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Flood Damage Assessment and Management

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Preface

The view that floods are a negative consequence of civilization activity which has damaged nature does not have any real professional support in the history of the Earth's development or in the history of humanity. However, it is true that humans have been transforming ecosystems, changing surface runoff conditions and vegetation composition, spreading urbanization, and disturbing the natural hydrological regime in the landscape for centuries (Krejčí et al. 2002), (Hlavínek et al. 2008). Humanity's problems with floods began only when, in contrast to their positive effects such as the floods on the Nile in Egypt helping to secure the livelihood of the ancient Egyptian population, floods began threatening the lives, health, and property of the population, and economic activity of developed society (Bačík and Ryšavá 2011).

The issue of floods was, is, and will be topical, because as the hydrological community emphasizes, floods cannot be prevented, but people need to learn to live with them. Water simply determines our life whether we have enough, a lack, or a surplus of it (Solín 2006).

At present, there are clear trends around the Earth indicating that the risk of flooding will increase in the coming period. The extent and extreme nature of recent flood episodes already points to the necessity of a comprehensive design policy for the building of flood protection structures, and of supplementing existing flood protection measures in potential flood plains (Houghton et al. 2001). Following the floods in Central Europe in the summer of 2002, several member states of the then European Community directed the Council of the EC's attention to the issue of flood prevention and protection. In October 2004, the Council agreed to their proposal that all member states, coordinated by the European Commission, prepare a European Flood Action Program, which after appropriate legislative processes would become a common, binding legal instrument for all EC member states (Bačík et al., 2006). On October 23, 2007, this initiative led the European Parliament and the Council to adopt Directive 2007/60/EC on the assessment and management of flood risks. The purpose of the Directive was to establish a framework for the assessment and management of flood risks at EC level in order to reduce the adverse effects of floods on human health, the environment, economic activity, and cultural

heritage. To achieve its objectives, Directive 2007/60/EC obliged all member states to carry out a preliminary flood risk assessment, to be completed in December 2011, to prepare flood hazard maps and flood risk maps (which were completed in 2013), and to develop flood risk management plans by 2015. Subsequent steps must be updated every 6 years.

In order to meet the objectives of the Directive, more and more attention is being paid to risk assessment and analysis methods, as they allow us to assess the cost-effectiveness of mitigation measures and thus optimize investment (Ganoulis 2003; Hardmeyer and Spencer 2007). The analysis is closely related to the classification of each area according to its vulnerability, mathematical modeling of rainfall-runoff processes and water flow in channels, and inundation and damage assessment (Cipovová 2010). In general, most methods for determining potential flood damage used in the world are based on the same principle of application of the loss curve method. They differ only in the manner of expression, detail, and description of the endangered property, and further in the form of the loss curves themselves (Horský 2008).

The use of mathematical models and Geographical Information Systems (GIS) in flood management has become a common approach for evaluating and interpreting data. The aim of the deployment of these tools is primarily to accelerate the procedure of processing risk analysis data from flood plains, and subsequently to create flood damage and risk maps. The aim is also to use data sources that are easily accessible, maintained over time, and have a uniform structure for the whole territory. Similarly, multi-criteria analysis has become a commonly used tool in flood management decision-making process as well.

This book deals with the issue of flood risk assessment and management with the aim of establishing effective procedures for reducing flood risks and thus increasing the level of flood protection. It has been prepared in accordance with the current legislation in the field of flood protection, in particular, pursuant to the aforementioned Directive 2007/60/EC on flood risk assessment and management. The main aim of the thesis is to extend the scientific knowledge in the field of flood risk assessment and management, and then to propose flood risk management improvements in order to reduce the adverse impacts on human health, the environment, and the economic activity associated with floods.

The methods used in this book are based on practical experience as well as knowledge gained from available literature and consultations with experts dealing with the issue in practice. The scientific part of the thesis proposes a methodical procedure for the selection of effective flood protection in order to meet the objectives of flood risk management.

The proposal for a procedure for selecting the most cost-effective combinations of measures with a view to reducing the impacts of floods on human health and assets as well as the environment is based on calculations of the loss of human life and environmental and economic damage. This procedure can serve as a basis for the development of flood risk management plans. The calculation of the different categories of damage requires a special approach and different input documents, which are described in Chap. 2.

