

Southern Illinois University Carbondale
OpenSIUC

Dissertations

Theses and Dissertations

12-1-2016

MULTILEVEL GOVERNANCE IN
EUROPEAN RIVER BASINS: CHALLENGES
IN THE INTEGRATION OF ADAPTATION,
DISASTER RESPONSE, AND RESILIENCE

Shanna N. McClain

Southern Illinois University Carbondale, shannamcclain@hotmail.com

Follow this and additional works at: <http://opensiuc.lib.siu.edu/dissertations>

Recommended Citation

McClain, Shanna N., "MULTILEVEL GOVERNANCE IN EUROPEAN RIVER BASINS: CHALLENGES IN THE INTEGRATION OF ADAPTATION, DISASTER RESPONSE, AND RESILIENCE" (2016). *Dissertations*. 1280.
<http://opensiuc.lib.siu.edu/dissertations/1280>

This Open Access Dissertation is brought to you for free and open access by the Theses and Dissertations at OpenSIUC. It has been accepted for inclusion in Dissertations by an authorized administrator of OpenSIUC. For more information, please contact opensiuc@lib.siu.edu.

MULTILEVEL GOVERNANCE IN EUROPEAN RIVER BASINS: CHALLENGES IN THE
INTEGRATION OF ADAPTATION, DISASTER RESPONSE, AND RESILIENCE

By

Shanna N. McClain

B.A., Florida State University, 2003
M.S., Florida International University, 2010

A Dissertation
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Philosophy

Environmental Resources and Policy in
the Graduate School
Southern Illinois University Carbondale
December 2016

DISSERTATION APPROVAL

MULTILEVEL GOVERNANCE IN EUROPEAN RIVER BASINS: CHALLENGES IN THE
INTEGRATION OF ADAPTATION, DISASTER RESPONSE, AND RESILIENCE

By

Shanna N. McClain

A Dissertation Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Doctor of Philosophy

in the field of Environmental Resources and Policy

Approved by:

Dr. Silvia Secchi, Chair

Carl Bruch Esq., Co-Chair

Dr. Kofi Akamani

Professor Cindy Buys

Dr. Jonathan Remo

Graduate School
Southern Illinois University Carbondale
October 6, 2016

AN ABSTRACT OF THE DISSERTATION OF

Shanna Nicole McClain, for the Doctor of Philosophy degree in ENVIRONMENTAL RESOURCES AND POLICY, presented on October 6, 2016, at Southern Illinois University Carbondale.

TITLE: MULTILEVEL GOVERNANCE IN EUROPEAN RIVER BASINS: CHALLENGES IN THE INTEGRATION OF ADAPTATION, DISASTER RESPONSE, AND RESILIENCE

MAJOR PROFESSORS: Dr. Silvia Secchi and Carl Bruch, Esq.

This dissertation examines some of the strengths and weaknesses in basin level governance particularly as it relates to three current policy priorities: adaptive governance, international frameworks for response to natural and man-made disasters, and resilience in integrated water resources management. While these priorities are well-established in the academic and policy literature, in practice the ability to implement them at multiple levels has proven challenging. Though my dissertation highlights these challenges using case studies of European river basins, the observations and lessons for improving integrated management at multiple levels of governance, in multiple sectors, and among various actors are more broadly relevant to other natural resource governance settings.

The first paper of this dissertation explores adaptive governance in the Tisza sub-basin, considering both constraints and policy options for strengthening adaptive governance at the sub-basin level. The Tisza is the largest sub-basin to the Danube River basin, and faces increasing pressures exacerbated by climate change. The Tisza countries have experienced challenges with managing climate change adaptation in a nested, consistent, and effective manner pursuant to the European Union Water Framework Directive. This is due, in part, to inefficiencies in climate change adaptation, such as weakened vertical coordination. This paper examines the conceptual domains relating to adaptation in international governance,

and adaptation in transboundary water management in particular, with a focus on multilevel governance. International laws and policies governing transboundary waters in the Danube basin and Tisza sub-basin are reviewed. Using interviews and document analysis, the paper highlights challenges to adaptation in the Tisza sub-basin, including policy, fiscal, institutional, and capacity. The paper concludes with an exploration of possible policy options for sub-basin management, such as the development of a sub-basin commission, the establishment of a permanent Tisza expert group to be housed at and coordinated by the ICPDR, the use of new or existing bilateral treaties, and designing a framework for managing the Tisza.

The second paper analyzes the transition in international frameworks of response to natural and man-made disasters as incorporated and integrated at multiple levels of governance. It begins with a discussion of the distinctions between so-called “natural” disasters and “man-made” accidents, how and why they are treated differently, and how recent developments in international law and practice are raising questions about the merits of these historic distinctions. Anthropogenic climate change drives more extreme and sometimes cascading disasters that require complex and overlapping types of response; it is argued that the distinctions in response to natural and man-made disasters are counterproductive, outdated, and ultimately flawed. The paper examines the policy and institutional frameworks governing response to natural disasters and man-made accidents in the Danube River basin and Tisza River sub-basin. Using expert interviews and legal and policy analysis, it then explores the differences in how natural disasters and man-made accidents are monitored and how they are responded to. The paper concludes with an analysis of the implications of transitioning policies toward a more holistic framework for response, regardless of whether the cause is natural, man-made, or (as is increasingly the case) some combination.

The third paper advances the concept of a new approach – resilient IWRM – and how this approach can be applied to the management practices of the Danube and Rhine River basins and other river basins around the world. Using the Sendai Framework for Disaster Risk Reduction, the leading framework for resilience, and supported by expert interviews, the paper analyzes what resilience measures have been addressed, and what gaps remain in the basin management frameworks of the Danube and Rhine River basins. The paper concludes with a discussion of the current constraints in the resilient IWRM framework of the Danube and Rhine River basins, in addition to options for overcoming these challenges.

This dissertation concludes with a discussion of crosscutting dimensions of analysis, specifically the challenges faced in integrating climate change adaptation, response to natural and man-made disasters, and resilience into multiple levels of water governance. While these conceptual elements are well-established, the ability to operationalize these elements has proven difficult from multiple perspectives highlighted in this dissertation. The difficulties suggest a more nuanced and pragmatic approach to both their framing and their operationalization.

ACKNOWLEDGMENTS

There are many I would like to acknowledge for their time, guidance, and support. First, I would like to thank my mother, who gave me the courage and confidence to fight for my dreams, and made the completion of this degree possible.

I would also like to thank my co-advisors, Dr. Silvia Secchi and Carl Bruch, who helped me to deftly navigate the NSF IGERT fellowship and PhD program – both of which were uncharted waters for me. Dr. Secchi gave me the strength to work independently, to manage circumstances calmly, and to judge all situations with a fair and impartial eye. I will be forever grateful to have earned her confidence and respect. Mr. Bruch is both a revered mentor, and a colleague whom I admire greatly. I remember every word of advice he has given me, and my life is continually improved by his counsel and encouragement.

I must also acknowledge my committee: Dr. Kofi Akamani; Professor Cindy Buys; and Dr. Jonathan Remo. Your time, your suggestions, and our sometimes lengthy conversations contributed immensely to both my work and to my growth as a professional. I am a better person for having met each of you, and am thankful for your time and your support.

I would also like to acknowledge my gratitude to the International Commission for the Protection of the Danube River (ICPDR) for providing me with an internship in 2013. My collaborations with Raimund Mair, Igor Liska and Diana Heilmann contributed greatly to the success of my research, and their support of my work provided me with unique opportunities that will never be forgotten.

Finally, I would like to acknowledge the SIU Environmental Resources & Policy Ph.D. program, the NSF IGERT program in Watershed Science & Policy, and the Geography and Environmental Resources department.

PREFACE

This dissertation consists of three separate papers. All three are the culmination of the National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship (IGERT) Fellowship and six months abroad working as an intern with the International Commission for the Protection of the Danube River (ICPDR). Before departure, I designed a series of questions related to each paper, one set of questions related to climate change adaptation, one set on international frameworks for disaster response, and one final set related to disaster resilience and integrated water resources management. All questions were framed from the perspective of multilevel governance and the interplay of basin and sub-basin implementation of European laws, including challenges and innovations experienced at each level.

Semi-structured interviews were conducted during an eight month period of January to August 2013. The interviews were conducted in various locations throughout Europe, and continued over skype upon my return to the United States. 71 interviews were conducted in total. The interviews took place with experts working within the United Nations Economic Commission for Europe, the United Nations Industrial Accidents Convention, the United Nations Office for the Coordination of Humanitarian Affairs, the European Commission, the International Commission for the Protection of the Danube River (ICPDR) and with the expert groups of the ICPDR (Tisza Group, River Basin Management, Flood Protection, Accident Protection and Control), with respondents working at the national ministries, water management directorates, and non-governmental organizations in the Tisza sub-basin, Danube and Rhine River basin countries.

The first paper (Chapter Two), “Adaptation in the Tisza: Innovation and Tribulation at the Sub-basin Level,” is published in *Water International*. For this manuscript, I completed

a legal and policy analysis of European law and policies regarding multilevel governance in the European Union in relation to climate change adaptation. I used a secondary data analysis to discuss the effects of subsidiarity and vertical coordination in relation to the Tisza sub-basin, and supported my conclusions with use of the 71 interviews detailed above. I developed interview questions related to climate change adaptation and multilevel governance, analyzed the responses, integrated the interview responses into the policy analysis, and formulated conclusions in collaboration with co-authors Carl Bruch and Dr. Silvia Secchi.

The second paper (Chapter Three), “What Does Nature Have to Do with It? Reconsidering Distinctions in International Disaster Response Frameworks in the Danube Basin,” is under review with the journal *Natural Hazards and Earth Systems Science*. For this manuscript, I completed a legal and policy analysis of international European law and policies on the Danube River basin in relation to international response to natural and man-made disasters. I supported the secondary data analysis with the use of 71 interviews I completed during my internship with the ICPDR. I developed interview questions related to international disaster response, analyzed the responses, integrated the interview responses into the policy analysis, and formulated conclusions in collaboration with co-authors Carl Bruch and Dr. Silvia Secchi, and Dr. Jonathan Remo who also provided critical revisions of the article.

The final paper (Chapter Four), “Resilient Integrated Water Resources Management: Implications of a New Paradigm for the Danube and Rhine River Basins,” will be submitted to the journal *International Journal of Water Resources Development*. In this manuscript, I completed an analysis of the 2015 Sendai Framework for Disaster Risk Reduction and current policies regarding resilience in Europe and in the Danube and Rhine River basins. This included examining the levels of preparedness and response to natural and man-made disasters that both the Danube and Rhine River basins implemented, including risk assessments. I

developed interview questions regarding resilience, integrated water resources management, and disaster management with the aid of Dr. Silvia Secchi and Carl Bruch, and used responses from 26 individuals from the United Nations, the European Commission, and from water directorates and ministries located within the Danube and Rhine River basins. I analyzed the responses of the interviews, integrated them into the policy analysis, discussed the development of a new concept - resilient integrated water resources management – and the challenges associated with integrating this concept in the Danube and Rhine River basins. The conception of the article and critical revision was completed in collaboration with Dr. Silvia Secchi, Dr. Jonathan Remo, and Carl Bruch. The development of the new conceptual framework and the conclusions for the paper were developed in collaboration with Carl Bruch.

