

Analysis of Strategies to Attain a Resilience Approach in Adaptation to Urban Flooding

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Abstract

The Integrated Flood Management (IFM) concept intends to obtain the maximum of benefits from the use of floodplains and the minimum of losses from flooding which seems to be the ideal outcome of flood management. For this, different strategies are recommended in order to reach this objective. The implementation of this concept leads to a resilience approach for the adaptive management of floods and is currently on its way to be better understood and integrated as part of the water resources management.

There exist a fair amount of strategies to adapt to flooding that have been recommended or already implemented either as planned or autonomous ways of adaptation but their effectivity depends on the specific case where they are applied. This is why this paper looks to give a better overview of the different recommended or implemented strategies by analyzing them regarding their inherent advantages and disadvantages.

Key Words: Urban Flooding, Resilience, Adaptation Strategies

1. INTRODUCTION

Floodplains provide an important share of natural resources to populations worldwide. Nowadays the increase of flood risks in these areas due to issues like population pressure and degradation of ecosystems is of general concern, with climate variability and change being the most recent addition to these problems. Furthermore, the inadequate flood planning and management of the floodplains that leads to exacerbate the impacts of the flooding. The traditional approaches used in the past years to solve these problems, like resistance or predict-and-prevent approach, cannot cope anymore with the increased risk and especially with the uncertainty that climate change and variability present now and in the future [8][14]. Therefore, new concepts like the Integrated Flood Management recommended by the WMO[5] and resilience strategies which are being intensively studied by several countries like Netherlands for the Rhine and Meuse rivers[7][8][11][13] and France for the Loire [9]are needed in this field. The objective of these studies is to be able to obtain more sustainable, less prone to risks and better adapted systems. The feasibility of some of these measures is

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still under study; nevertheless, the results obtained from the research done so far indicate a significant improvement towards sustainability and resilience.

2. RESILIENCE STRATEGIES EVALUATION FOR FLOOD MANAGEMENT

2.1 The concept of Resilience

The concept of resilience was originated in Ecology as a term to define the capacity of an ecosystem to “...withstand shocks and rebuild itself when necessary...”. This concept has led to the idea of imitating nature by adopting a resilience approach to target different problems. From here, the Resilience Approach has emerged as a plan of action to create a system able to adapt and return to the desired state of development after it has been impacted by a disturbance.

De Bruijn [7] uses the concept of resilience in the context of flood risk management defining it as “the ability of a system to recover from floods”, where recovery refers to the overcoming of the negative impacts caused by the flood and the system being the basin, city, etc.

The Resilience Approach in flood management needs to work with integrated short-term as well as long-term strategies, even if the disturbance of interest, in this case the flooding, is a sudden event.

2.2 Analysis of Strategies

As flooding has always been one of the main concerned issues for human settlements, many strategies have been developed and implemented to alleviate the damage caused by it. Studies on flood management have been made to a great extent and by going through this literature flood management strategies can be classified into two general groups: Physical or Structural and Regulatory or Non-Structural with further classifications.

Resilience been a recently adopted concept in the management of risks does not seem to have a defined structure of strategies since authors have not yet agreed on the extent of it or even on a formal definition within the field of adaptation. Therefore, to bring the concept into flood management is still what it appears to be a combination of adaptation and flood management strategies, having still an extensive open space for new ideas and innovation. The structural strategies found, that were considered to contribute to the increase of a system’s resilience to flooding are shown in table 1.

Table 1. Structural flood management strategies that contribute to the resilience of the system

Resilience in Flood Risk Management	Runoff Management	Increase infiltration	Urban surfaces desealing
		Water storage	Roof greening, Ponding, Rainwater harvesting
	Flooding Adaptation	Increase Discharge Capacity	Green Rivers, Floodplain lowering
		Controlled Flooding	Compartmentalization, detention areas, calamity polders. Relocation, removal, controlled breaking of dikes, embankments, flood walls
	Water Transfer	Channels	Diversion channel / Channel conveyance. Stream Channel Strips. Road System Design
		Drainage	Dual drainage. SUDS
		Pumping System	Urban sewer relief from flood water. Groundwater extraction/lowering during flood event
	Architectural	Materials	Water permeable/impermeable. Easy to repair. Separable
		Flexibility	Mobile, demountable, inflatable defenses
		Design	Building greening. Retrofitting. Elevation of central heating, electrical circuits and high monetary items

2.3 Advantages and Disadvantages

Besides the intended purpose for which the strategies are implemented such as flood probability reduction or flood impact mitigation, several other inherent advantages and disadvantages can be identified for each of them. A general review indicates common advantages among the resilient strategies: runoff reduction, water storage, reduction of water levels, increase discharge capacity, reduce sewer flooding, increase water quality, faster recovery and faster evacuation. Only two of the advantages seem to be contradictory, runoff reduction and increase of discharge capacity when intended to be through the road system design or through the major drainage system of a dual drainage; but in reality a combination of both will give a higher level of resilience for the system.

