Chapter 10
Catastrophe Models and Policy Processes: Managing Flood Risk in the Hungarian Tisza River Basin – An Introduction

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Abstract In this chapter we provide an introduction to this section of six chapters, which examine how catastrophe models can contribute insights to multi-stakeholder policy processes by focusing on flood risk management in the Hungarian reach of the Upper Tisza river. The flood problem in this vulnerable region remains today acute mainly because of increasing flood risk due primarily to land use and perhaps also to climate change, as well as to a management regime in flux. A recent popular movement to change the management regime from the traditional *river defense paradigm* (RDP) to a more environmentally oriented *working landscape paradigm* (WLP) has been stalled. This stalled regime shift highlights the critical importance of reaching consensus, not only on flood measures that promote the sustainable development of the region, but also on the distribution of the losses from floods. The papers in this section focus on the latter by demonstrating how catastrophe models can aid a participatory process aimed to design a flood insurance and public compensation system. In addition, the papers address flood risk in the region, and how it will be impacted by climate change, as well as the vulnerability of the Tisza basin residents.

Keywords Multi-stakeholders policy processes • Insurance program • Catastrophe modeling • Tisza river basin • Flood risk management • Climate change impact

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10.1 Scope

This section of six chapters examines how catastrophe models can contribute insights to multi-stakeholder policy processes by focusing on flood risk management in the Hungarian reach of the Upper Tisza river. The flood problem in this vulnerable region remains today acute mainly because of increasing flood risk due primarily to land use and perhaps also to climate change, as well as to a management regime in flux. A recent popular movement to change the management regime from the traditional *river defense paradigm* (RDP) to a more environmentally oriented *working landscape paradigm* (WLP) has been stalled. The reasons are complex, including major cost overruns in the construction of the necessary reservoirs, and also a lack of political will especially for subsidizing changed land use practices (Borsos B, 2011, UNDP Technical Advisor, personal communication, 10 February, Budapest). Adding to this list are burden-sharing issues. In planning a reservoir in the Bereg region, for example, farmers demanded far more for their expropriated land than the government was offering (Borsos B, 2011, UNDP Technical Advisor, personal communication, 10 February, Budapest). This stalled regime shift highlights the critical importance of reaching consensus, not only on flood measures that promote the sustainable development of the region, but also on the distribution of the costs and benefits of these measures (Sendzimir et al. 2010).

This set of chapters shows how modeling research can contribute to flood risk management and particularly to the exploration and resolution of conflicts on who gains and who loses from social and environmental policies. For the most part, this research was conceived and carried out before recent attempts to shift the Tisza flood risk management to more environmentally oriented pathways; yet, the methods and results are highly relevant to current events. After examining present-day vulnerability in the region, the chapters turn to the design of a country-wide flood compensation and insurance system, and show how catastrophe models have helped to clarify the distributional issues inherent in any risk-sharing system. These latter chapters are based on interviews and workshops with stakeholders in the Upper Tisza region that were part of a project funded by The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, and carried out by IIASA, Stockholm University and the Hungarian Academy of Sciences.

Given the critical importance of institutions and procedures for sharing benefits and costs, it is surprising that the discourse on the recent regime shift in the Tisza region has not confronted this issue in a rigorous manner – perhaps leading in some part to the delays we are currently witnessing. It is hoped that the methodologies presented in this section, many of which were designed to aid participatory processes, will be useful for all research intent on providing useful information to controversial policy issues such as those characterizing the policy discourse today in Hungary.

We begin by describing the history and current policy debates surrounding the controversial regime shift from flood defense to ecological and adaptive management of the river, and argue that risk sharing systems (compensation and insurance) are vital for enabling such shifts. We then turn to describing the chapters in this section, and conclude by underlining the importance of integrated research that connects the economic, social and ecological systems for sustainable management of today's river basins.

10.2 Background and Context

With its origins in the Ukrainian Carpathian mountains, the Tisza river flows along the border of Romania and then southwest across the great Hungarian plain, eventually flowing into the Danube river in the Serbian Republic. Precipitation falling on a vast mountainous area is concentrated in the Tisza, resulting in some of the most sudden (24–36 h) and extreme (up to 12 m) water floods in Europe (Halcrow Group 1999; Koncsos and Balogh 2007). Such extremes occur on average every 10–12 years in the Tisza basin (Bran and Borsos 2009), but the last century has seen rising trends in all facets of flooding: flood peak height, volume and frequency. The Tisza ranks as one of the highest flood-risk areas, as well as one of the poorest, in Europe.

