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FLOOD RISK AND FLOOD RISK MANAGEMENT – AN OVERVIEW

Questions of how to handle flood risk are as old as many human settlements themselves. Risk management has been established as a well defined procedure for handling risks due to natural, environmental or man made hazards, of which flood are representative. In certain European river basins, transboundary water resources management has flood risk management a long history (e.g., the Rhine, the Danube and the Iberian river basins). However, transboundary cooperation is not simple and requires concerted efforts from riparian countries. Transboundary flood management is a long process and typically undergoes different stages. The aim of this paper is describe flood risk, basic methodology for flood risk assessment and flood risk management.

1. Introduction

Flooding is the most common of all environmental hazards. The assets at risk from flooding can be enormous and include private housing, transport and public service infrastructure, commercial and industrial enterprises, and agricultural land. In addition to economic and social damage, floods can have severe consequences, where cultural sites of significant archaeological value are inundated or where protected wetland areas are destroyed. Regarding floods in Europe, two trends point to an increased flood risk and to greater economic damage from floods. First, the scale and frequency of floods are likely to increase in the future as a result of climate change, inappropriate river management and infrastructure development in flood risk areas. Second, an increase in vulnerability has been noted due to the number of people and economic assets located in flood risk zones. Therefore the coming decades are likely to see a higher flood risk in Europe and greater economic damage [1].

On 16th of November 2007 the European Commission adopted a Directive on the assessment and management of flood risks (EU Floods directive 2007/60/ES). It was developed to establish a framework for assessment and management of flood risks, with the aim of reducing adverse consequences for

human health, the environment, cultural heritage and economic activity associated with floods in the European union (EU).

The directive requires EU member states:

(a) to assess whether watercourses and coastlines are at risk from flooding by 2011;

(b) to map the flood extent, the assets and the populations at risk in these areas by 2013; and

(c) to take adequate and coordinated measures to reduce the flood risk - to establish flood risk management plans focused on prevention, protection and preparedness by 2015.

The directive is to be implemented in coordination with the EU Water framework directive [2], notably by coordinating flood risk management plans and river basin management plans, but also by coordinating the public participation procedures for preparation of these plans. All assessments, maps and plans prepared are to be made available to the public. Member States must furthermore coordinate their flood risk management practices in transboundary river basins, including with third counties, and should not undertake measures that would "significantly increase flood risks" in neighbouring countries, unless these measures have been coordinated and an agreed solution has been found. Member states should in take into consideration long-term developments, including climate change, as well as the sustainable land use practices in the flood risk management cycle addressed in the directive [3].

2. Defining terms and concepts

Flood risk management can be roughly divided into two parts: flood risk analysis & assessment on the one hand and risk mitigation on the other. For both parts, risk assessment and the evaluation of risk mitigation measures, it is required to quantify flood risk as exactly as possible [4].

In order to fully understand flood risks it is crucial to be familiar with the different components that construct risks. Flood risk involves both the statistical probability of an event occurring and the scale of the potential consequences. All development of land within the floodplain of a watercourse is at some risk of flooding, however, small. The degree of flood risk is calculated from historical data and expressed in terms of the expected frequency 10 year, 50 year or 100 year flood. Flood risk is a function and a product of hazard and vulnerability, that is:

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability}$$

A real flood risk level requires a certain level of hazard, and for the same location, a certain level of vulnerability. A situation of risk is due to the incompatibility between hazard and vulnerability levels on the same land plot [5].

Hazard is the probability that in a given period in a given area, an extreme potentially damaging natural phenomena occurs that induce air, earth

movements, which affect a given zone. The magnitude of the phenomenon, the probability of its occurrence and the extent of its impact can vary and, in some cases, be determined.

Vulnerability of any physical, structural or socio-economic element to a natural hazard is its probability of being damaged, destroyed or lost. Vulnerability is not static but must be considered as a dynamic process, integrating changes and developments that alter and affect the probability of loss and damage of all exposed elements.

Risk can be related directly to the concept of disaster, given that it includes the total losses and damages that can be suffered after a natural hazard: death and injured people, damage to property and interruption of activities. Risk implies a future potential condition, a function of the magnitude of the natural hazard and of the vulnerability of all the exposed elements in a determined moment [5, 6]. According the directive 2007/60/ES [3] is flood risk defined as "a combination of probability of a flood event and of the potential adverse consequences for human health, environment, cultural heritage and economic activity associated with a flood event".