TABLE OF CONTENTS

<u>CHAPTER</u>	<u>PAGE</u>
ABSTRACT.....	i
ACKNOWLEDGMENTS.....	iv
PREFACE.....	v
LIST OF TABLES.....	x
LIST OF FIGURES.....	xi
CHAPTERS	
CHAPTER 1 – INTRODUCTION.....	1
CHAPTER 2 – ADAPTATION IN THE TISZA: INNOVATION AND TRIBULATION AT THE SUB-BASIN LEVEL	
INTRODUCTION.....	6
OVERVIEW OF METHODOLOGY AND STUDY AREA.....	7
GOVERNANCE OF ADAPTATION IN INTERNATIONAL WATERS.....	12
ADAPTATION INNOVATIONS IN THE TISZA.....	22
CHALLENGES TO SUB-BASIN ADAPTATION.....	26
CONCLUSIONS.....	31
CHAPTER 3 – WHAT DOES NATURE HAVE TO DO WITH IT? RECONSIDERING DISTINCTIONS IN INTERNATIONAL DISASTER RESPONSE FRAMEWORKS IN THE DANUBE BASIN	
INTRODUCTION.....	33
OVERVIEW OF METHODOLOGY AND STUDY AREA.....	35
DISTINCTIONS BETWEEN NATURAL DISASTERS AND MAN- MADE ACCIDENTS IN POLICY FRAMEWORKS.....	40
DISASTER FRAMEWORKS IN THE DANUBE AND TISZA.....	44

QUESTIONING THE DISTINCTION.....	58
BUILDING HOLISTIC APPROACHES FOR INTEGRATING MULTILEVEL DISASTER RESPONSE.....	61
CONCLUSIONS	63
CHAPTER 4 – RESILIENT INTEGRATED WATER RESOURCES MANAGEMENT: IMPLICATIONS OF A NEW PARADIGM SHIFT FOR THE DANUBE AND RHINE RIVER BASINS	
INTRODUCTION.....	65
OVERVIEW OF STUDY AREA AND METHODOLOGY.....	67
SHIFTING PARADIGMS FROM IWRM TO RESILIENCE USING THE SENDAI FRAMEWORK.....	70
ANALYZING IMPLICATIONS FOR RESILIENCE USING THE SENDAI FRAMEWORK.....	77
CONCLUSIONS	93
CHAPTER 5 – SUMMARY.....	95
REFERENCES	98
VITA.....	112

LIST OF TABLES

<u>TABLE</u>	<u>PAGE</u>
Table 2.1. Professional affiliations of experts interviewed and corresponding acronyms.....	11
Table 2.2. Water-related bilateral agreements among Tisza countries	23
Table 2.3. Sources of funding for the Danube basin.....	28
Table 3.1. Organizations from which experts were drawn for interviews.....	40
Table 3.2. Natural and man-made disasters in the Danube basin, reported by country.....	46
Table 3.3. Estimated human and economic loss in Danube per flood event	48
Table 3.4. Bilateral agreements on transboundary watercourses and disasters among Danube countries.....	55
Table 4.1. Governance levels of experts interviewed regarding resilience.....	70
Table 4.2. Natural and man-made disasters in the Danube and Rhine basins, by country.....	72
Table 4.3. Key elements of resilience in the Sendai Framework’s Priority Areas for Action.....	87

LIST OF FIGURES

<u>FIGURE</u>	<u>PAGE</u>
Figure 2.1. The Tisza River sub-basin in the Danube River basin.....	8
Figure 3.1. The Danube River basin and Tisza River sub-basin.....	36
Figure 4.1. The Danube and Rhine River basins, and Tisza River sub-basin.....	68

CHAPTER 1

INTRODUCTION

This dissertation examines some of the strengths and weaknesses in basin level governance, particularly as it relates to three current policy priorities: adaptive governance, international frameworks for response to natural and man-made disasters, and resilience in integrated water resources management (IWRM). When looking at the implementation of these concepts, challenges to integration are particularly true for multidimensional and intersectoral elements where policies on multilevel governance are either in need of improvement at multiple levels, or require modification of policy frameworks at multiple levels. This is reflected in the case studies of European river basins and sub-basins provided in this dissertation.

This research project consists of three separate papers on multilevel governance and the challenges experienced with integrating policy priorities across different levels of international water governance, including: adaptation to climate change, response to natural and man-made disasters, and resilience. The first paper analyzes the constraints to integrating climate change adaptation at the Tisza sub-basin into larger Danube basin-level processes, particularly in light of limited resources and weakened vertical governance. The second paper examines the international policy frameworks governing response to natural and man-made disasters, including naturally triggered technological (or “natech”) accidents, in the Danube basin and Tisza sub-basin, and explores what the transition to a more holistic international framework for response might mean. The third paper explores the implications of a new paradigm – resilient IWRM – and applying this approach in the practices of the Danube and Rhine River basins using the Sendai Framework for Disaster Risk Reduction; it also discusses the challenges associated with incorporating resilient IWRM methods.

The dissertation concludes with a summary highlighting three observations that cut across the analysis, including 1) when resources are limited and policy action is pursued at multiple levels, the sub-basin often has the least resources and is thus unable to achieve the desired policy objectives; 2) when a specific policy approach has been replicated throughout multiple levels of governance, updates need to occur at multiple levels as the value of new approaches are recognized; and 3) even when existing policies in multilevel governance are not necessarily flawed, new concepts, priorities, or paradigms may require modification of policy frameworks at multiple levels.

Basin and Sub-basin Governance

The 1992 Dublin Conference and Agenda 21 have operationalized theory into policy by directing participatory approaches in water governance be carried out at the basin or sub-basin level (ICWE 1992; UNCED 1992). Increasingly, these participatory approaches are finding application in the management of international waters (Bruch et al. 2005). Multilevel governance within polycentric systems suggests that a nested hierarchy of decision making is being utilized, and that authority does not reside solely at one level (Akamani and Wilson 2011). While commentators have theorized that redundancies in polycentric systems present an advanced ability to adapt to changing environments and therefore a higher resiliency, multilevel governance has noted inefficiencies with respect to climate change adaptation due to ineffective vertical interplay stemming from the large number of decision points and actors (Newig and Fritsch 2009; Pahl-Wostl 2009). Improved coordination is the intended outcome, but the cost of coordination, reaching agreement, and enforcing such an agreement can be quite high, and if coordination fails, a duplication of efforts and additional costs can ensue (Huitema et al. 2009).

Adaptive Governance, Disaster Response, IWRM and Resilience

Issues such as climate change and natural and man-made disasters often pose management challenges for many basin organizations, therefore the more flexible and capable of reacting to changing circumstances, the better-performing the river basin organization (Nashipili et al. 2008). For example, when developing a climate adaptation strategy, a basin organization can choose between broad measures that allow for more local level adaptation measures, or more concrete measures that guide specific adaptation measures at the basin level. Given the complex nature of water resources and the socio-economic factors affecting water use, much uncertainty exists regarding long-term water needs and the availability of water resources; this is exacerbated by anthropogenic climate change (Gleick, 2000).

Climate change adaptation provides a framework for governing water resources in a manner that can account for uncertainties. Adaptive governance involves the devolution of management rights and power sharing in order to promote participation; however, in order for participation to occur, collaborative networks must exist (Folke et al. 2005). Thus, adaptive governance can be conceived as the synthesis of collaborative management and adaptive management (Huntjens et al. 2010). Adaptation policies related to climate change need to be developed to minimize the negative impacts on water resources, ecosystems, and people, and to avoid transferring the problems among the integrated sectors (UNECE 2011).

In order to address the lack of coordination and disjointed planning that can occur among sectors, IWRM was developed as a process to mainstream the management of water, land, and related resources and maximize economic and social welfare (GWP 2005). This often occurs through basin or sub-basin level organizations that coordinate management efforts based on monitoring and assessment through data collection, and in turn provides information necessary

for adaptive governance (Troell and Swanson 2014). However, in areas like the Danube and the Tisza – where non-EU countries continue to be influenced by Soviet-era institutions, laws, and practices – national coordination and implementation of IWRM can remain difficult (UNECE 2011).

Cumulative uncertainties from climate change, and the increasing frequency and severity of disasters are leading to policy shifts toward more holistic frameworks of response that incorporate both natural and man-made disasters. Historically, a distinction has been drawn between the scope of natural and man-made disasters, largely to account for moral hazard; however, this distinction is absent from the Sendai Framework for Disaster Risk Reduction, which adopts a common multi-hazard risk approach providing management tools for disasters that are both natural and man-made (UNISDR 2015). Human, economic, and environmental losses are worse in highly populated areas; the world’s population is becoming more concentrated in urban areas, which places them at greater risk to natural and man-made hazards (Huppert and Sparks 2006). For this reason, natech accidents and other cascading disasters are particularly problematic where a distinction in response is made between natural and man-made hazards. Simultaneous response efforts are required to attend to the industrial, chemical, or technological accident as well as the triggering natural disaster. Therefore, broad definitions of disaster, as well as broad frameworks for response to multiple types of disaster are needed in order to recognize that many disasters can arise from multiple hazards—and to take the necessary measures to reduce the risks of those hazards.

Increasingly, basin organizations are considering methods for incorporating resilience into existing water resource management plans. Resilience can be constructed through the use of dynamic strategies that account not only for multiple actors and institutions, but also distinguish

among the phases of disasters – emergency response, short-term (i.e., housing for displaced people), medium-term (i.e., reconstruction and development), and long-term (preparedness and mitigation measures) (Rose 2009). Sector-specific risk assessments at the basin level can be developed, followed by measures to increase resilience and preparedness and response (UNECE 2011). Addressing gaps in resilience, particularly those that relate to institutional challenges, can prove challenging. The 2015 Sendai Framework for Disaster Risk Reduction, adopts a multi-hazard risk approach for disasters that are both natural and man-made, and recognizes the role of multiple levels of governance to reduce disaster risk, with an emphasis on building resilience and preparing for climate change (UNISDR 2015).

Integration of adaptive governance, disaster response, and resilience into multilevel water governance will now be explored using case studies of European River basins and sub-basins provided in this dissertation.

CHAPTER 2

ADAPTATION IN THE TISZA: INNOVATION AND TRIBULATION AT THE SUB-BASIN LEVEL

Introduction

The Tisza sub-basin is larger than most European river basins; however, its management is underdeveloped, especially compared with overall Danube basin management. Flooding and surface water pollution present the greatest challenges to the surface waters of the Tisza, and concern regarding climate change is driving interest in managing these pressures in a consistent, and effective manner. Drawing from interviews conducted in the Danube basin and the Tisza sub-basin, and from literature on adaptive governance, this article explores whether, in the context of adaptation, bottom-up governance can be successful in the Tisza, and discusses the broader implications for climate change adaptation at the sub-basin level.

Industrial and agricultural production significantly decreased in the Tisza as a result of political and economic change in the last two decades; however, many industrial sites lack fully implemented municipal sewage treatment or were left abandoned and continue to present serious pollution and accidental risk (Becker 2005). In 2000, a series of significant flood events in Baia Mare, Romania led to a breach in a mine tailings dam, resulting in the release of over 100,000 m³ of cyanide, copper and other heavy metals into the Tisza eventually traveling to the Danube and through to the Black Sea (Csagoly, 2000).