The most important information sources and materials used in this work are as follows:

- Ph.D. thesis: Flood risk management in selected water flow rivers with regard to the implementation requirements of directive 2007/60/EC (Gaňová 2015);
- Ph.D. thesis: Methods of evaluation of potential flood damage and their application by means of GIS (Horský 2008);
- Ph.D. thesis: Loss of life estimation in flood risk assessment. Theory and applications (Jonkamn 2007);
- Ph.D. thesis: Estimation of the Loss of Human Lives in a Flood (Brázdová 2012); and
- Ph.D. thesis: Environmental risks in conditions of selected watercourses in eastern Slovakia (Bendíková 2003).

The common objective in the calculations of individual categories of potential flood damage is to determine the levels of environmental, social, and economic risk due to floods (Chap. 2), which serves as a basis for the selection of effective flood protection measures at specific sites.

The processing and analysis of the input data as well as the visualization of the results obtained are carried out in the GIS environment (ArcGIS 9.3, 10) integrated with a spreadsheet program (Microsoft Excel).

The importance of this work lies not only in providing a current overview of knowledge in the field of flood assessment and management, but also in designing a methodology important for flood risk management and meeting the requirements of Directive 2007/60/EC.

The contribution of this work is a comprehensive proposal for a procedure for selecting effective flood protection measures, which can be used to meet the objectives of Directive 2007/60/EC reducing the likelihood of floods as well as their potential adverse consequences.

The submitted thesis consists of four chapters. The introduction briefly describes the state of knowledge in this field, assesses the timeliness of the topic, and presents the stated purpose and aim of the work and outlined solution procedure. Chapter 1 provides the main overview of knowledge in the field of flood assessment and management, with an emphasis on possible approaches to assessment, legislation on the issue, and the classification of flood damage. Chapter 2 is devoted to the design of a methodological procedure for the selection of effective flood control measures. The application of the proposed procedure is described in Chap. 3. The conclusions of the research are presented in Chap. 4.

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About the Authors

Martina Zeleňáková is Associate Professor in the field of environmental engineering at the Institute of Environmental Engineering, Faculty of Civil Engineering at the Technical University of Košice, Slovakia. In the framework of her scientific-research activities, she has focused on solution of water management problems; rainwater management; environmental impacts assessment; and separately on the assessment of environmental risks in river basins in relation to flood events, drought, and water pollution. The results of her scientific-research work have been published in national and international journals, scientific conference proceedings, and proceedings of national and international conferences. She is author, editor, co-author, and co-editor of educational textbooks and monographs, and she has cooperated in solving national and international projects, as the principal investigator or partner.

Lenka Gaňová graduated Master's degree and Ph.D. degree in the field of environmental engineering at the Institute of Environmental Engineering, Faculty of Civil Engineering at the Technical University of Košice, Slovakia. Her scientific work as well as her thesis was devoted to flood risk assessment. She was participating in a project implementation regarding the flood protection and she published the results of her research in scientific proceedings of national and international conferences.

Daniel Constantin Diaconu works as Assistant Professor at the Department of Meteorology and Hydrology at University of Bucharest, Romania. He does research in hydrology focusing on flood protection, environmental sciences, and integrated water resources management. He is an expert in bathymetry and limnology. The results of his scientific work have been published in journals and conference proceedings. He is participating in scientific projects mainly within Research Center for Integrated Analysis and Territorial Management (CAIMT) within the University of Bucharest.

Chapter 1
Flood Risk Assessment—State of the Art

Just as floods are one of the extreme manifestations of the water cycle in nature, flood protection is a process that is endless for human civilization. It began in the distant past and will, unfortunately, be with very uncertain results, part of every other stage of the society's development. Currently, the theme of floods resonates much more than it has been in the past, mainly thanks to the considerable media coverage that contributes to making more people realize this issue.

The main reason that led us to choose this theme for the book is that floods are one of the phenomena of contemporary life that affects each one of us and cannot be ignored. Evidence that flood protection and prevention are justified and one of the most important components of land-use planning is damage to property, and even life damage is no exception.

The aim of this book is to address the issue of flood risk assessment and management with the aim of effective management aimed at reducing flood risks and thus increasing flood protection. The book is elaborated in the sense of the current legislation in the field of flood protection, in particular, the Directive 2007/60/EC on the assessment and management of flood risk and the Act no. 7/2010 Coll. on Flood Protection, by which the Directive is transposed into Slovak legislation and implemented in the Slovak Republic.

1.1 Assessment of Flood Risk

When dealing with flood issues an important task is defining the term "risk." It should be noted that the issue of risk has evolved and formed in a wide range of different disciplines (crisis management, economics, environmentalism, geography, and sociology), each of which understands and perceives it somewhat differently (Gozora 2000).

Although the notion of "risk" is currently a frequently encountered concept, it is characterized by complexity and ambiguity (Mika 2009). This contributes to the fact

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