SCIENCE-POLICY BRIEF No. 1

CORFU
FP7 Collaborative research on flood resilience in urban areas

FLOOD RISK MANAGEMENT IN CHINA

This brief explains the role that Collaborative research on flood resilience in urban areas (CORFU project) has played in changing flood risk management and planning policy in China. The ideas behind the research have led to changes in the National Urban Drainage Policy, and the technical and scientific innovations in the project have demonstrated how these policies can be implemented.

Urban flooding is a widespread problem in China. In recent years, urban flooding has hit a number of cities causing significant economic damage and the loss of life. Based on current trends, the problem of urban flooding is expected to become more significant. Over the past few decades, China has witnessed a rapid increase in its urban population, largely as a result of rural-to-urban migration. Between 1980 and 2012, the number of people living in urban areas quadrupled from 191 million to nearly 712 million, and the percentage of people living in urban areas grew from 19.4% to 52.5%. The total number of people living in urban areas is projected to reach 1 billion by 2030. Not only does this population growth mean more people will be affected by flooding, but population growth places demands on land as well, and the area of impervious surfaces will grow, leading to more runoff. This growth has been, and will continue to be combined with economic growth, increasing the value of assets exposed to flooding. Finally, climate change could lead to more extreme rainfall, leading to more flooding.

These challenges have been addressed by the Collaborative Research on Flood Resilience in Urban Areas (CORFU) project, which was established to investigate state-of-the-art methods to increase flood resilience. The partners of this research project have investigated seven case studies from Europe and Asia, including Beijing.

Recent flooding in Beijing

Beijing has been struck regularly by urban flooding, and a notable event occurred in July 2012, where 79 people were reported to have been killed, and economic damages were estimated at 10 billion Yuan ($1.6bn). As a result of this event, a number of strategies to deal with the urban flooding problem in Beijing have been proposed:

- To carry out actively emergency engineering construction works as soon as possible in seriously flooded areas. Retention tanks will be built to solve the flooding problems in the 56 sunken roads in flyover/underpasses areas in Beijing over the next three years.
- To improve the urban storm water drainage system, following the new “Outdoor Drainage Design Standards”, using increased design standards.
- To plan and design a new urban flooding prevention engineering system (Major drainage system).

Technical and scientific advances from the CORFU project

In the Beijing case study, a number of scientific tasks have been undertaken. First, the historical rainfall patterns in Beijing were analysed using the most up-to-date data to get a better

understanding of the potential for extreme rainstorms, both now and in the future as a result of climate change. For example, in Beijing in 2050, the daily rainfall will increase up to 30%. This study used a state-of-the art weather generator to produce time series of daily rainfall, and showed the increase in rainfall for both 2020 and 2050 under climate change scenarios.

Secondly, detailed flood modelling was undertaken to understand the flood risk in both Central Beijing, and in Yizhuang, a new satellite town. Yizhuang has been designated as a site of important national economic and technical development, and has seen significant investment. This area is typical of many of the new urban developments that are being constructed to meet the requirements of China's growing urban population and economic development.

Large, complex models used information on the surface elevation as well as data on the subsurface drainage networks. In the case of central Beijing, this involved the modelling of over 90,000 km of pipes, which was completed using DHI MIKE URBAN software. This was combined with information on the buildings and value of exposed assets to estimate the total damage. For the 50 year event, the expected damage for Yizhuang was 497 million RMB (61 million Euros). By 2050, this was estimated to almost double to 970 million RMB (120 million Euros) (Hammond et al 2014a, 2014b).

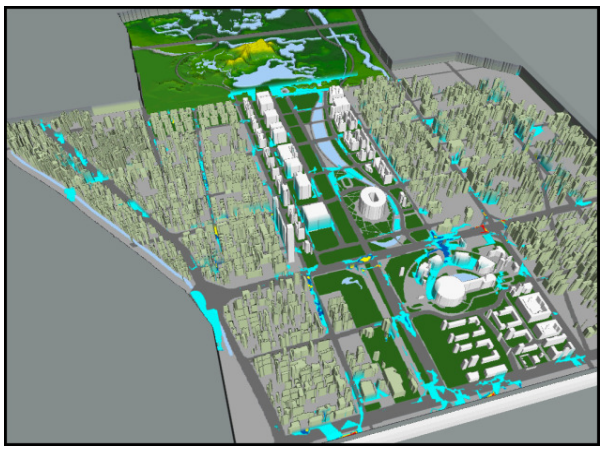

Figure 1. Flood modelling in the Beijing Olympic Park

Furthermore, a significant problem in Beijing is the disruption to traffic caused by the urban flooding, as a number of underpasses were flooded in the July 2012 event, leading to significant delays and resulting in large economic costs (Figure 2).

One technical innovation has been made to model a number of vulnerable underpasses to identify flood risk hotspots. Figure 3 shows the digital elevation data for one such underpass. These have been combined with traffic simulation models to quantify the disruption to, allowing planners to understand the total impacts of floods. These results are being used to evaluate the effectiveness of different strategies to mitigate flood risk.