The process of adaptation enables a system to better cope with, manage or adjust to a changing condition, hazard, risk, or opportunity, such as those present in the Tisza sub-basin. Adaptive strategies aim to reduce vulnerability to these changing conditions, and increase adaptive capacity (WWF, 2009). Governance refers to the interactions by private and public actors and includes the formulation and application of principles to guide their interactions, and care for the

institutions that enable them (Munaretto et al. 2014). The growth in failed attempts at delivering efficient and reliable ecosystem goods and services has led to calls for adaptive governance regimes capable of incorporating the inherent complexity and uncertainty of social-ecological systems (Dietz et al. 2003; Folke et al. 2005; Walters 1997).

We argue that there are four key challenges constraining adaptation at the sub-basin level in the Tisza: policy, fiscal, institutional, and capacity. This article begins with an overview of the study area and a description of the methodology. Next is an examination of conceptual domains relating to adaptation in international governance and adaptation in transboundary water management, including multilevel governance. Then the international laws and policies governing transboundary waters relevant to the Danube basin and Tisza sub-basin are explored. The final section highlights the challenges to adaptation in the Tisza sub-basin, drawing on expert interviews and document analysis. The article concludes with a brief reflection on the lessons to be drawn from these experiences.

Overview of Study Area and Methodology

Among the tributaries of the Danube River, the Tisza has the largest catchment area, and covering approximately 160,000 km² (20 percent of the Danube's catchment area), and serving 14 million inhabitants (Figure 2.1). The upper portion of the Tisza begins in the Ukrainian Carpathian Mountains, where it moves along the border of Romania, flowing southwest into the flat, middle portion of the great Hungarian Plains, then into the lower Tisza, downstream of the Hungarian-Serbian border, where it joins with the Danube River (ICPDR 2008a). Precipitation is concentrated in the mountainous upper catchment, resulting in some of the most sudden and extreme flooding in Europe, with floods reaching up to 12 m in 24-36 hours (Nagy et al. 2010).



Figure 2.1. The Tisza River sub-basin in the Danube River basin.

Extensive runoff, deforestation, and channelization have reduced the ability of the catchment area to attenuate the flood wave, leading to sudden water level rise that threatens human lives and extensively damages infrastructure and croplands (ICPDR 2008a). Regional forecasts have indicated that the frequency of extreme floods and serious droughts are expected to increase as a result of climate change (Schneller et al. 2013). After the Netherlands, the Tisza ranks as one of the highest flood-risk areas in Europe, and it is also one of the poorest (Linnerooth-Bayer et al. 2013).

Extreme flood events occur every 10-12 years on average in the Tisza River sub-basin; however, the trend has been toward increases in all facets of flooding, including flood peak height, volume, and frequency (Sendzimir et al. 2007). Climate change projections suggest less precipitation in summer, more precipitation in winter and spring, and higher temperatures resulting

in earlier snowmelt, which can aggravate three main water-related problems in the Tisza: flooding, inland water stagnation, and drought (Schneller et al. 2013; Werners et al. 2011). Floods are already the most widespread hazard in the Tisza, and, combined with the poor water quality treatment in the region and poor socioeconomic conditions (e.g., extreme poverty, social exclusion), they are projected to seriously affect the food supply and increase disease, injury, malnutrition, and mortality (Schneller et al. 2013).

The root of the increasing flood stages began with the original Vasárhelyi Plan in 1870. During this period the Tisza fell within the territory of a larger Hungary, and the Austrian and Hungarian ruling parties developed the Tisza to meet socio-political demands for grain production and export, habitation, and flood protection (Sendzimir et al. 2008). The Tisza was shortened by 400 km and deepened to hasten water flow, facilitate navigation and transport. In recent history, Hungary has opted for river engineering methods that created large networks of levees, and approximately 3,000 km of embankments. These remain inadequate to protect against increasing flood frequency and discharge, because they require repeated raising; additionally, the need to drain water quickly during floods has led to later scarcity of clean water during drought periods (Linnerooth-Bayer et al. 2013). The 2003 implementation of the Improved Vasárhelyi Development Plan—an elaborate river restoration plan to combine water retention, floodplain rehabilitation, and rural development as a strategy to replace prevailing engineering approaches—holds lessons for adaptation through support of floodplain production systems and environmental protection (Linnerooth-Bayer et al. 2013; Sendzimir et al. 2008). However, the Improved Vasárhelyi Plan has been considered a failure due to escalating costs, lack of political will beyond the water authorities, and obstacles to land acquisition (Sendzimir et al. 2010; Werners et al. 2009).

The four main drivers of adaptation in the Tisza sub-basin are: the cyanide spill of 2001 that raised awareness for transboundary vulnerabilities (particularly of industrial waste) following

record-breaking floods in 2001; the promotion of alternative approaches to river science, practice, and policy pioneered in Germany and the Netherlands; European Union water and natural resource management policy (especially the Water Framework Directive (European Community 2000); the Birds Directive (European Community 2009); and Habitats Directive (European Community 1992)); and the shift toward more experimental management policies, which broadened management targets to include adaptive strategies and stakeholder participation (Sendzimir et al. 2010).

The Tisza countries have experienced challenges with managing their transboundary waters in a nested, consistent, and effective manner at the sub-basin level within the existing European Union (EU) legal and policy frameworks, principally the Water Framework Directive (WFD). Ultimately, adaptation efforts in the Tisza sub-basin highlight the practical and political limitations of subsidiarity. Subsidiarity is a guiding principle for EU governance that requires action—and interaction—between the EU and member states and delimits legislative powers between the EU and EU member states so that decisions are taken as closely as possible to that of the EU citizen (European Union Member States 2012). The water legislation governed by the WFD provides an adaptive framework by affording the opportunity to adapt measures into future basin management plans via six-year monitoring and assessment cycles; however, it fails to specifically address climate change, and provides only a cursory mention of sub-basin management (European Community 2000, Article 13(5)).

Methodology

The examination of adaptive governance in the Tisza sub-basin level was conducted through a combination of primary data analysis of semi-structured interviews, and literature review of peer-reviewed and secondary data, including an analysis of laws, policies and institutions within the Danube basin and Tisza sub-basin. This qualitative approach followed methods described by

Patton, Sawicki and Clark (2013), which suggested that the mixed use of interviews, review of reports, and data analysis overcomes the potential for bias. Between the eight-month period of January to August 2013, 71 interviews were conducted in various locations throughout Europe. The interviews took place with experts working within the International Commission for the Protection of the Danube River, within the expert groups of the International Commission for the Protection of the Danube River (Tisza Group, River Basin Management, and Standing Working Group), with respondents working at the ministries, water management directorates, and non-governmental organizations in the Tisza countries, as well as with experts working within the European Commission, the United Nations, and the United Nations Economic Commission for Europe involved in the Danube basin and Tisza sub-basin. Given the respondent's public roles, the interviews are intentionally left anonymous to foster candidness in responses (Table 2.1). The questions focused on how Danube basin and Tisza sub-basin policies and laws were implemented in practice, as well as the perceptions of the experts regarding the interplay of implementation as it concerned adaptive governance and the role of climate change adaptation in the Tisza sub-basin.¹

Table 2.1. Professional affiliations of experts interviewed and corresponding acronyms.

Role of Expert	Acronym
European Commission official	EC
Ecosystem and biodiversity	EB
Danube River basin	DRB
Tisza sub-basin	TSB
Regional water manager	RWM
Flood protection	FP
Government official	GO
United Nations Economic Commission for Europe officer	UNECE
Freshwater biologist	FB
Regional water director	RWD
Global Environment Facility/United Nations Development Programme officer	GEF/UNDP

¹ Questions relevant to adaptation and multilevel governance included: 1) Are there any policies that directly or indirectly address decentralization of water governance in the Tisza sub-basin? 2) What gaps exist between policy and practice in multilevel governance? 3) What are some of the constraints and opportunities for adaptation in the Tisza? 4) What are the trends in adaptation and what level of governance are they coming from?

Governance of Adaptation in International Waters

Globalization has profoundly altered the theory of government and the nation-state, as well as the roles and functions of the political actors regulating public affairs and promoting development. Politics has become more polycentric, with the nation-state as one of many levels in a complex system of overlapping and sometimes competing agencies of governance (Finger et al. 2006).

Governance of International Waters

There is an ongoing shift from government to governance, in which formal and informal institutions and individuals, public and private, are involved in a continuing process of cooperation and accommodation in order to actively balance conflicting or diverse interests (Dellapenna and Gupta 2009). Government is no longer the sole decision-making authority, exerting sovereign control over civil society; instead, ideas of multilevel governance contribute to policy development and implementation through the participation of a variety of actors in diverse settings (Pahl-Wostl 2009). Governance is a reflection of shared goals and behaviors that may not be derived from formal prescriptive responsibility, nor does it necessarily require police power to ensure compliance (Rosenau 1992).

Increasingly governance includes the role of non-state actors, as well as the private sector and public participation. Participatory approaches in natural resource management reflect the emergence of new modes of governance and knowledge generation in times of increasing uncertainty and complexity (Pahl-Wostl et al. 2007). Increasingly, these participatory approaches are finding application in the management of international waters (Bruch et al. 2005). Due to the resource-intensive nature of participatory processes, they can result in decreased efficiency, even while they tend to increase compliance and overall effectiveness (Pahl-Wostl 2009).

Multilevel governance refers to governance practices at the local, state/provincial, regional, national, and international levels that work in a connected manner, within a single, integrated command structure, and where decisions made at one level impact other levels (Finger et al. 2006; Kuhlmann 2001; Marshall 2008). Multilevel governance within polycentric systems suggests a nested hierarchy of decision making, and authority at multiple levels (Akamani and Wilson 2011). While commentators have theorized that redundancies in these systems present an advanced ability to adapt to changing environments and therefore higher resiliency, multilevel governance has noted inefficiencies with respect to climate change adaptation due to ineffective vertical interplay stemming from the large number of decision points and actors (Newig and Fritsch 2009; Pahl-Wostl 2009). Improved coordination is the intended outcome, but the cost of coordination, reaching agreement, and enforcing such an agreement can be quite high, and if coordination fails, a duplication of efforts and additional costs can ensue (Huitema et al. 2009).

The principle of subsidiarity motivates and underpins the process of assigning responsibilities across governance levels. In areas where the EU does not have exclusive competence, the principle of subsidiarity seeks to protect the capacity of the member states to take decisions and action, and authorizes intervention by the EU only when the objectives of an action cannot be sufficiently achieved by a member state (European Parliament 2004). The European Community has adopted subsidiarity as a central organizing principle. The 2007 Treaty of Lisbon expanded its application to include proportionality where competencies between the European Union and member states are defined, and control mechanisms were introduced in order to monitor its application (European Community 2010). Marshall (2008) notes that while the principle of subsidiarity may open up interpretations in use that can be beneficial for promoting experimentation and learning across governance systems in how tasks are assigned to various levels, it is important to detail the criteria by which the nesting of subunits at higher levels should

occur. Governments can underestimate the capacities of subunits to address particular problems, thereby inappropriately retaining responsibilities that should be undertaken by lower levels of government.