3. A methodology for flood risk assessment

The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions. The aims of assessment are to introduce a sound science-based assessment method to people working in river basins; and to point out how using the methodology makes environmental assessment data more useful to managers [7]. General methodological framework for flood risk assessment is given by the following figure 1:

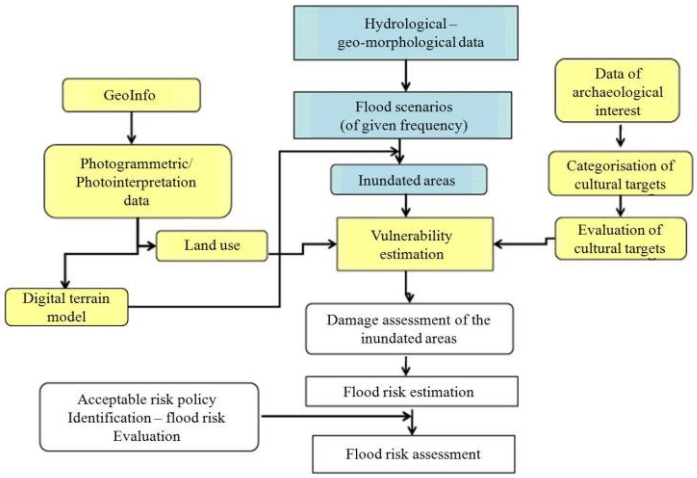

Fig. 1 Methodological framework for flood risk assessment [1]

The procedure for the assessment of flood risk is developed by allocating the workload into three categories of steps that can be initiated independently and represented with different colour. The first category (coloured yellow) refers to the task of collection and processing the necessary data in order to determine the boundaries of the system under risk (in this case particular cultural sites) and subsequently to identify the socio - economic conditions of the surrounding areas (for instance to determine the local land use establishment). The second category involves (coloured blue) the development of hazard scenarios, the estimation of their probability of occurrence. At each scenario the production of the respective floodplain mapping delineation is given in ArcGIS environment so as to identify the flood prone areas and therefore the cultural sites that are under the inundation threat. The third category in the workflow depends on the results of the two previous ones and so it is always performed last. It assesses the expected damage of the affected system and consequently it estimates the annualised flood risk in monetary units, if possible [1].

4. Flood risk management

Rivers are dynamic systems and society is changing all the time. Integrated flood risk management is hence a cyclic management process (see figure 2). The flood risk management cycle is described in the Directive on the assessment and management of flood risks [3]. This cyclic process encompasses the following steps [3, 8]:

Prevention - flood prevention measures are as follows:

- engineering, bioengineering and administrative (focused on removal and elimination of causes of floods) – these generally fall under responsibility of land owners, administrators and local municipalities;
- management and control activities / measures - these measures and above mentioned measures fall under responsibility of state flood protection administration where local municipalities play a certain role, due to transfer of state administration from a central to local level.

Protection - these measures are focused on decrease of floods probability and/or their consequences on a certain area through landscape management, applied in case of a flood event (it means management of flood and its consequences). In Slovakia, Slovak water management enterprise through its branches (i.e. river basin authorities) is managing existing flood defense infrastructure.

Preparedness - in case of flood events, informing public on floods risks and measures that have to be taken during floods.

Rescue action - coordination of rescue activities in river basins and human settlements during flood events.

Restoration and exchange of experiences - goal of this phase is to return an area, damaged by flood, into normal conditions as soon as possible and thus to reduce social and economic consequences on general public.