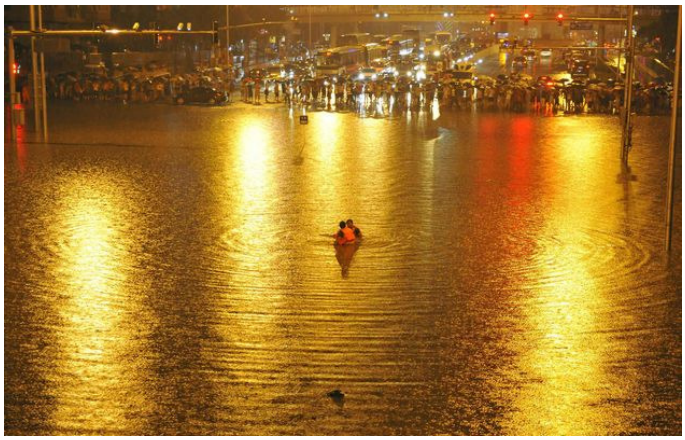

Figure 2. Flooded main road in Beijing (Joe Chan, Reuters)

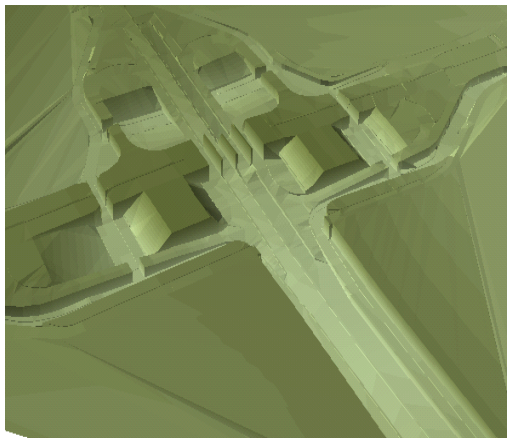

Figure 3. DEM model for Lianhua Bridge

One key advance has been the development of methods to model flood risk for entire mega-cities, using a multi-cellular technique. The multi-cellular model was applied in Beijing (area more than 1000 km^2), and it was able to reproduce the observed flood extent (Hénonin et al, 2013).

Policy Impact of CORFU

The resilience approach adopted in the CORFU project has led one of the project partners, the China Academy of Urban Planning and Design, to produce two national guideline documents: *Notification on the Enhancement of the Construction of Urban Drainage and Urban Flooding-protective Facilities from the General Office of the State Council of the People's Republic of China*, and, a *Technical Guidance for the Formulation of Integrated Urban Storm Water Drainage Engineering System (Minor Drainage system) and Urban Pluvial Flood Mitigation Engineering (Major Drainage system) Planning*.

The first document sets out a number of tasks for cities in China with regards to their urban drainage planning. Some of the identified key tasks are:

- Comprehensively investigate the potential for flood risk, building Geographical Information Systems as soon as possible, updating Intensity-Duration-Frequency curves and information on extreme storm rainfall events which is used for further research and analysis.
- Determine the standard of the design on the basis of flood risks. In megacities such as Beijing, design standards should be increased.
- Formulate the new version of integrated Urban Storm Water Drainage and Flood Mitigation Planning in all the cities.
- Increase investment and accelerate the programme for the renovation and construction of improved urban drainage, including low impact development solutions, such as permeable surfaces.
- Improve emergency response measures, such as the development of emergency response warning systems which is used by relevant organizations to response to extreme flood events.
- Strengthen the research on urban design rainfall patterns, impact assessment and urban flood mapping.

The second document presents guidelines on how to formulate integrated Urban Storm Water Drainage and Flood Mitigation Planning. Some of these guidelines have been adopted directly from the CORFU project. Key steps in the development of Flood Risk Management planning include:

- Investigate the physical (climate, geological) and socio-economic situation of the city.
- Determine the existing flood risk in the city through modelling and surveys of key infrastructure, as well as investigating the historical flood record.
- Undertake flood risk assessment and risk mapping.
- Consider a range of mitigation measures such as runoff volume control, pollution control and the utilization of rainfall resources.

The CORFU project has demonstrated how its framework could be used to assess flood risk in Beijing now and in the future, and how the effectiveness of different strategies could be assessed. These lessons can be transferred to other cities in China.

Further Information on the CORFU Project

Start / End Date of Project:

1st April 2010 to 30th June 2014

Participating institutions:

University of Exeter, UK (Coordinator)

Hamburg University of Technology, Germany

DHI, Denmark

University of Nice - Sophia Antipolis, France

Indian Institute of Technology in Bombay, India

AREP Group, France

Institute of Water Modelling, Bangladesh

Beijing University of Technology, China

China Academy of Urban Planning Design, China

Beijing Municipal Institute of City Planning and Design, China

CETaqua, Spain

Hydrometeorological Innovative Solutions, Spain

Cranfield University, UK

Dura Vermeer Business Development, Netherlands

Hamburg Institute of International Economics, Germany

Programme:

The CORFU project received funding from the European Union through the 7th Framework Programme, Grant Agreement Number 244047.

Web-link:

www.corfu7.eu

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