Basin and Sub-basin Level Governance

The 1992 Dublin Conference on Water and the Environment, and Agenda 21, have operationalized theory into policy by directing participatory approaches in water governance be carried out at the basin or sub-basin level; however, challenges remain in reconciling the boundaries of this resource with its respective institutions (ICWE 1992; UNCED 1992). The scale of governance of river basins is associated with spatial area as well as the degrees of government authority, not only vertically (international, national, regional, state, local), but also horizontally (scope of activity and authority) (Griggs 2015). Ekstrom and Young (2009) theorize that failures in spatial fit, as applied to environmental resource management, occur when an institution fails to account for the nature, functionality, and dynamics of the ecosystem it influences. While theories of subsidiarity suggest a downscaling process to more local-level actors, particularly for natural resource governance, global climate change necessitates an upscaling of policy.

While a river basin approach may seem simple, problems and opportunities within a basin are multiple and overlapping, and vary from the local to the regional, thus increasing the geographic scale of institutional arrangements (Huitema et al. 2009; Moss 2012). At the same time, too many autonomous centers of decision making without clear institutional roles or set modalities for interaction or coordination can also constrain the implementation of government policies, such as those for climate change mitigation and adaptation (Nanni 2012). In this regard, the WFD represents an ambitious attempt at arranging water resources based upon the principle of basin level management (Moss 2012). The integrated approach is promoted through water pollution control and principles and practices at the basin level that aim to achieve “good status” for surface

and ground water (European Community 2000). In a 2003 WFD Guidance Document, the European Community recognized that “by creating a spatial unit for water management based solely on river basins, spatial conflicts could occur with policy sectors structured on administrative and political boundaries” (European Community 2003, 17). However, river basin can often be too large a unit to manage effectively, and in some of the world’s largest rivers - such as the Volga, the Amazon, and the Danube - failure to properly integrate sub-basin management weakens vertical coordination in multilevel governance (UNEP 2014b). In addition to basin size, other factors that limit effective management are inter-jurisdictional conflicts among governments, the presence of groundwater basins that affect surface water management, and the other water management areas (e.g., hydropower) requiring different management options, all of which exist in the Tisza (Caponera 2007). While water managers argue that not all problems require a basin-level approach, alternative levels of management are not often considered because the river basin is considered the optimal spatial unit for managing water (von Keitz and Kessler 2008; Grünewald 2008). Additionally, arguments have been made nationally in support of selective forms of basin level management when specific issues are considered advantageous, particularly in the case of upstream/downstream relations, flooding, drought, and low water levels (Moss 2012). However formal recognition and legitimacy must be provided for lower levels of basin management, as without it member states may undermine existing governance structures and power relations between stakeholders, and create institutional gaps difficult to overcome between basin countries (Del Moral and Do Ó 2014). Uncertainty remains in regard to spatial fit at the sub-basin level, as well as how to manage adaptation when neither is specifically prescribed by EU law.

Adaptive Governance

Given the complex nature of water resources and the socio-economic factors affecting water use, much uncertainty exists regarding long-term water needs and the availability of water

resources (Gleick 2000). Adaptive management provides a framework for governing water resources in a manner that can account for these uncertainties. Adaptive governance involves the devolution of management rights and power sharing in order to promote participation; however, in order for participation to occur, collaborative networks must exist (Folke et al. 2005). Thus, adaptive governance can be conceived as the synthesis of collaborative management and adaptive management (Huntjens et al. 2010).

Few institutional frameworks are developed specifically for adaptive governance; although components of adaptive frameworks are often present (Bruch 2009; Troell and Swanson 2014). Finding a balance between bottom-up and top-down governance is an important element for adaptive management in river basins and large-scale, complex systems (Huntjens et al. 2010). Adaptive governance requires secure, adequate, and flexible funding. While a variety of funding mechanisms and informal networks are available, providing dedicated resources to train, support, incentivize, and institutionalize capacities into practice is still challenging (Wyborn 2015). A more decentralized approach would, for example, attempt to integrate best practices from smaller financed pilot projects and scale them up to catalyze change at multiple levels and across sectors, with the intention of learning at larger scales and for longer periods of time (Barchiesi et al. 2014).

Policy Frameworks

Adaptation in international river basins is governed by a range of global, regional, and national laws, policies, and soft-law instruments. In the Tisza sub-basin, this includes the 1992 United Nations Framework Convention on Climate Change (UNFCCC), the 1992 Helsinki Watercourses Convention, the 1997 United Nations Watercourses Convention, the WFD and the EU Strategy on Adaptation to Climate Change, as well as adaptation policies at the level of the Danube basin.

United Nations

The UNFCCC presents several guiding principles for the international community to utilize in preventing and adapting to climate change. Under Article 4, clear commitments on adaptation to the adverse impacts of climate change are listed, including how to formulate and implement national programs to facilitate adequate adaptation to climate change (Article 4(1)(b)).² While the UNFCCC provides guidance on how to address climate change adaptation, the ability to assess institutions, and the role of institutions in relation to their adaptive capacity, are not addressed (Gupta et al. 2010).

Though the UNFCCC is most effective at guiding adaptation at the national level (Gupta et al. 2010), the UN Economic Commission for Europe (UNECE) is a regional commission that oversees the implementation of regional agreements, including the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (the Helsinki Watercourses Convention) (UNECE 2010). The Helsinki Watercourses Convention – formerly a regional, now universal framework – is open for participation from a variety of countries from within and outside of Europe, including Asia. The Convention aims to protect and ensure the quantity, quality and sustainable use of transboundary water resources by facilitating cooperation among shared watercourses (UNECE 2010). Though the Helsinki Convention does not explicitly mention climate adaptation, it provides a framework for transboundary cooperation and the development of adaptation strategies, and requires parties to enter into bilateral and multilateral agreements to eliminate contradictions with principles of the convention. This includes provisions for consultation, research and development, monitoring and assessment, and the establishment of institutions for cooperation and management of shared watercourses (UNECE 2010). At the 2009 Meeting of the Parties, member states adopted the Guidance on Water and Adaptation to Climate

² All sub-articles in 4(1) include other adaptation-related commitments.

Change, which provides non-binding guidance on how to perform risk assessments, measure vulnerability, and design and implement adaptation strategies (UNECE 2010). The guidance is reinforced by pilot projects that are undertaken by the UNECE to strengthen the capacity of developing countries to create basin-wide adaptation strategies (UNECE 2010).

The 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourses Convention) entered into force in August 2014. The convention is significant mainly for the codification of three principles of customary international law: equitable and reasonable utilization; prevention of significant harm; and prior notification of planned measures (McCaffrey 2014). A significant role of the convention is the encouragement of watercourse states to enter into watercourse agreements and establish a framework of general principles to guide the behavior of the states (Sands 2007). Interestingly, not all riparians of the Tisza have signed or ratified the convention – only Hungary has (UN 1997). It was reported in multiple interviews that experts from Hungary were interested in seeking specific sub-basin management arrangements for the Tisza sub-basin, through the development of a sub-basin commission or other negotiated framework (Interviews DRB #11, GEF/UNDP #54, RWD #49).

While the UNECE Watercourses Convention was intended as a regional instrument for Europe and was eventually opened for accession to states beyond the European region, the UN Watercourses Convention and the UNECE Watercourses Convention remain compatible and the treaties have essentially the same object and purpose – cooperative use, management, and protection of shared freshwater resources (McCaffrey 2014). Article 3 of the UN Watercourses Convention also expressly respects pre-existing basin agreements, and therefore will not disrupt the interpretation or implementation of regional or basin agreements (UNEP 2014a).

EU Directives and Policies on Adaptation

In 2000 the EU adopted the WFD, which establishes an adaptive framework in water policy

and aims at achieving a “good status” for European waters. The directive shifts away from national, control-specific directives (e.g., water pollution, ground water, agricultural management) and toward basin level governance (Dellapenna and Gupta 2009). This is carried out through a six-year cyclical process via cooperation among nationally-identified competent authorities from each basin country, and is considered adaptive by allowing the opportunity to incorporate information into each new basin management cycle (European Community 2000). Specifically, as part of the WFD the EU member states must: 1) identify the individual river basins within their national territory and assign them to international river basin districts (RBDs, e.g., the Danube Basin district); 2) characterize the RBDs in terms of pressures, impacts and economic uses of water, including a register of protected areas within each RBD; 3) carry out a calibration of the ecological status classification systems; 4) make operational the monitoring of water status; 5) identify a programme of measures for achieving the environmental objectives of the WFD; 6) produce and publish river basin management plans for each RBD, including the designation of heavily modified water bodies; 7) implement water pricing policies that enhance the sustainability of water resources; 8) to make the programme of measures operational; and 9) implement the programme of measures and achieve the environmental objectives (European Community 2003). However, the WFD has been criticized for its failure to explicitly reference climate change, calling into question its ability to adequately address climate change issues (Nanni 2012).

In 2013, the EU released its Strategy on Adaptation to Climate Change, which reinforced the recommendations of the UNFCCC to create national adaptation strategies and risk management plans (European Commission 2013b). In recognition of the cross-sectoral nature of climate change adaptation and the need to integrate these activities across multiple levels and projects, the EU dedicated a portion of its cohesion policy funding mechanism to member states that want to improve their adaptation measures, as long as they have developed the requisite national or

regional risk assessments outlined by the UNFCCC (European Commission 2013b). The cohesion policy is the EU's principal investment policy and has the primary responsibility of mainstreaming the environment into EU programs and projects by strengthening vertical and horizontal approaches to management. To meet the criteria for funding under this mechanism, country gross domestic product must be less than 75% of the Community average – this removes almost all the territory of the Tisza except Romania and some portions of Hungary. However, the EU has endorsed a macro-regional strategy for three specific regions that could benefit from strengthened cooperation, and economic and social cohesion – the Danube Region, the Baltic Sea Region, and the Adriatic and Ionian Region (European Commission 2014b). Thus, the EU's adaptation strategy does not align adaptation activities with those at the basin-level, nor does it align with other EU directives. It is up to each member state to decide whether and how they will adapt to climate change, and the process for applying for adaptation funding from the EU requires meeting guidelines from a global authority (the UNFCCC).

From a policy and legal perspective, adaptation at the basin-level is therefore directed at the national level through the UNFCCC and the WFD, but not at the sub-basin level; any activities that occur at the sub-basin level exceed what is required by law.

Danube Basin-Level Adaptation Policy

In 1998, predating the adoption of the 2000 WFD, the International Commission for the Protection of the Danube River (ICPDR) was established as a transnational body to implement the Danube River Protection Convention (DRPC). The DRPC is the primary legal instrument governing transboundary water management and cooperation in the Danube basin, and ensures the sustainable and equitable management and use of the Danube River by all countries sharing the basin, including non-EU countries; the EU is also a member to the DRPC (ICPDR 2008a). Because the WFD is an EU mechanism, it is only binding on member states to the EU. Through the DRPC,

the Danube countries appointed the ICPDR as the coordinating body for the WFD, and EU and non-EU countries have agreed to manage their portion of the Danube basin according to WFD regulations (ICPDR 2008a). Therefore, in the event of a dispute related to the DRPC, rules for arbitration and the involvement of the UN's International Court of Justice have been stipulated (ICPDR 1994).