The two main disadvantages found for several of the strategies presented in table 1 are the high cost of implementation or maintenance and/or the need of space or land for the implementation of the strategy. Some may even deteriorate the landscape of the area (ponding, compartmentalization, detention areas, and calamity polders).

The specific situation and level of adaptation will decide which strategies are more suitable to be implemented. Studies carried out on the feasibility of the resilience strategies in the Loire in France have stressed that the detention areas strategy is the only type of measure that is capable of reducing the water level in downstream areas of the strategy implementation. The other strategies will, on the contrary, push the water level slightly up downstream of the measure. The efficiency of strategies like excavation of river banks is considered low due to the high cost involved and the relatively small effect in lowering the water level.

3. APPLICATION EXAMPLE

Complete polder systems have been created in Netherlands between the 16th and 19th century with primary river dikes and secondary dikes that formed closed compartments within the polder that would delayed the propagation of the flood increasing the time for evacuation. Nevertheless, during the 20th century due to the improvement of the primary river dikes the secondary defense system was neglected. Current assessments of risk and potential damages due to dike breaching or overflowing show that a well-design compartment layout, comprising both modern and repaired embankments, to protect the more vulnerable parts is needed to improve the safety situation in the polders[2].

The viability of this technique has been explored by other countries like Bangladesh through projects like CPP (Compartmentalization Pilot Project), where it was demonstrated by means of simulation techniques that a multi-compartment setting is technically viable with benefits to agriculture, aquaculture and the prevention of flood damage. It is also revealed from the flood inundation maps that flooding situation in the region would improve significantly due to the multiple compartments setting [1].

4. RECOMMENDATIONS

Wardekker et al. (2009) presents a methodology to gather a set of ideas that lead the target society to a resilience approach in order to adapt to climate change, which is suitable to their local situation. As they call it, a way of “operationalising a resilience approach”. Some of these ideas that have been considered strategies to cope with a changing climate can also contribute or be implemented in flood management. Strategies like re-buildable cities (especially the ones that get frequently flooded), diversification of income, budget, activities, industries, crops, livelihood, energy supply options, inland transportation of goods; multiplicity of building functions, routes, electricity supply and removal of sewage, crisis centers and access levels in buildings, are just some ideas that can be adopted or adapted to adapt and cope with floods.

This type of methodology, which targets all aspects of the society (economic, structural, organizational, etc.), finds its most difficult constraint in getting the agreement of all the parties to collaborate with each other. Therefore it is recommended to introduce and get all areas of the society to adopt the resilience concept to achieve an integrated approach in such way that the collaboration is done because all the interested parties are looking into the same direction (resilience in each of their own areas) and not by forcing them to include each other’s interests into their own.

5. CONCLUSIONS

Resilience is still a relatively new concept in the field of flood management and therefore more studies on its extent and new ways of carrying it out are essential. An effectivity analysis of the strategies should also be carried out in a local and regional scale, as well as the possible implications for other areas. It is necessary to explore other resilience strategies

that could be adapted to flooding by analyzing and looking towards other research areas and types of risks. The adaptation strategies to climate change, a field of great concern in the present, are closely related to building resilient societies and therefore to produce less vulnerable societies to different risks including the impacts of flood. Therefore, it is recommended to review these adaptation ideas in order to attain a more complete scheme with better and innovative results in flood management.

It is of general agreement that higher levels of resilience are obtained with greater levels of integration. To talk about a resilience approach is to include all concerned parties in the implementation of strategies. Thus, the implementation of a resilience approach into flood management does not only include strategies directly related to flooding but also strategies that lead to a stronger, less vulnerable society. This means that regulatory and adaptation strategies in other fields, in addition to the flood management measures, could also contribute to the increased resilience of the system at risk.

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