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Preface

"Outcomes of the RIMAX programme: risk management of extreme flood events"

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In recent years, attitudes towards the management of floods have changed. It is being recognised more and more that complete safety cannot be ensured. This is, amongst other things, due to the limits of technical defence measures, limited financial resources and uncertainties in our understanding of processes that lead to flooding. This change in attitude is accompanied by a shift in planning from flood hazard to flood risk. Flood management is no longer focused on flooding processes and probabilities, but considers more and more the negative impact on society and the environment. Traditionally, flood policies concentrated on the control or reduction of flood hazard. Design standards were applied to specify the level of flood protection, which had to be ensured by technical means. In recent years, they have been replaced by broader concepts, where the level of protection is determined by more comprehensive considerations than some predefined design level, e.g. the 100-year flood, and traditional flood defence strategies are complemented by non-structural mitigation measures. In short, we are moving from a flood control approach to flood risk management.

This special issue of Natural Hazards and Earth System Sciences (NHESS, http://www.nat-hazards-earth-syst-sci.net/special_issue82.html) contains 17 papers that are based on the German research programme "Risk management of extreme flood events" (RIMAX), funded by the German Federal Ministry of Education and Research (BMBF). Almost 40 projects spent more than 20 million € in order to develop and implement improved methods and tools for flood risk management. Some of the results of RIMAX are presented in this special issue. More information is available at http://www.rimax-hochwasser.de. In the following, we summarize the content and main results of the papers contained in this special issue. The papers were pooled into two groups, namely "analysis of flood processes and risk assessment", and "mitigation and risk management".

The group "analysis of flood processes and risk assessment" comprises of nine papers, covering different aspects of the flood risk chain "triggering meteorological event – flood generation and retention in the catchments – flood processes in the river system including behaviour of defence systems – inundation – impact on society and environment". Pluntke et al. (2009) and Jatho et al. (2010) have developed methods for improving the representation – in space and time – of highly resolved precipitation in low mountain ranges. By applying different methods for regionalization of precipitation fields, Pluntke et al. (2009) show that the selection of the method should be based on the type of event, using objective and subjective approaches. Jatho et al. (2010) combine gauge and radar data for the provision of spatial rainfall in an online tool. The precipitation product benefits, in particular, from the inclusion of the small-scale variability of the radar. Bartl et al. (2009) have studied the potential of historical sources for extending discharge data. For the gauge Dresden/Elbe, one of the oldest gauges in Europe, they demonstrate how historical archives can be used to obtain much longer discharge time series with smaller errors. Hence, this project points to the potential of historical information for improving data availability and consequently flood risk estimates.

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Another contribution to improving risk assessments concerns the simulation models. Herbst et al. (2009) investigate the capabilities of three distributed watershed models to reproduce flood events. They demonstrate that the method of Self-Organizing Map (SOM) helps to understand under which conditions the models provide good simulations, and to identify the most relevant model parameters. They caution against the use of simple and overly rigorous calibration strategies. Sommer et al. (2009) use simulation models to analyse complex flooding situations in urban areas. They couple three numerical models, namely a hydrodynamic model for surface flooding, a groundwater model and a sewer model. This coupled-modelling approach allows the analysis of the interactions between the three compartments (surface, groundwater, sewage system) and shows that high groundwater levels, associated with fluvial floods, result from a multicausal process.

Four papers extend the flood risk chain by studying the impacts of flooding. Kreibich et al. (2009b) investigates the problem of damage caused by high groundwater levels. This damage type is usually ignored even though it may cause considerable damage. They show that the risk of groundwater flooding is underestimated and they argue for an intensified risk communication by the authorities. The paper of Kreibich et al. (2009a) quantifies the relevance of flow velocity as a damage-influencing parameter. The combination of hydraulic modelling and damage data analysis leads to the conclusion that flow velocity is important for structural damage, in particular on roads. However, no significant influence is found for other damage types. The review paper of Merz et al. (2010a) on the assessment of direct economic damages outlines that flood damage estimation is built on simple models and scarce data and, therefore, more efforts in data collection, analysis of damage processes and damage modelling are needed. Finally, Kühlers et al. (2009) simulate the impact of floods on public water wells via flood retention areas. While some contaminants are detained along their path through retention area, soil zone and groundwater zone, others reach the well field.

The eight papers of the group "mitigation and risk management" cover a broad spectrum, from the problem of risk communication to operational issues, such as strengthening dikes during floods. Starting from the observation that the boundary conditions for flood risk management are changing, and that the future development is highly uncertain, Merz et al. (2010b) explore how flood risk management may be adapted to incorporate change and uncertainty in decision making. Among other factors, social and organizational characteristics that foster adaptive capacity should be promoted. The case study of Martens et al. (2009) points to the heterogeneity in citizens and, hence, the need for tailored information in order to communicate the risks and mitigation options. Nijssen et al. (2009) investigate the design of a system of flood retention measures in large basins. The novelty of their approach is the development of a deterministic-stochastic generator that produces a large number of flood scenarios, including multi-variate characteristics of hydrological loads. This approach allows a differentiated view on the performance of complex flood retention systems. Dittmann et al. (2009) present a method to optimize reservoir operations, considering ecology and flood control targets.

A number of papers deal with operational flood management. Dietrich et al. (2009) develop a prototype of a flood forecasting system that provides forecast uncertainties based on ensemble predictions. Forecasts from different weather prediction systems are combined and used as input into a hydrological model whose uncertainties are represented by a parameter ensemble approach. This prototype system demonstrates the applicability of discharge ensemble forecasts in an operational environment. Kron et al. (2010) extend the flood-risk chain by coupling large-scale meteorological and hydrological models with local hydraulic and geotechnical models. This system is meant to enable decision-makers to quantify inundation and dike breach scenarios shortly before or even during a flood, providing a means for evaluating damage reduction options in operational mode. One of the possible options for reducing the danger of dike failure is the drainage of dikes during floods. Riegger et al. (2009) report on a stabilization technique that controls the seepage in the dike by installing drainage devices during floods. The ability to rapidly provide information on the extent of inundation areas is important for crisis management. Martinis et al. (2009) develop an automatic near-real time inundation detection algorithm for very high resolution Synthetic Aperture Radar (SAR). The algorithm works in a completely unsupervised way and does not assume training data, making it particularly feasible for disaster situations when the collection of ground truth is not feasible.

This special issue illustrates the breadth of today's flood risk management. We hope that it will be informative and inspirational for scientists trying to better understand flood risk processes and to improve methods for the management of floods. We thank the authors for their contributions, and we gratefully acknowledge the work of the reviewers for their dedicated collaboration with the Guest Editors.

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