In the 2010 Danube Declaration, the EU and high-level representatives from Danube countries committed to reinforce sustainable, transboundary management, with a particular emphasis on developing a climate change adaptation strategy for the basin, and to organize a conference with relevant financial institutions and donors to draw attention to the financial constraints some countries in the Danube Basin face and to identify mechanisms for the financing of projects (ICPDR 2010a). One important step in improving transboundary management of the Danube was the development of the 2013 Strategy on Adaptation to Climate Change for the Danube River Basin (ICPDR 2013). Although the Strategy was envisioned as a method for integrating climate change adaptation into the Danube River Basin Management Plan (DRBMP) of 2015 and future iterations, it highlights the need for more comprehensive planning at the sub-basin and national levels (ICPDR 2013). The strategy also notes that while conducting a basin-wide vulnerability assessment would be beneficial, following EU Common Implementation Strategy guidelines, the compilation of existing local and national vulnerability assessments throughout the basin was chosen instead (ICPDR 2013). The ICPDR's adaptation strategy illustrates some of the challenges in planning, balancing, and prioritizing its limited resources for adaptation (Barchiesi et al. 2014).

In the first DRBMP, released in 2009, climate change was addressed as an issue of basin-wide importance, and the identification of future pressures on the aquatic environment was considered a priority (ICPDR 2009a). In the 2015 iteration of the DRBMP, the Danube countries

acknowledge the uncertainties related to climate change stresses on water resources (ICPDR 2015a). They also address the difficulty in decoupling climate stressors from anthropogenic stressors and therefore have integrated climate change into the DRBMP. While there are no specific climate change adaptation measures, the DRBMP indicates that, by noting the effects of climate change on water-related sectors, cooperation can take place among various inter-sectoral activities (e.g., flood risk management, inland navigation, hydropower, agriculture) (ICPDR 2015a).

Adaptation Innovations in the Tisza

Building on the theories of adaptive governance discussed earlier, and from the functional adaptive management strategies in the Danube Basin, this section explores the source of adaptation innovations in the Tisza, including memoranda of understanding, the Integrated Tisza Basin Management Plan, and the Tisza Sub-basin Flood Management Plan. While the WFD does not explicitly prescribe management at the sub-basin level, the Tisza sub-basin has developed several, noteworthy innovations. The ability to coordinate and implement these actions over the long term is essential for consistent and sustainable management.

Memoranda of Understanding

At the sub-basin level, the WFD allows the development of supplemental actions. In this regard, the Tisza countries have forged a memorandum of understanding (MOU) to manage activities at the sub-basin level. From this MOU, an ad hoc Tisza Group was formed in 2004 to coordinate the activities of the MOU.

The MOU is distinct from legally binding treaties, although MOUs may be viewed—in the words of the UN’s International Law Commission—as “treaties in simplified form” (International Law Commission 1966). They can provide signatories with the benefits of entering into an agreement without having to meet the formalities associated with negotiating, ratifying, and

amending a treaty. Unlike its sister sub-basin the Sava, however, the Tisza has been managing its activities without a formal basin commission, and without formal treaties beyond those shared bilaterally with riparian states (Table 2.2).

The 2004 MOU that created the Tisza Group also included a provision to develop a sub-basin management plan by 2009. In 2010, a Ministerial Statement entitled “Towards the Development and Implementation of a River Basin Management Plan for the Tisza River Basin” was signed by the Tisza countries; this Statement sought to ensure the ultimate completion of the first Tisza sub-basin management plan in 2011 (ICPDR 2010a).

Table 2.2. Water-related bilateral agreements among Tisza countries (adapted from ICPDR 2009a).

Countries	Transboundary watercourses	Disasters/emergencies	Environmental protection
Hungary-Romania	1986		2000
Hungary-Slovakia		No Date	1999
Hungary-Ukraine	1997	1998	1993
Ukraine-Romania	1997		
Ukraine-Slovakia	1995	2000	

In 2011 the Tisza Group signed a new MOU on Strengthening of Tisza River Basin Cooperation, in addition to setting a 2012 deadline for developing a case study for climate change impacts for the Tisza sub-basin, as well as a 2015 deadline for the updated Tisza Basin Management Plan (ICPDR 2011a). Additionally, the MOU promotes regional cooperation toward the protection of mountain resources with the Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention 2006). While participation and cooperation with the Carpathian Convention is ongoing, the first tasks of the MOU have not occurred; reasons for this will be discussed below in the upcoming section on challenges to sub-basin adaptation.

Integrated Tisza River Basin Management Plan

While the delay in ultimately creating the ITRBMP reflects common challenges to sub-

basin management—namely fiscal and capacity challenges— interest in advancing activities at this level was reported in multiple interviews (Interviews FP #33, GEF/UNDP #54, GO #36, RWD #47, TSB #25). Funding was provided for the ITRBMP from the governments of Tisza basin countries, from EU funding, and from support provided by the United Nations Development Programme / Global Environment Facility. This split the activities of the ITRBMP into two separate modes: first, to develop a sub-basin management plan for the Tisza based on funding from the Tisza countries and the EU, and second, to implement a set of pilot projects focused on mainstreaming wetlands and floodplains restoration into national policy (ICPDR 2011b).

In contrast to the DRBMP, the ITRBMP accounted for rivers with a catchment size > 1,000 km² (instead of > 4,000 km²), natural lakes >10 km² (instead of 100 km²), main canals, and groundwater bodies > 1,000 km² and of basin-wide importance. Recognizing that many of the problems of water quality and quantity do not appear in isolation, and that climate change can present major challenges to the sub-basin, the Tisza countries identified the pressures and potential impacts to the region that could occur from each of the issues – and that currently affect two or more Tisza countries. These include hydromorphological pressures from flood protection measures, accidental pollution from flooding, loss of wetlands, solid waste, groundwater depletion due to over-abstraction, and increased irrigation and surface water abstraction (ICPDR 2011b). Furthermore, each country reported the extent to which it had a climate change strategy in place (whether one was present or not), as well as any activities that were taking place in the sub-basin at the local level (ICPDR 2008a).

Finally, the ITRBMP explicitly addressed horizontal measures related to the integration of water quality and quantity (ICPDR 2011b, p. 111). Here the Tisza countries recognized that local action alone is not sufficient to effectively implement the ITRBMP, and requested that consistent action should be taken from both the Tisza Group as well as through bilateral commissions

addressing water management in the Tisza, including under the work of the regional Carpathian Convention. The ITRBMP recommended that inter-ministerial or inter-sectoral committees be established to help coordinate implementation, and to develop an overall communication strategy for the Tisza sub-basin in order to target different levels of authority and include aspects of climate change for long-term sub-basin management. Compensation schemes and incentives must be considered in long-term management of sub-basin activities, particularly in cases where flood protection and water retention could be requested as land management alternatives.

Sub-Basin Level Tisza Flood Action Plan

In acknowledgement of the number of fatalities caused by flooding, the large numbers of people displaced, and the extensive damage caused both to the environment and to the economy, the EU adopted the 2007 Directive on the Assessment and Management of Flood Risks (Flood Directive, FD) (European Community 2007). The terminology of the FD is unique in that, unlike the WFD, it provides for situations where the units of management can be something other than the river basins – they can also be coastal areas (European Commission, 2014a). However, European Commission guidance documents on the WFD and FD indicate that a sub-basin cannot be a unit of management for the purposes of the FD because it has to include all surface water flows that terminate at the sea (European Commission 2014a, p. 12). While the FD expressly states that this cannot be a sub-basin, the flood events in 2002 and again in 2007 moved the Flood Protection Expert Group of the ICPDR to develop a sub-basin level flood action plan for the Tisza River basin in 2009 (ICPDR 2009b; Interview GEF/UNDP #54). A potentially problematic aspect of the Tisza plan, however, is that unlike in the Danube Basin, and as directed by the FD, the Tisza plan indicates that it will only be updated as appropriate, or as determined by the bilateral river commissions, which means that it is not necessarily linked to broader Danube basin governance, the cyclical basin management cycle of the Danube, or the adaptive management process of the

Tisza (ICPDR 2009b).

Challenges to Sub-basin Adaptation

The Tisza Group was created to manage the pressures on water resources, including adapting to climate change, but its activities have largely faltered as a result of lacking legal and policy frameworks, inadequate funding, and institutional and capacity challenges. These are considered now.

Policy Challenges

Without a policy framework to guide sub-basin management in the EU WFD, the Tisza lacks formal vertical integration into the broader Danube basin management process. This presents complications for subsidiarity in climate change adaptation at the sub-basin level, given that adaptation is often implemented at the domestic level through national policies. While the monitoring and assessment present in the river basin management plan cycle may help to detect climate change-related impacts on water resources, such basin-level efforts often do not translate into national-level adaption policies or action (Nanni 2012). Hungary, Romania, Slovakia, and Ukraine have regularly submitted their Annex I National Communication Reports containing information on national vulnerability and adaptation to climate change per the UNFCCC, and Serbia developed its first non-Annex I National Communication Report in 2010, indicating the financial and capacity needs for developing the first National Action Plan for Adaptation. Such action plans reported to the UNFCCC are not mandated under the WFD, but they are tied to EU funding mechanisms, which provides an impetus to develop them. While any ongoing adaptation activities would be included in the submitted national reports, none of these national reports contain information on projects related to the Tisza. However, if there is a lack of inclusion by institutions in vertical governance at the sub-basin level, a balance is not found between centralized and decentralized control, and adaptive management is less likely to occur. Interviews also

indicated that government documents on national water policy discuss the use of water, but not the need for cooperation among transboundary bodies governing water and adaptation – and without country-level interest in furthering sub-basin level activities, action will continue as directed by the WFD and national water law (Interviews GO #36 and #48, RWD #47). Given the interest expressed by Tisza countries in strengthening horizontal measures in the ITRBMP, this represents additional policy challenges at the national level in sub-basin management.

Fiscal Challenges

While the EU Common Implementation Strategy helps develop a Europe-wide understanding for taking a basin-level approach to management, and provides technical guidance for implementing the WFD, there is no specification of funding schemes for river basin management in the Common Implementation Strategy or the WFD, which leaves the question of funding projects for climate adaptation, or other water-related projects across river basins entirely up to the member states (Moss 2012). Each EU fiscal cycle provides the opportunity for basins to decide what projects they want to develop, and a variety of funding mechanisms are available based on the type of project. Funding for adaptation to climate change in Europe is also offered through a variety of instruments, and is aligned with the six-year fiscal cycle of the corresponding WFD river basin management plans. In order to fund the administration of the ICPDR, the countries are charged an annual fee assessed from taxes, which is usually an equal amount across the basin, except for times of country transition or other ad hoc exceptions. These fees also partially fund pilot projects for the Danube basin, as agreed on by the Danube countries – the fees do not drive activities at the sub-basin level.

For projects being undertaken by the ICPDR, funding is applied for from a variety of sources (Table 2.3). As indicated previously, basin-level activities are specifically prescribed under the WFD, and are therefore given priority. Interviews in Hungary and Serbia revealed that

perceptions regarding funding insecurities led to preferences for more local pilot projects within the Tisza sub-basin (Interviews GEF/UNDP #54, GO #36 and #48, RWD #47, RWM #26 and #27). Concerns that projects developed at the sub-basin level would not be completed, or that funding would run out and that local citizens would not be reimbursed for their investments, was reported during interviews, and examples were provided of situations where this had occurred in Romania, Hungary, Serbia, and Ukraine were provided (Interview, GO #36 and #48, RWD #47, TSB #25, UNECE #39).

Table 2.3. Sources of funding for the Danube basin (adapted from ICPDR 2009a).

