Integrated flood-damage and risk assessment

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Introduction

Flood losses used to be assessed statistically, based on the risk analysis approach (CUR, 1990; Vrijling, 2001). With the development of remote sense technology and driven by the rapid climate change, the physical-based approach becomes more frequently applied (Van de Sande et al., 2003). Both approaches appear important in decision making: the former in long-term flood defense planning and the latter in short-term flood mitigation management.

The study of natural systems calls for an integrated approach in risk assessment. In Europe, shifted from structural measures to non-structural measures, modern flood risk management has moved towards improving flood mitigation through the improvement of flood warning and modelling systems (Penning-Rowsell et al., 1994). However, in densely populated river basins in countries such as China, structureal measures remain important (Yin et al., 2001). Thus, risk assessment is required to be able to analyze the possible outcomes of *any* plan, strategy or project, at *different* temporal and spatial scales. In this study, attention shall be paid to the issues mentioned below.

Figure 1. Flood damage caused by high flow velocity (from BBC 2004: http://news.bbc.co.uk/1/hi/in_pictures/3571748.stm).

- Most of the damage functions were depth-based. Improvement is needed due to the neglect of quantified inclusion of important variables such as velocity (Kelman, 2004; Fig. 1).
- Previous uncertainty analysis of flood risk assessment focuses on internal parameters involved in the risk model (e.g. NRC, 2000). External uncertainty such as uncertainty propagation through hydraulic models is rarely reported.

Methodology and case study

Key components and processes of the integrated flood damage and risk assessment system are shown in Figure 2. A case study has been set up on the river reach near Sandau in the River Elbe in Germany. Monte Carlo simulation propagates uncertainty through the system. The dike effect is studied with an artificial dike break simulated with SOBEK2D.

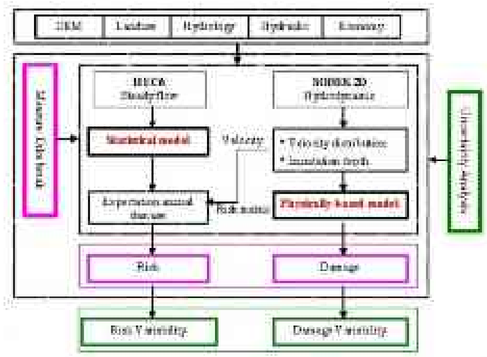

Figure 2. Framework of the integrated flood risk assessment system.

Results

The system can assess flood risk with: (1) expected annual damage; (2) damage associated with a certain flood event; (3) the impact of flood mitigation measures. Here, two typical results are presented.

1. A risk-level map (Fig. 3) – This map has been obtained by combining the maps of percentage damage and the velocity distribution. The idea is to distinguish four risk levels indicated by the indexes of R1 to R4, which are corresponding to activities to be taken for decision making. The levels of risk can be different nationwide.
2. The dike-break-effect (Fig. 4) – This effect was assessed using Monte Carlo simulation of the event-based damage

model. The result shows that damage is always higher when dike break occurs. However, this result only shows the local impact. Non-local impacts can be obtained by enlarging the modelling area downstream towards the area of interest. This work is still in progress.

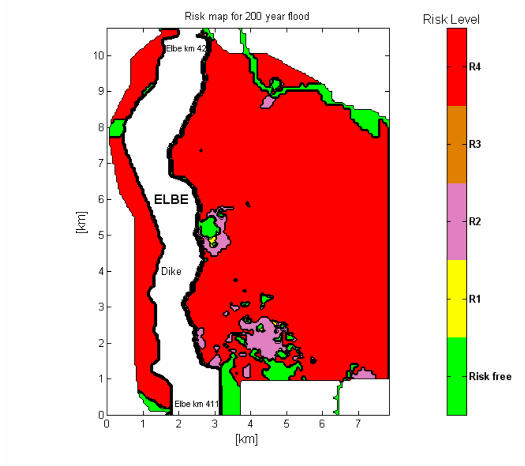

Figure 3. Risk-level map

Conclusions

- An integrated flood risk assessment system has been developed. It can be used to provide multi-dimensional aids to flood management decision making in long-term planning and short-term operations of the flood defence system.
- Inclusion of velocity improves the damage-driven forces.
- Integrated uncertainty analysis assists flood risk presentation with more comprehensive information.

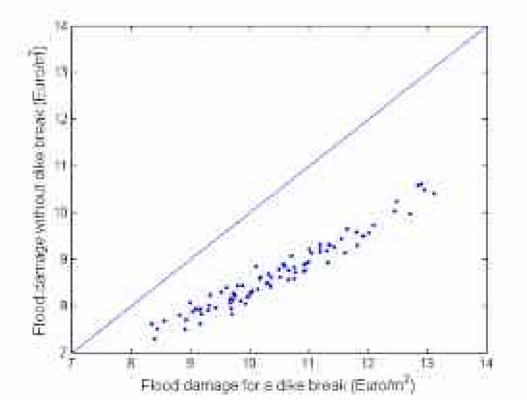

Figure 4. The dike-break-effect

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