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FloodProBE: technologies for improved safety of the built environment in relation to flood events

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ABSTRACT

The FloodProBE project started as a FP7 research project in November 2009.

Floods, together with wind related storms, are considered the major natural hazard in the EU in terms of risk to people and assets. In order to adapt urban areas (in river and coastal zones) to prevent flooding or to be better prepared for floods, decision makers need to determine how to upgrade flood defences and increasing flood resilience of protected buildings and critical infrastructure (power supplies, communications, water, transport, etc.) and assess the expected risk reduction from these measures.

The aim of the FloodProBE-project is to improve knowledge on flood resilience and flood protection performance for balancing investments in flood risk management in urban areas. To this end, technologies, methods and tools for assessment purposes and for the adaptation of new and existing buildings and critical infrastructure are developed, tested and disseminated.

Three priority areas are addressed by FloodProBE. These are: (i) vulnerability of critical infrastructure and high-density value assets including direct and indirect damage, (ii) the assessment and reliability of urban flood defences including the use of geophysical methods and remote sensing techniques and (iii) concepts and technologies for upgrading weak links in flood defences as well as construction technologies for flood proofing buildings and infrastructure networks to increase the flood resilience of the urban system.

The primary impact of FloodProBE in advancing knowledge in these areas is an increase in the cost-effectiveness (i.e. performance) of new and existing flood protection structures and flood resilience measures.

1. Introduction

Floods, together with wind related storms, are considered the major natural hazard in the EU in terms of risk to people and assets (European Environment Agency, 2010). Between 2000 and 2009, Europe has witnessed some of the largest flooding events in its history. Recent major flooding events include the 2007 floods in the United Kingdom and the Elbe and Danube river floods during the summer of 2002. Over the last 10 years, floods in Europe have killed more than 1000 people and affected over 3.4 million others (Guha-Sapir et al., 2010; EM-

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DAT, 2010). Currently, more than 40 billion € per year is spent on flood mitigation and recovery (incl. compensation of flood damage) in the EU. More than 75% of the damage caused by floods occurs in urban areas (Ashley et al., 2007). About 3 billion € per year is spent on large-scale flood defence structures alone.

Losses due to floods have increased in Europe over the last few decades. Population increase and increases in asset values in flood prone areas may contribute to this. (European Environment Agency, 2010). The ongoing urbanisation worldwide, as reflected by the growth of the number of megacities, also in deltaic areas, will thus require even more action in relation to this hazard. 70% of the population will live in urban areas by 2050 (United Nations Population Division, 2008) and the economic values in these areas are constantly growing. Urban areas are mostly located in deltas close to rivers and the sea which are often subject to land subsidence. This means that flood risk in urban areas will increase disproportionately: flood damage figures in Europe could rise to 100 billion € per year by the end of the century (European Environment Agency, 2008).

Although there is no clear evidence that increased flood losses over the last decade are related to climate change, research on Flood Risk Management also has to address concerns coming from climate change scenarios regarding the likelihood of further increases in hydrologic flooding (Barredo et al., 2008; Barredo, 2009; Defra, 2008; European Environment Agency, 2010). In addition to increased numbers of extreme weather events such as more frequent intensive precipitation, the increasing temperature has caused more melting water, particularly from polar ice. This causes the sea level to rise and expose coastal areas and cities to flooding during storms creating a more hazardous situation for the billions of people who live only few meters above or even below sea level. The increasing temperatures are likely to change weather patterns in many areas. Heavy rainfall increases the frequency of flash floods and more snow in wintertime causes serious floods during the snow melt periods.

Thus climate change and concentration of population and assets in urban areas are the main trends likely to affect flood related societal costs, risk to human life and loss of assets in the near future.

The problem owners for the issues outlined above are the public authorities responsible for flood protection and water management as well as other asset managers.

Urban flood defences comprise both soft soil embankments and hard structures that may stem from centuries ago and built from locally available materials. Due to this their status is often not fully know. Failures are very often caused by internal and/or external erosion processes, particularly at transitions between defence types. Complex combinations of defence types are typical in urban areas. Since flood defence systems are only as strong as the weakest links (''risk hotspots''), these have to be identified, assessed and strengthened.

Traditionally, flood management practices have focused on defensive practices. In the past two decades, due to the realisation that risk could and should be actively managed, a shift has been observed from predominantly defensive actions to the wider focus of pro-active management of risk. Land use is possibly the most significant aspect of flood risk management, hence it is essential to ensure that this is an integrated process. The key messages from the update of the UK 2004 Foresight Future Flooding study (Evans et al., 2004, 2008) are that (i) river and coastal defences have the greatest potential impact for reducing overall flood risk, (ii) better land use planning and the flood-proofing of buildings still appears amongst the most important risk reducers, and (iii) finding the space in urban areas to accommodate increased overland flows is one of the most important responses.

This rethinking and substantial change in the traditional approach to flood risk management has to be developed within an appropriate regulatory framework. Necessary restrictions in the land use planning in areas prone to flooding have to be included in development plans for all types of flooding. Flood preparedness will be mainly influenced by increasing the resilience of the built environment (in the widest sense). In parallel, contingency planning encompasses all activities and resources in case of a hazard event that include emergency response; emergency infrastructure; financial preparedness and recovery plans.

It follows from the above that traditional flood risk management approaches omit important ways of dealing with floods pro-actively at city level, and of building on bottom-up responses that reduce their impact and enhance recovery.

2. Project objectives

The project FloodProBE is funded under the Seventh Framework Programme from the European Union starting November 1st 2009 and running for four years. The principal aim of the project is to provide cost-effective means for flood risk reduction in urban areas. To this end, FloodProBE will develop technologies, methods, concepts and tools for enhanced assessment and adaptation of urban systems related to floods. Major bottlenecks that hamper the adoption and wide spread uptake of these technologies are amongst others: (i) lack of understanding of current and future risks, (ii) lack of long-term planning, poorly integrated and comprehensive planning, (iii) lack of understanding of the effectiveness of these technologies, and (iv) inadequate controlling roles of local and regional authorities, and lack of formal guidance and policies for implementation.

The current research will build up on the results of key initiatives such as the European FLOODsite (www.floodsite.net) and ComCoast projects and national/regional projects such as FRMRC (UK), RIMAX (DE), NOAH/FLIWAS (NL, DE), FloodControl2015, SBW (NL), Criterre and ERINOH (FR). Priority issues for urban flood risk management are subject of research in FloodProBE.

The specific project objectives are:

1. To improve methods for assessing the vulnerability of the urban environment related to floods, especially by extending conventional methods with the ability to assess indirect impacts of damage to critical networks and assets with a high value density.
2. To improve the understanding and assessment of urban flood defence performance, in order to develop suitable