-
- National commitments from Basin countries
 - EU funding mechanisms (e.g., Common Agricultural Policy, Cohesion Fund, Structural and Life Funds, and EU Neighbourhood Fund)
 - International funding institutions (e.g., European Investment Bank, European Bank for Reconstruction and Development, World Bank)
 - Water pricing policies (e.g., application of polluter pays principle)
 - Other external organizations (e.g., Global Environment Facility, Environment and Security Initiative, World Wildlife Fund)
-

Institutional Challenges

The ICPDR has a consultative and advisory function, but the basin states are the ultimate decision-making authority. The activities of each expert group are led by a chairman nominated by the countries represented in each group. The position is supposed to change every two years, and the ICPDR cannot recommend who can be seated at these meetings - this is the role of the basin states (Interview DRB #12). The activities of the Tisza Group were initially led by a representative of the European Commission, but over time the EU Commission has lessened its role in the workings of the sub-basin and has looked to the countries to take lead on the activities they want to see advance. Interviews indicated that commission participation as chairpersons was a driver of activities, but that as the commission assumed a reduced role, the effectiveness of the group also lessened (Interviews DRB #12, EC #14, TSB 25). Suggestions for strengthening effectiveness in

the Tisza Group have been to nominate someone who is active at multiple levels within one government, who is familiar with the directives and laws of the countries, and who can report across multiple levels, including the ICPDR (Interviews DRB #11 and #12, EC #4, RWM #27).

Differing visions about what the Tisza Group should do and how it should operate, compounded by perceptions of counterparts by other states as difficult and driving their own agenda have effectively reduced productivity of the Tisza Group (Interviews DRB #11 and #12, GO #36, TSB #25). The Tisza Group MOU was updated in 2011 and included the intention to develop a case study for climate change impacts in the Tisza by the end of 2012. The study has yet to occur, and there are no current plans to complete it (ICPDR 2011a). Additional activities for the Tisza Group include a 2015 date for the development of the updated ITRBMP (ICPDR 2011a), but this too has yet to occur.³ Interviewees described how countries often know what goals they are trying to achieve nationally in order to meet the suite of EU water quality Directives, but this does not always translate into sub-basin cooperation (Interviews DRB #12, GO #36, TSB #25). Furthermore, problems of political divisions within the countries or gaps in knowledge can lead to issues of trust and delays in financing projects that countries had originally agreed to support. This has specifically been the case with projects relating to climate change adaptation in the Tisza sub-basin, where a large interest in advancing projects on adaptation has been voiced by multiple people at multiple levels, but where concerns over lacking coordination and direction have led to cessation of activities (Interviews DRB #12, EC #4, GO #36 and 49, RWD #47, TSB #25, UNECE #34).

Capacity Challenges

While the WFD requires each country to assign the competent authority in river basin

³ While the 2004 and 2011 MOUs are non-binding, they have provided a framework for establishing the Tisza Group, developing the Tisza sub-basin management plan, and eventually the flood management plan. Notwithstanding the MOU to develop an Adaptation Strategy for the Tisza, to date this has not been done.

management, the responsibilities of national ministries and agencies, their institutional roles and modalities for coordination of water resources management, and the interaction with local authorities, water users, and NGOs, which would normally be defined in new legislation, are left to national governments (Nanni 2012). And, because there are only a limited number of national experts in each country capable of participating in meetings where knowledge of both hydrologic systems and water governance is necessary, it is not uncommon for the same experts to attend multiple meetings.

The consistency in attendance would seem important, given the large number of activities from the UN, EU, Danube, Tisza, national, regional, and local levels; however, some experts reported feeling overextended (Interviews EB# 7, EC #4, FB #42, GO #36 and 51). Given the vast differences between local and regional climate conditions, experts have requested that training be made available to better understand the variability in decisions and levels for which they are managing adaptation projects (Interviews GO #36, RWD #47). Uncertainty related to climate change has been considered an excuse for not taking action, or for not updating climate change into national policies (Interviews GO #36, RWD #47). Ministries in Hungary have worked to determine the scale of possible impacts of climate change, but due to lack of agreement on climate change scenarios, for example, this has not been written into Hungarian water policy (Huntjens et al. 2010). Additionally, the author observed limitations in the ability for country representatives to be present for the Standing Working Group Meeting when the ICPDR and high level representatives meet to decide on objectives for the year ahead and provide political guidance for the entirety of the basin.

Experts interviewed also noted that the generation and exchange of information and data allows compatibility of perceptions, fosters communication among parties, which - over time - aids in building commitment toward common goals, helps address difficulties in a cooperative,

technical and ultimately more effective manner, and builds trust. Furthermore, this also allows coordinated action to be decentralized to the local level through smaller pilot projects where communities and local government can better see tangible results (Interviews GEF/UNDP #54, GO #48, RWD #47, RWM #27, UNECE #39 and #61).

Conclusions

While it has been increasingly recognized that the effects of climate change on water resources are best addressed within a river basin context (Bruch and Troell 2011; Nanni 2012), the failure, or inability, to properly integrate sub-basin management weakens vertical coordination in multilevel governance (UNEP 2014b). The WFD supports horizontal coordination by linking water quality, water quantity and environmental integrity. However, multilevel governance posits that a tiered structure of river basin and sub-basin organizations are in place and operating effectively — a tenet of effective decentralization and subsidiarity that the EU WFD discounts, at least when it comes to sub-basin management.

Experiences in the Tisza indicate that there are many challenges to governance at the sub-basin level, and that these challenges have constrained the ability to undertake effective sub-basin measures to adapt. Notwithstanding these challenges, the Tisza Group has shown the potential to develop incremental measures to adapt to climate change, especially in response to specific flood events and industrial accidents.

In acknowledgement of financial resource constraints, there are four options that could improve vertical integration of adaptive governance. First, a sub-basin commission could be created. A sub-basin commission could provide for regional management of the Tisza sub-basin and would require an agreement of the Tisza member states that would allow the sub-basin states to highlight the pressures in need of the most attention (flooding and adaptation to climate change). Second, the Tisza Group could be housed at and have actions coordinated through the ICPDR. In

this regard, the Tisza Group could hold a permanent position in the ICPDR, similar to the expert groups. Previous forms of the Tisza Group have worked on an ad hoc basis through memoranda of understanding developed to address particular activities. Third, existing or new bilateral treaties could be used for sub-basin management. While bilateral treaties currently exist among many of the Tisza countries (Table 2.2), many are outdated or cover only specific arrangements (e.g., disasters/emergencies, environmental protection). These would need to be individually developed or updated with each neighboring sub-basin country and define the objectives to be achieved by the bilateral parties. Finally, a framework for managing the Tisza could be developed. This option allows for the development of a sub-basin river organization, without the formal creation of a sub-basin commission. More flexibility is possible here, since these types of organizations can exist through councils, committees, or agencies through the establishment of a mandate for the organization (what it is expected to do), its authority (including formal and informal actors), and its capacity (resources and financing). All four options face policy, financial, and resource constraints similar to those witnessed to date, and thus are unlikely to improve adaptive management at the sub-basin level unless more resources are provided. Alternatively, it will be necessary to rethink the assertion that adaptation needs to occur at all levels.

This is not unique to the Tisza sub-basin. Of the more than 260 transboundary basins in the world, many have transboundary sub-basins and many are in the developing world. These countries have fewer resources, and are likely for the foreseeable future to have fewer resources for sub-basin management. Therefore, more attention should be paid to conceptual and operational frameworks governing adaptation in transboundary sub-basins where resources are limited.

CHAPTER 3

WHAT DOES NATURE HAVE TO DO WITH IT? RECONSIDERING DISTINCTIONS IN INTERNATIONAL DISASTER RESPONSE FRAMEWORKS IN THE DANUBE BASIN

Introduction

What are the benefits of maintaining the distinction between natural and man-made disasters? What are the consequences of eliminating this distinction? When a disaster occurs, local and national capacities can be overwhelmed, often triggering a request for external, international assistance. The actors engaged in disaster response have historically been determined by the nature of the disaster (i.e., industrial accidents, nuclear accidents, marine oil spills); but with growing recognition that anthropogenic climate change is driving more extreme, and sometimes cascading events (e.g., where the effects of disasters are multiplied, or where they are composite, or concurrent) that require complex and often overlapping types of response, the question of eliminating this dichotomy is brought to the forefront.

In Europe, natural and man-made disasters combined caused total losses of US\$ 13 billion in 2015 of which only US\$ 6 billion were insured; the predominant losses came from flood events (Swiss Re 2016). Flooding and pollution are considered to be the primary transboundary pressures of the Danube River basin; however, a number of other man-made accidents occurred in the region (ICPDR 2015a).

In 2000, the Baia Mare and Baia Borsa mine-tailing pond failures mobilized approximately 100,000 m³ of metal-contaminated water into the Tisza River, eventually polluting the Danube River and Black Sea. Since the industrial accidents occurred originally as a result of significant rainfall and flooding, these events are an example of what are commonly referred to as natech accidents, technological accidents triggered by natural disasters. In 2010, an industrial accident

occurred in the Hungarian portion of the Danube River when a dam containing alkaline red sludge collapsed, releasing 1.5 million m³ of sludge into the surrounding land (approximately 4000 hectares) and waterways (including Kolontár, Torna Creek, and the Danube River), killing 10 people and injuring several hundred more (ICPDR 2010b). In 2014, following Cyclone Tamara, over 1,000 landslide events occurred in Serbia as well as significant flooding, resulting in damage to properties and infrastructure and the inundation of agricultural land. Due to concern over possible breaches in infrastructure to mine tailing dams in the surrounding area, and the harmful effects to human health, technical experts investigated mining sites and provided recommendations for local evacuations (NERC 2014). In all three disasters, the need for disaster response exceeded the capacity of national actors; therefore, international response involved the United Nations, the European Commission, and various other international organizations.

While international humanitarian law is generally well defined, the law of international disaster response is still incomplete (Fisher 2008). Historically, a distinction has been drawn between the scope of natural disasters and man-made disasters; however, this distinction is absent from the 2015 Sendai Framework for Disaster Risk Reduction, which adopts a multi-hazard risk approach providing management tools for disasters that are both natural and man-made (UNISDR 2015). The European Union's disaster response framework is also holistic and includes natural and man-made disasters, and some multilateral sub-regional agreements are also taking similar approaches, such as those adopted by the Association of South East Asian Nations (ASEAN) and the Baltic Sea Economic Cooperation (BSEC).

With international policies starting to shift toward more holistic frameworks of response that incorporate both natural and man-made disasters, this article explores what this trend will mean for regional institutions in the Danube basin and Tisza sub-basin, whose policy frameworks for monitoring and response continue to distinguish between types of disasters.

This article begins with an overview of the study area and a description of the methodology. Next is a discussion of the distinctions between natural disasters and industrial accidents – how and why they have been treated differently and how recent developments in international law and practice are raising questions about the merits of these distinctions. It is followed by an examination of the international frameworks governing disaster response in the Danube basin and Tisza sub-basin. Subsequently, the differences in how natural disasters and industrial accidents are monitored, and how they are responded to, are explored. The final section discusses the transition of international policies toward more holistic frameworks for response, and how this might affect the Danube basin and Tisza sub-basin. The article concludes with a brief reflection on the lessons to be drawn from these experiences.

