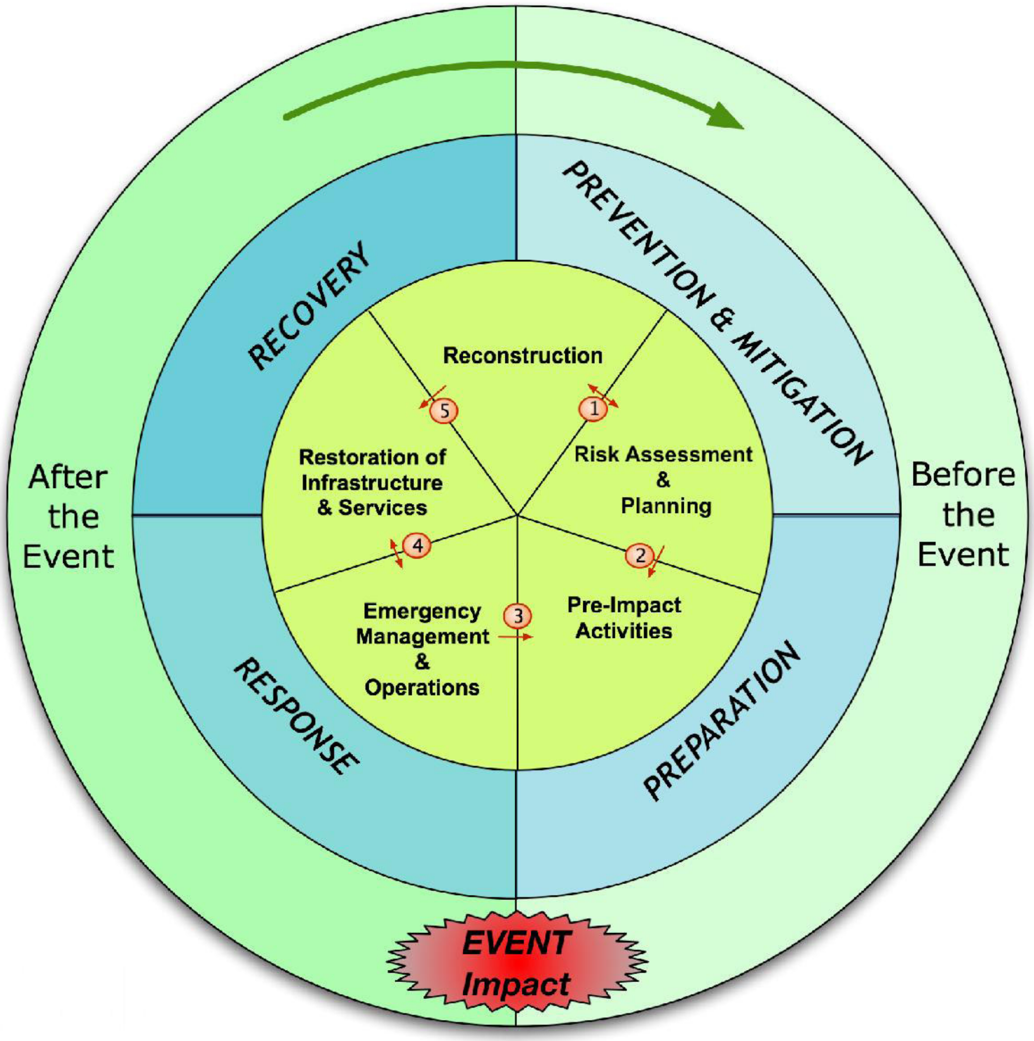


**Figure 2** Flood Risk Management Cycle (Lumbroso, 2007)

As denoted in Article 7, §2, the Floods Directive focuses on the reduction of potential adverse consequences of flooding with regard to human health, the environment, cultural heritage and economic activity. Until now, the majority of the flood risk calculations only consider economic losses. Social cost-benefit analyses are ideal instruments to bring together the tangible (economic losses) and intangible elements (social and ecological aspects). For example, the revised Sigma plan, a master plan for flood safety along the river Scheldt, has implemented such analyses to evaluate different scenarios (e.g., heightening of river embankments, controlled overflow zones and reduced tidal areas, etc.).

It is of paramount importance to work with a common framework (using monetary values or another quantified method) to evaluate the effects of different scenarios. Recently, more information is becoming available to directly or indirectly valuate the human and social aspects, the ecology and the cultural heritage. As part of the European FloodResilienCity project, Flanders tried out an integrated approach in the area of Leuven and the Woluwe catchment. Such exercises are valuable to meet the objectives of the Floods Directive in terms of flood risk management plans, but the number of scenarios worked out in the case studies is still too limited to derive conclusions yet. Moreover, these exercises show that the complete process is time-consuming because of the participatory approach. This approach involves the organization of several workshops in which different aspects of the flood risk management planning are explained to the participants. These participants are mainly professionals, but it is intended to involve the public in the future as well.