The historical response to flooding has been in the form of hydro-engineering operations that have reconfigured the river basin (Balogh 2002). In the early eighteenth century the Tisza region was a diverse landscape with ploughed land, forests, floodplain orchards, meadows, fishing and cattle that co-existed with frequent and routine flooding (Andrásfalvy 1973; Bellon 2004). To provide the conditions for large-scale intensive agriculture (mainly wheat) and transport, the river was canalized, straightened and bracketed with levees to prevent flooding, and the floodplains were drained. As an unintended result, sediments previously flushed out by floods accumulated on the floodplain. Complaints by local farmers eventually provoked an agreement to expropriate the entire floodplain, which had previously been common land, for grain production.

10.2.1 The River Defense Paradigm

In recent history, the Hungarian government has continued to invest huge sums in the vast network of protective levees, including about 3,000 km of embankments, which must be continually heightened to protect against increasingly worsening floods (Balogh 2002). The government also typically takes responsibility for private damages in the event of a levee breach, compensating victims generously for groundwater inundation and other types of flood damage. After the Tisza floods in 2001, for instance, the government fully rebuilt nearly 1,000 houses that had been washed away (Vári et al. 2003).

Estimates show that damage to built capital and commerce from a major flood event could reach as high as 25% of the basin's GDP, or 7–9% of national GDP (Halcrow Group 1999). Understandably, the government is concerned about its tradition of taking almost full responsibility for flood risk management, including flood prevention, response, relief and reconstruction. Hungarian membership in the European Union has committed the government to a program of fiscal austerity, and for this reason the financial authorities would welcome more private responsibility for the reduction and response to flood disasters.

Moreover, critics of the "river defense paradigm" argue that it is neither economically nor ecologically sustainable especially in light of climate change (Sendzimir et al. 2010; Werners et al. 2010a, b). The levees remain inadequate to protect against increasing frequency and discharges of floods (Balogh 2002), and the lack of water retention is aggravating another problem in the region, scarcity of adequately clean water resources in dry periods. Ecologically, the RDP threatens existing unique freshwater wetland ecosystems that can provide valuable eco services and biodiversity so essential if the region switches to a more diversified agricultural and livelihood production (Sendzimir and Flachner 2007). This switch, many argue, is necessary given the increasing economic, environmental and social impoverishment of the region.

10.2.2 The New Vasarhelyi Plan

In response to the decline of the Tisza region, a network of experts, NGOs and intellectuals (called the "shadow network") recently became influential in promoting a changed management paradigm (Sendzimir et al. 2010). Instead of flood defense strategies implemented from Budapest in pursuit of building profitable export agriculture in the floodplain, this network advocated policies that enhance biodiversity, restore ecosystems and produce a more diversified landscape of livelihoods in the region. This would mean a shift from the *flood defense paradigm* to a *working landscape paradigm.*

Supported by the European Union, the shadow network organized a broad participatory process that gained the attention of the Hungarian government, which itself was facing huge costs from it flood defense policies. This social movement, along with four extreme flood events revealing the insufficiency of the levees, prompted the launching in 2003 of the New Vasarhelyi Plan (VTT) that emphasizes environmental protection and nature conservation (Government Decision No. 1107/2003 (X1.5). The new strategy calls for (i) reinforcing dikes where they do not meet the once-in-a-century standards required by the EU Water Directive, (ii) improving flood conveyance of rivers (reducing summer dikes, rehabilitating pastures and mosaic-type forests, and (iii) increasing existing and creating new flood plain areas, i.e., providing enough room for the river. For the latter, 75,000 ha of detention basins have been selected with a storage capacity of 1.5 b m^3 (about 6% of basin annual runoff), which engineers predict should be enough to decrease peak level events by 1 m all along the Tisza.