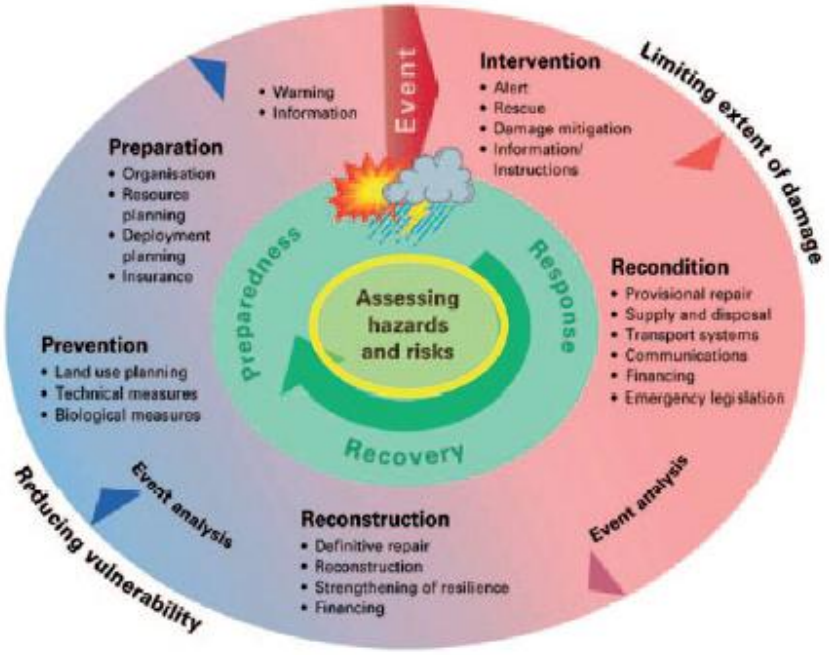

Fig. 2 The cycle of integrated risk management [8]

Integrated flood risk management requires adopting a river basin approach to planning that involves many disciplines and stakeholders in efforts to reduce flood vulnerability and risk and to preserve ecosystems. It also seeks to strengthen our adaptive capacity to climate variability and change. It is based on the following principles [8]:

• River basin management. Water management should be based on boundaries of the river basin, not on administrative areas or country borders, thus taking into account a river system as a whole, from source to mouth.

• Solidarity. Problems should not be shifted to neighbouring countries or regions. Negative effects between upstream and downstream areas should be prevented, and positive effects should be stimulated.

• Sustainability. Integrated water resources management aims at a combination of economic development, ecological protection and improvement of social welfare and justice. River basin management should start with a cohesive approach in which a broad spectrum of interests, disciplines and policy fields are involved. Different aspects, e.g. water quality, water quantity, groundwater use, land use, economy, ecology and the environment, need to be

balanced. In the context of flood management, the principles of sustainable development involve ensuring livelihood and security among different population groups as well as the viability of ecosystems and floodplain functions, including in the long term.

• Public participation. Active public involvement in the development and implementation of water management strategies and plans.

In the policy of Slovakia, some investment measures are in contradiction. On the one hand, it underlines importance of integrated river basin management and overall protection of landscape, but on the other hand, it proposes investment measures that as a partial solution can serve local needs, however, contribute to increased flood risk in river basins as a whole (e.g. stream regulation, restoration of pumping stations, etc). It is necessary to reassess implementation of these measures in the context of their overall impact on increase or respectively on decrease of river basins ability to retain water. Proposed measures are not solving elimination of floods causes [9].

5. Conclusion

The anticipated climate change may result in an increased occurrence of flood discharges. Basic approach to deal with flood protection must be based on respect to the natural character of these extreme phenomena and on the need to mitigate their impact. It is appropriate to prefer such targets and measures that are of multipurpose features and help to increase the retention capacity of landscape and to stabilize landscape water regime [10].

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FLOOD RISK AND FLOOD RISK MANAGEMENT: AN OVERVIEW

S u m m a r y

River floods are considered one of the most important natural disasters in Europe as well as worldwide. It has now been widely accepted that the frequency and magnitude of river floods may increase because of climate change. Nevertheless, it can be complex, targeted measures to reduce their range and at least partially reduce the adverse effects. Floods do not respect boundaries, by the national, regional or institutional. Therefore, trans-boundary flood risk management is imperative – it involves governments – as borders are involved – and their people – as risk is involved. However, it is not easy to implement: joint monitoring, forecasting and early warning, coordinated risk assessment and joint planning of measures, and appropriate legal and institutional frameworks are all necessary. To support the transition from traditional flood defence strategies to a flood risk management approach at the basin scale in Europe, the EU has adopted Directive (2007/60/ES). The paper deals with overview about flood risk, flood risk assessment and basic principles of flood risk management.