Preamble 17 of the Floods Directive states that synergies between – and benefits of – the Water Framework Directive (EU COM, 2000) and the Floods Directive have to be found. Hence, adequate coordination of the objectives and of the measures proposed in both plans are required. Flanders is surpassing the requirements by combining the River Basin Management Plans (for the Water Framework Directive) and the Flood Risk Management Plans of 2015 into one plan (one document). The legal framework to do so was already set up by the Decree of Integrated Water Policy of 18 JUL 2003 (Belgisch Staatsblad, 14 NOV 2003) where aspects of flooding were already taken into account. The first generation of the River Basin Management Plans and the Programme of Measures (CIW 2010) already contains a group of flood measures.

## 4. Flood disaster Management

Disaster management can be regarded as the reaction on an event, which is indicated by the response and recovery phase in the scheme of Lumbroso (2007) (see Figure 2). Whereas flood risk management applies to a whole range of events, flood disaster response will try to minimise the effects from just one specific flood disaster.

We demonstrate the difference between flood risk and disaster management with the following example. A flood risk equal to zero does not exist by definition. Even a null flood risk for mortal victims is fictitious since an exceptional – and unforeseen – event is always possible. Yet, as the probability decreases, the contribution to the overall flood risk drops below a point where (according to a social cost benefit analysis) additional measures are not justifiable any more. This is opposite to the way of thinking in disaster management. In case a flood disaster occurs, every possible means will be used to minimise its impact.

Contrary to flood risk management where statistical information is needed, real time information becomes vital in this context. Disaster response is defined by the actual situation, which means that the actual number of present people will define how much evacuations are needed and not the average number of inhabitants over a year. Likewise, weather patterns of today and the next days will define the actions and not the statistical weather over a (longer) time frame. As such, discussing the possible effects of demographic evolutions, land-use changes and climate change makes less sense in a context of disaster management than in flood risk management, where changing probabilities due to long-term evolutions are highly relevant in a social cost benefit analysis.

Overall, it makes no sense for flood disaster management to use the same complex maps as for flood risk management. Flood risk maps denote the impacts on human health, economic activity, ecology and cultural heritage, and which take different scenarios into account using detailed land-use data sets and stage-damage curves. On the contrary, unambiguous maps with clear key elements are of much more interest to flood rescue and disaster teams. Since the aim and the end-user differ between both management types, the use of tailor-made products is preferred. Geographic Information Systems and other digital techniques offer the opportunity to reach this goal.

Obviously, the picture is not black and white. The fact that there seems to be strong interconnectedness between flood risk and flood disaster indicates an overlap between both concepts to some extent. Moreover, flood disaster response and recovery needs preparation, which is supported by the outcomes of flood risk management. Nowadays Flemish water managers are preparing their flood risk management plans to report under the EU Floods Directive. Their contacts during the recent floods with fire brigades and the Civil Defence corps make them aware of the operational requests for disaster managers. Operational flood maps will be made together. And more than in the past disasters teams in the provinces ask for input from the water management authorities when updating evacuation plans and specific flood disaster plans.

## 5. Conclusions

Due to the structure of the Belgian federal State, regional and federal governments have different responsibilities – respectively for water management (including flood risk management) and disaster handling (including crisis management). As one of the responsibilities cannot be handled without understanding the role of the other actors, having a '*common language*' or '*interpretation key*' is essential. There's no need for a totally shared terminology (as long as the meaning is clear for all stakeholders). In the actual situation the same terminology is only common in name.

'Flood risk' and 'flood disaster' are closely related concepts and the context (i.e., their definition) is necessary to understand what is meant exactly. A distinction between the two concepts cannot be made solely based on required data. Both concepts can be described in detail, where specific and local information is essential. For flood risk management, knowledge of local damage during past floods to update stage-damage functions for better risk evaluation of scenarios can be seen as an example. For flood disaster management, details for example entail the exact number of people and their possibilities in an elderly house during an evacuation.

Having an overview, as well as different levels of detail in the information, is needed and the comparability of data becomes essential. During the planning phase, flood risk managers want to compare their data with others in the same international river basin district or along the same coastline. Then rougher information can bring added value, not as an absolute truth but as a possibility to focus on the robustness of information and the elements that are known rather than on the unknown information. Space born data can be of assistance as they cover larger areas and are not restricted to administrative boundaries. A European land-use map, such as CORINE Land Cover, can be too rough for local analysis but can add big value if the objective is to compare situations in different countries.

The same is true during flood disaster response. Summarized information helps the high-level decision makers in their strategic choices. For hazard data rainfall radars give an impression of the rainfall over the whole area, however such radars provide less accurate information than gauging stations. At the vulnerability side, an overview (and selection) of hotspots as e.g. schools, hospitals and elderly houses, is needed.

In recent years in flood research communities, the concept of risk as a function of hazards and vulnerabilities or a combination of probability and consequences is extended. Often the word 'resilience' appears in the definition. Without focussing on the definition, the term resilience is integrating a variety of dimensions (e.g. social, socio-cultural-historical, legal-institutional, political and economic characteristics), differing with the flood type and the degree of awareness as well as with the uncertainties and the way they are dealt with (Schwindt & Thieken, s.d.). This concept can bridge flood risk management and flood disaster management. An increase of the resilience (also referred to as 'adaptive capacity' or 'coping capacity') is a 'before the event' action to minimize or decrease the negative consequences after the flood disaster.

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