Views differ on the success of the VTT. While proponents claim that in its first phase (2003–7), 6 out of 11 retention basins would be scheduled for restoration (Bran and Borsos 2009), critics claim that only one new retention basin, the Ciga'nd

Polder covering about 25 km^2 of floodplain, has been built, and that little has been invested in rehabilitating pastures and forests. Because of cost overruns and an increasingly unfavorable economic environment, the planned reservoirs were reduced from 11 to 6. According to these critics, the failure of the regime shift called for by the VTT can be attributed to complex and systemic institutional and procedural issues (for a full description, see Sendzimir et al. 2010), of which the distribution of the burdens from its implementation appear to have played a role along with many other factors including escalating costs and lack of political will outside the water authorities (Borsos B, 2011, UNDP Technical Advisor, personal communication, 10 February, Budapest).

In hindsight, it appears that too little attention may have been given to the distribution of the costs of implementing the VTT. While the VTT contains clauses about compensating farmers for inundated lands and crop losses, there have been no estimates of what this would mean for the government's budget. Calls for compensation have greatly exceeded what the government can reasonably afford, which may be one factor leading to a breakdown in the government's resolve to implement the plan.

10.2.3 Sharing Costs: A Hungarian Compensation and Insurance System

Concurrent with the unsatisfactorily slowed implementation of the VTT, at least as perceived by many of its proponents, another related policy arena was experiencing similar difficulties in implementing government policy. The Hungarian government has recently legislated a nation-wide flood insurance program with the aim of shifting much of the post-flood burden from the government's budget to accumulated funds in this program (Linnerooth-Bayer et al. 2006). The insurance was fully underwritten by the government, and very low-income households would receive subsidies to enable them to purchase policies. However, insurance uptake remains extremely low because of the unwillingness of Hungarians to pay the premiums, and the unwillingness of insurers to write policies covering damages except those from breached levees. It is perhaps not coincidental that in the same year as the launch of the VTT, the government also launched its Wesselenyi fund (guaranteed by the state) for the compensation of uninsured damages caused by water.

10.3 How Models Can Contribute to Flood Risk Management

This book is dedicated to the notion that the development of efficient and equitable policies for managing disaster risks and adapting to global environmental change is critically dependent on robust decisions supported by integrated modeling. The chapters in this section examine how catastrophe models can provide insights on flood risk management in the Tisza region with the intent of contributing to policy processes – and robust decisions – that reduce risk and vulnerability of the mainly low-income residents.

We begin, not with a chapter on catastrophe modeling, but an empirical analysis titled *Social Indicators of Vulnerability to floods***,** by Anna Vári, Zoltan Ferencz and Stefan Hochrainer. The analysis is based on an empirical survey conducted in the Bodrogköz and in the Bereg region within the Tisza flood basin. The questionnaire revealed that, while impacts are dependent mainly on exposure (location), important factors influencing vulnerability included: health status, education, savings, availability of post-flood financing, trust in the community and its institutions, and preparedness of institutions. Setting the stage for the chapters that follow, among other recommendations the authors note the importance of access to loans and other routes for obtaining post-disaster financing.

The following chapters point to alternative designs for a flood insurance program that are based on stakeholder views, and importantly aided by a flood model of the region. They underline the importance of identifying realistic flood management strategies considered fair by the stakeholders in the region and elsewhere. A main issue was to investigate different insurance schemes in combination with governmental compensation, or combining private responsibility with nation-wide solidarity. The research was focused on the Palad-Csecsei basin (the pilot basin), which is situated in the Szabolcs-Szatmár-Bereg County in northeastern Hungary. This region is one of the poorest agricultural regions of Europe, and floods repeatedly strike large areas.

The chapter by Joanne Linnerooth-Bayer, Anna Vári, and Lisa Brouwers shows how a participatory process can be aided by a computer model. Their chapter titled ***A Model-Based Stakeholder Approach*** for ***Designing a Flood Management and Insurance System in Hungary*** takes account of contending views on the flood problem and solutions held by the Hungarian stakeholders, including the public, the local authorities, government ministries and private insurers. The challenge was to design a national flood insurance system that would provide incentives for reducing flood risk, as well as fairly compensating victims in this poor and vulnerable region. A 3-year stakeholder process was aided by a catastrophe model that helped to clarify the distributional issues by showing how simulated flood losses would be shared among the victims, the government and the insurers depending on the design of the insurance pool.