Overview of Study Area and Methodology

The Danube River basin covers more than 800,000 km² – over 10 percent of continental Europe – and flows through the territories of 19 countries with nearly 80 million people residing within the basin. Today, 14 of the 19 countries, plus the EU, have committed to transboundary cooperation in protecting the Danube via the Danube River Protection Convention (DRPC), and work jointly toward the sustainable management of the Danube basin and the implementation of both the European Union’s Water Framework Directive (WFD) and Floods Directive (EU FD) (ICPDR 2015a). Among the tributaries of the Danube River, the Tisza sub-basin has the largest catchment area, and covers approximately 160,000 km² (20 percent of the Danube basin’s area), with approximately 14 million people (Figure 3.1). There exists a distinct socio-economic contrast in the basin between western and former socialist countries, and since the end of communism in the late 1980s, the central and lower Danube has experienced a rapid shift to free market democracy within the context of increased globalization, privatization, and deregulation. This has led to rural decline as well as increased poverty, unemployment, and depopulation (WWF 2003).

Additionally, as a result of the continuing conflict in Syria and neighboring states, countries in the Danube and throughout Europe are experiencing a significant increase in population from refugees, displaced persons, and other migrants who are escaping persecution, conflict, and poverty, and are settling in empty buildings, hotels, or refugee camps that have become ad hoc shelters (UNHCR 2016).



Figure 3.1. The Danube River basin and Tisza River sub-basin.

The headwaters of the Danube are located in the Black Forest of Germany. After leaving the Black Forest the Danube flows generally south-east through Central and Eastern Europe to the Black Sea in eastern Romania (Figure 3.1; ICPDR 2009a). International measures regulating the Danube were first undertaken in 1882 for flood protection and navigation. Dams were constructed within the upper Danube basin for flood mitigation, hydroelectric power generation, and regulation of river levels for navigation. The operation of the dams for these services has been attributed with

altering the flow regime of this segment of the river and consequently varying the ecological disturbance regime within the river and on the floodplain, resulting in substantial changes in the riverine ecosystem. The flow regulation provided by the dams and the construction of levees has allowed for the conversion of floodplains and riverine wetlands into areas suitable for agricultural and urban development. Today only 12 small reaches (<1 km in length) of the Upper Danube remain relatively untransformed (Schneider 2010). In the Middle and Lower Danube, the river bed has been dredged repeatedly to maintain a navigable river channel. Along these segments of the Danube River, levees and dams mitigate or prevent inundation of over 72 percent of the floodplain. The substantial reduction in the Danube's connection with its floodplain combined with wastewater discharge from agricultural and industrial sources, and increasing levels of pollutants along these river segments have substantially altered or damaged riverine ecosystem and reduced resiliency of urban and rural communities to large floods which exceed the protection level of their flood mitigation measures (Schneider 2010; UNECE 2011). The degree of industrial development and amount of pollution created by the industrial sector varies among Danube countries. In general, pulp and paper industries represent the largest contributors of pollution, followed by chemical, textile, and food industries (ICPDR 2009a).

The Tisza headwaters are located in the Carpathian Mountains in Ukraine. From these headwaters, the Tisza River flows southwest across central portions of the great Hungarian Plain into the Danube River in Serbia (Figure 3.1; ICPDR 2008a). Precipitation within the Tisza basin is generally concentrated in the Carpathian Mountains within the upper portion of the watershed. The intensity of the rainfall and the steep terrain coupled with deforestation and channelization of many streams within this portion of the Tisza watershed, result in some of the most sudden and high-energy flooding in Europe. Flood levels along the upper reaches of the Tisza can range up to 12 m deep within as little as 24-36 hours (Nagy et al. 2010). The sudden water level rises coupled with the high

energy of the flows often threaten human lives and result in substantial damage to infrastructure and croplands (ICPDR 2008a).

While industrial production has dropped drastically in the Tisza since the 1990s, there remain a variety of industries that contribute to the economy of the region, and the legacy of heavily concentrated industrial activities continues to threaten the surrounding ecosystems. The main industrial regions of the Tisza are located in Romania and Hungary, where the potential for greatest flood damage and losses is also greatest. Chemical and petrochemical industries (including oil refinery, storage and transport) are important for both Hungary and Ukraine, and the cellulose and paper, textile, and furniture industries are also present predominantly in the upper portion of the Tisza in Slovakia, Romania, and Ukraine (ICPDR 2011a). Beyond the threat of mobilizing hazardous materials from industrial activities directly into the Danube or Tisza Rivers, the risks posed from industrial accidents to the surrounding communities, particularly with increasing urbanization, is of growing concern.

Mining activities, and the accidental spills of chemical substances, have affected the aquatic environment and water quality within the Tisza sub-basin since the 2000 Baia Mare and Baia Borsa natech accidents. Natech accidents present significant challenges, as natural events can trigger multiple and simultaneous accidents in one installation, or depending on the impact of the natural hazard, in several hazardous facilities at the same time (Krausmann and Baranzini 2012). A 2009 assessment identified more than 92 potential sources for industrial and waste deposits; however, the list does not include abandoned mine sites and their mine tailing dams – only those from currently operational mines. Therefore, the potential risk of accidental pollution could be substantially higher (ICPDR 2015a).

Methodology

The analysis of policy and institutional frameworks for monitoring and responding to natural disasters and man-made accidents in the Danube River basin and Tisza River sub-basin was conducted through a combination of primary and secondary data collection and analysis. The primary data collection and analysis consisted of semi-structured interviews, while the secondary data analysis included literature review of peer-reviewed publications and an analysis of international laws, policies, and institutions within the Danube basin and Tisza sub-basin. Semi-structured interviews were conducted over an eight-month period from January to August 2013.

Seventy-one interviews were conducted in various locations throughout Europe. The interviews took place with experts working within the International Commission for the Protection of the Danube River, within the expert groups of the International Commission for the Protection of the Danube River (i.e., Tisza group, river basin management, flood protection, and accident prevention and control), with respondents working at the national ministries, water management directorates, and non-governmental organizations in the Tisza and Danube countries, as well as with experts working within the European Commission, and the United Nations involved in the Danube basin and Tisza sub-basin. Given public roles, the interviews are intentionally left anonymous to ensure candidness in the responses (Table 3.1). The numbers appearing in brackets in the table below reflect multiple interviews conducted at each level of governance indicated. The questions focused on how Danube basin and Tisza sub-basin policies and laws were implemented in practice, as well as the perceptions of the experts regarding the frameworks and implementation of disaster monitoring and response throughout the Danube basin and Tisza sub-basin.⁴

⁴ Questions relevant to international frameworks for disaster response included: (1) What are the respective roles in multilevel governance in regard to response for natural and man-made disasters? (2) To what extent are natural and man-made disasters included in policy frameworks for response; in what context and at what level, and what is the language being used? (3) What gaps exist between policies and practice in regard to response for natural and man-made disasters? (4) What constraints or opportunities exist in including policies for response to natural and man-made disasters; which type would be most effective and at what level?

Table 3.1. Organizations from which experts were drawn for interviews.

International	United Nations, United Nations Economic Commission for Europe, and United Nations Environment Programme (UNEP)/UN Office for the Coordination of Humanitarian Affairs (OCHA) Joint Environment Unit [1]
Regional	European Commission [2] International Commission for the Protection of the Danube River (ICPDR) and Expert Groups (Tisza Group, River Basin Management, Flood Protection, and Accident Prevention and Control) [3]
National	National Ministries of Environment, Rural Development, Interior, Environment Agency [4] Water directorates [5]
Non-State Actors	NGOs [6]

* Numbers in brackets refer to interview citations in text.

Distinctions between Natural Disasters and Man-Made Accidents in Policy Frameworks

Traditionally the approaches used for describing, limiting, and categorizing disasters fundamentally shapes the methods for monitoring and responding to disasters. They determine the solutions utilized, the resources allocated, and the governance frameworks selected by categorizing the types of disaster into that which is natural or man-made. It is therefore important to understand the etiology of disaster in order to understand why the distinctions among the various types of disaster still remain. These are discussed below.

Rationale for Different Treatment

The manner in which disasters are framed by society has evolved over time, still the role of human responsibility features prominently in disaster narratives. Natural disasters are naturally occurring physical phenomena, which can include earthquakes, landslides, tsunamis, volcanoes and floods. Natural disasters have historically been characterized either (1) as a direct form of punishment from God for the sins of humanity, or (2) more recently as an “act of God” that removed humans from culpability (Rozario 2007). The framing of natural disasters continues to shift, and some natural events – earthquakes, hurricanes, tsunamis – only become disasters as they impact and interact with individuals and communities. The consequences of natural disasters

become a function of where people reside – along coastlines, in floodplains, in vicinity of fault lines, and within mountainous regions – and their overall vulnerability, including aging infrastructure and a function of their ability to monitor and prepare for these events. Vulnerability within and between populations can vary, and occur for multiple reasons – social inequalities, community demographics (e.g., age and poverty), lack of access to health care, and limited access to jobs or to lifelines (e.g., emergency response, goods, services) (Cutter and Emrich 2006). While building in disaster-prone areas is not the sole responsibility of individuals, they do share responsibility for investing in the risk involved. The existence of moral hazard⁵ can increase the amount of damage from disaster and reduce the capacity of insurance to cover disaster loss; this occurs due to individuals acting irresponsibly and because of those who erroneously believe there is coverage for any loss incurred (Smith 2013). For example, offering insurance encourages people to build and live in flood-prone areas, in spite of the known risks – if insurance were not available, the household would absorb the entirety of the risk and prospective buyers would most likely choose to reside elsewhere. Additionally, as seen with some large disasters such as Hurricane Katrina, losses suffered by policyholders can be several times larger than collected premiums, consuming insurers' capital and, if the losses are severe enough, not only jeopardize claim payments, but also cause insurance companies to declare bankruptcy before covering any – or only some – insured losses (Nekoul and Drexler 2016). For example, while the total economic loss incurred during Hurricane Katrina is assessed at approximately US\$ 125 billion, insured losses covered an estimated US\$ 45 billion, however, only an estimated US\$ 2 billion in insurance claims were paid (Munich Re 2005). Moral hazard can also exist in disaster preparedness and

⁵ For purposes of this paper and described by Munich Re (2007), moral hazard is a lack of incentive by an individual to guard or protect against risk (or to enter into a situation of risk), knowing that they are protected from risk through insurance, which results in higher insurance loss claims. Examples provided are assured compensation for flood damage, leading to increased building in flood-prone areas and assured compensation for crop losses in drought-prone areas that encourage farmers to grow more compensated crops instead of planting alternative crops or adopting alternative land uses.

response activities when actors believe they are sufficiently prepared to respond to any event or crises. During Hurricane Katrina despite emergency preparations, preexisting social vulnerabilities and the collective failure to adequately respond to the emergency made response inadequate for the type of complex emergency relief needed (Cutter and Emrich 2006).