This simulation model and its use in the Tisza participatory process is described in more detail in a chapter titled ***Consensus by Simulation: a Flood Model for Participatory Policy*** by Lisa Brouwers and Mona Riabacke. This chapter gives important details on the design, implementation and use of the dynamic and spatially explicit flood simulation model, which incorporated micro-level representation and Monte Carlo techniques. The model was equipped with an interactive graphical user interface designed for the particular context to facilitate its use as a decision support tool in the participatory setting with multiple users. The model supports comparisons between pre-defined policy options as well as the design of new policy options. During the concluding workshop the model was used interactively by the stakeholders to aid their decision making process.

In the absence of a stakeholder process, consensus can be modeled as shown in an innovative chapter by Mats Danielson and Love Ekenberg, titled ***A Risk-Based Decision Analytic Approach to Assessing Multi-Stakeholder Policy Problems.*** With an understanding of the preferences of the stakeholder groups, the authors show that decision analysis can be a useful tool in establishing and ranking different policy alternatives. The approach was employed to assess options for designing a public-private insurance and reinsurance system in the Tisza case. The design of a nation-wide insurance system involves handling imprecise information, including estimates of the stakeholders' utilities, outcome probabilities, and other complications, all of which this chapter addresses. The general method of probabilistic, multi-stakeholder analysis extends the use of utility functions for supporting evaluation of imprecise and uncertain facts.

Using a different methodology Tatiana Ermolieva, Yuri Ermoliev and Istvan Galambos show how stochastic optimization can help in the design of a national insurance pool. In their chapter titled ***Financial Instruments in Integrated Catastrophic Flood Management: Demand for Contingent Credits*** they develop a flood management model that takes into account the inherent complexities in catastrophic risk management: highly mutually dependent flood losses, the lack of information, the need for long term perspectives and geographically explicit analyses as well as the involvement of various agents such as individuals, governments, insurers, reinsurers, and investors. Making realistic assumptions on the preferences of these groups, the authors design an "optimal" public multi-pillar program involving partial compensation to flood victims by the central government, the pooling of risks through a mandatory public insurance on the basis of location specific exposures, and a contingent ex-ante credit to reinsure the pool's liabilities. Policy analysis is guided by the GIS-based catastrophe models and stochastic optimization methods with respect to location specific risk exposures.

In the final chapter in this section, ***Flood Loss Considerations and Adaptation Strategies due to Climate Change in Hungary and the Tisza Region,*** Stefan Hochrainer, Reinhard Mechler, Nicola Lugeri and Georg Pflug address climate change and its implications for the Tisza region. Many regions and sectors in Europe are vulnerable to increasing disaster risks and climate adaptation is moving to the forefront of EU and national policy. Yet, little is known about changing risks and possible adaptation options under dynamic conditions. The Tisza region is one of the hot spots in Europe and a prime case to study new risk assessment methods and risk management techniques in light of a changing climate. Based on a risk modeling approach the authors present indicative quantitative results on the part of climate change on future flood losses for Hungary with a special focus on the Tisza region. Furthermore, they present an approach showing how such changes can be avoided with the help of adaptation strategies based on changes in different risk-layers over time.

10.4 Integration

In conclusion, we underline the importance of integrated research that connects the economic, social and ecological systems for sustainable management of the Tisza and all of today's river basins. In many ways the VTT and the government's insurance and compensation programs are interrelated and even mutually dependent, illustrating the importance of integrating environmental, social and economic policy. Strategies for compensating farmers for crop losses due to intentional inundation, or due to permanent loss of their land, are a critical part of any environmentally oriented program, and should be transparent. While insurance is not meant to compensate the "losers" of government programs, it can spread losses from extreme floods and, as these chapters show, even build in solidarity with subsidized premiums. If, as intended by the VTT, the flood system would tolerate some extreme flooding (which ecologists claim is vital for the ecosystems of the region), it is important to spread these losses across a wide community. The intent of the national flood insurance program was to spread these losses across residents throughout Hungary. The failure of the insurance program to provide such a comprehensive safety net greatly complicated implementation of the VTT.

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