Industrial accidents and other man-made accidents are traditionally considered separately from natural disasters. The role of human agency features even more prominently in these events, due to potential moral or legal obligations to mitigate risk (e.g., preparedness, insurance, disaster aid). Man-made disasters suggest potential moral and legal obligations to both aid the victims of the disaster in a response capacity in the period immediately following the disaster, as well as to compensate those who are harmed during their long-term recovery (Verchick 2012). The liability is only effective if a polluter can be identified or liability can be assigned. As disasters continue to multiply, become more complex, and their costs mount, responsibility for the disaster also becomes more complex. For example, in assigning liability to the 2010 red sludge spill in Hungary, early reports from the Hungarian Prime Minister Victor Orbán indicated that the breach was likely due to human error, and that “there was no sign the disaster was caused by natural causes, therefore it must be caused by people” (Dunai 2010). In ongoing efforts to determine human negligence, it was determined that flooding and subsidence led to structural breaches in the reservoir containing the alumina, yet it remained difficult to prove whether officials at the MAL alumina facility knew of the weakened infrastructure (NDGDM 2010).

The degree of uncertainty related to the amount of damage and probability of occurrence is very high with disasters, particularly those influenced by climate change (Greiving et al. 2012; Munich Re 2016). Liability can be more difficult to calculate and assign in these cases, in part because disaster loss agencies (i.e., Munich Re, Swiss Re), are often accounting for specific losses from flooding and sudden-onset disasters that are more easily quantified, whereas the impact of

slow-onset, or “silent”, disasters related to climate change can be more difficult to quantify since they occur slowly over time (IFRC 2013).

Dimensions for Different Treatment

Increased frequency of major disasters, legal barriers and the absence of response to natural disasters and man-made accidents have led to increased attention at a variety of levels for more integrated international frameworks for disaster response (IFRC 2007). The fragmented nature of disaster response has emerged from the need to address specific types of disasters, in specific regions, or response modalities. Furthermore, while natural disasters and industrial and nuclear accidents have established frameworks for response, natech accidents are often missing from chemical accident response programs (OECD 2015). Natech accidents can lead to the release of toxic substances, fires, or explosions and result in injuries and fatalities; therefore, the lack of consideration for natech response mechanisms, planning tools or response programs can be an external risk source for chemical facilities (Krausmann and Baranzini 2012). Some international instruments, such as the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and the Convention on Early Notification of a Nuclear Accident apply only to specific types of disaster. While the Nuclear Accidents Conventions were adopted almost immediately following the Chernobyl nuclear accident, there still remains no similar overarching global framework for notification or assistance in response to industrial accidents, or for environmental emergencies more broadly (Bruch et al. 2016). Other disaster frameworks, like the Tampere Convention, apply only to a single sector or area of relief (such as importing telecommunication resources following disasters caused by nature or human activity, or whether occurring suddenly or as the result of complex, long-term processes). However, the ability to provide disaster response for natural disasters is quite broad and is included in a number of international frameworks. A question of applicability of agreements arises, however, when a

complex disaster occurs and multiple institutions have a mandate for response, but it is unclear which institution should take the lead in responding or coordinating response efforts (Bruch et al. 2016). During the Lebanon crisis in 2006, international assistance was requested in response to the bombing of fuel storage tanks at a power station, and over 70 countries and organizations responded – it was unclear who should take lead, and the need for coordination was reflected among response efforts (Nijenhuis 2014).

An additional difficulty lies in the types of international actors engaged in natural disasters and man-made accident response. Generally, there is a failure to include non-state actors, the private sector, or individuals in response efforts to disasters. The Tampere Convention and the sub-regional Black Sea Economic Cooperation (BSEC) and Association of South East Asian Nations (ASEAN) agreements are exceptions. With the Tampere Convention, for example, the decision to offer assistance, the type of assistance provided, and the terms of assistance are up to the discretion of the non-state actors offering assistance (Bruch et al. 2016). Given the increasing role of private funds in disaster response and relief operations, considering the inclusion of these actors in disaster frameworks can be beneficial. Oftentimes, there is the assumption that assets and personnel are provided as a favor to an affected state government, where they might normally be expected to reimburse costs and manage how assistance is carried out. However, efforts are increasingly being made to clarify the respective roles of actors and institutions in regard to disaster response, and more recently laws are changing in favor of including broader terminology to comprise both natural and man-made disasters (IFRC 2007).

Disaster Frameworks in the Danube and Tisza

Response to natural and man-made disasters, including natech accidents, is governed by a range of global, regional and national laws, policies and soft-law instruments. In the Danube basin and Tisza sub-basin this includes the Industrial Accidents Convention and the Seveso Directive,

the Water Framework Directive and the Floods Directive, as well as treaties and policies developed at the level of the Danube and Tisza. Here, natural and man-made disasters continue to be treated as distinct and separate issues, where monitoring and response are managed independently.

Introduction to Danube and Tisza

In 1994 the Danube countries developed the Danube River Protection Convention (DRPC) to ensure sustainable management of the Danube River. Through the International Commission for the Protection of the Danube River (ICPDR), the DRPC requested the ICPDR to coordinate the activities of the EU Water Framework Directive (WFD) and EU Floods Directive among the EU member states. The WFD combines the monitoring and assessment of surface and groundwater quality in the basin, and the Floods Directive instructs national authorities to establish flood risk management plans by 2015, linking the objectives of the WFD and the risk to these objectives from flooding or coastal erosion through the Floods Directive, and integrating them into basin level activities via the ICPDR. However, because not all countries of the Danube are EU member states, not all measures and outcomes of the WFD and Floods Directive are implemented equally among the basin countries.

The Danube basin and the Tisza sub-basin have experienced numerous natural and man-made disasters, including natech accidents (e.g., Baia Mare Cyanide Spill, Hungarian Chemical Accident, and recent Serbian landslides). These are tallied in Table 3.2. However, the frameworks for disaster response at the levels of the United Nations, the European Union, and those utilized by the ICPDR and implemented at the national level by the Danube countries, are restricted to particular types of disaster – monitoring and response to flooding is the most advanced throughout the basin, while pollution is monitored, but does not have the same frameworks for response. Additionally, there remain a variety of natural and man-made disasters that occur throughout the basin that are not integrated into any type of basin monitoring or response framework, including

fire, drought, and other types of predictive climate modeling.

Table 3.2. Natural and man-made disasters in the Danube basin, reported by country (2000-2012) (Adapted from European Commission 2016b).

Disaster Year	Type of Event	Country
2000	Mine tailing failure/cyanide and heavy metal pollution (natech)	Romania, Hungary, Bulgaria, Macedonia
	Landslide/avalanche	Austria, Slovenia
	Extreme temp./drought	Bulgaria, Croatia, Slovenia
	Flooding	Croatia, Hungary, Romania, Slovenia Moldova, Ukraine
	Severe ice storms	Croatia, Slovakia
	Wildfires	Slovenia
	Factory fire	
2001	Mining accident (natech)	Slovenia
	Flooding	Croatia, Hungary, Romania, Slovakia, Ukraine
2002	Industrial fire at waste dump	Slovenia
2003	Mining accident (natech)	Slovenia
	Extreme temp./drought	Austria, Croatia, Germany, Slovenia, Bosnia and Herzegovina
	Flash floods/severe storms	Hungary
	Wildfires	Slovenia
2004	Drinking water pollution (natech)	Hungary
	Dam failure	Romania
	Earthquake	Slovenia
	Flooding/severe storms	Hungary, Slovakia
	Drought	Bosnia and Herzegovina
2005	Landslides	Slovenia
	Flooding/severe storms	All Danube Countries, except Ukraine
2006	Avian (H5N1) flu pandemic	Hungary, Romania, Slovenia
	Earthquake	Hungary
	Extreme temp.	Bulgaria
	Wildfires	Slovenia
2007	Wildfires/forest fires	Bulgaria, Croatia
	Hurricane	Germany
	Extreme temp./drought	Austria, Bulgaria, Croatia, Hungary, Romania, Slovakia, Bosnia and Herzegovina, Montenegro, Serbia, Moldova
	Flash floods/severe storms	Bulgaria, Germany, Hungary, Romania, Slovenia, Montenegro, Serbia, Ukraine
2008	Extreme temp.	Bulgaria
	Forest fires	Bulgaria
	Flash floods/severe storms	Hungary
	Flooding	Romania, Slovakia, Slovenia, Serbia, Moldova, Ukraine

2009	Swine (H1N1) flu pandemic Ice storms/blizzard	All Danube Countries Croatia, Romania, Bosnia and Herzegovina, Ukraine
2010	Chemical accident (natech) Earthquake	Hungary Serbia
2012	Ice storms/blizzards Extreme temp./drought	Bulgaria, Hungary, Romania, Montenegro, Serbia, Moldova, Ukraine Moldova

*Note that economic losses, deaths and displacements are not reported to either EC or ICPDR.

How Disasters are Treated Differently within Response Frameworks

In the absence of a centralized institution for disaster response, the development of a large and diverse international disaster relief community has occurred. Initially the large-scale relief work after natural disasters was undertaken by the Red Cross movement at the end of the 19th century, but eventually the disaster relief community expanded capacity and function to include a variety of disaster assistance activities and involve other international initiatives and organizations (IFRC 2007). The United Nations (UN) began humanitarian work shortly after World War II with agencies such as the United Nations High Commission for Refugees (UNHCR), and predecessor agencies such as the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) are now regularly engaged in disaster response and relief (IFRC 2007).

Numerous frameworks for response to natural disasters exist. One example is the 2002 UN General Assembly Resolution 57/150 on “Strengthening Effectiveness and Coordination of Urban Search and Rescue Assistance” (UN 2003). While non-binding, the resolution highlights the importance of national responsibility to victims of natural disasters within country borders, but in the event that an incident exceeds country capacity, Urban Search and Rescue (USAR) assistance through the International Search and Rescue Advisory Group (INSARAG) can supplement local rescuers, and the coordination of these resources, particularly following earthquakes or other events leading to structural collapse (INSARAG 2016).

Apart from natural disasters, the United Nations Economic Commission for Europe’s (UNECE) Industrial Accident Convention applies to land-based, non-military, and non-radiological industrial accidents (UNECE 2009). Through the convention, response for industrial accidents is provided through bilateral or multilateral arrangements developed in advance among the parties. If no prior agreements exist, an affected country can request assistance from other parties through mutual assistance agreements. However, in these situations, it is the responsibility of the requesting country to cover all costs incurred for disaster response, unless otherwise agreed upon among the responding countries (UNECE 2009). Flooding in the Danube in 2013 and 2014 caused approximately €15 billion in damage (Table 3.3), and while the economic cost from industrial and other man-made accidents are not monitored or reported in the same manner (Table 3.2), such accidents have occurred quite frequently and make apparent the need for improved agreements on bilateral or multilateral relief (ICPDR 2015b).

Table 3.3. Estimated human and economic loss in Danube per flood event (2002-2014) (Adapted from ICPDR 2008b and ICPDR 2015b).

Flood Year	# Deaths or # Displaced	Economic Losses €
2002	N/A	N/A
2006	N/A	> €6 billion
2010	35 deaths	€2 billion
2013	9 deaths	€2.4 billion
2014	79 deaths; 137,000 displaced	€4 billion

*N/A – Data not available

The facilitation of international disaster response can be inadequate if mobilization is untimely, or fails to include sufficient financial support. Response frameworks may neglect or place disproportionate attention on certain types of disasters, which could become more problematic with growing concerns over climate change and increased urbanization. For example, there is visible delayed response for sudden-onset disasters such as the 2005 Indian Ocean tsunami and the 2010 Haiti earthquake which received the majority of funding support within one to three months of the initial request, compared to the slow-onset drought events of the 2011 appeals by

Kenya and Somalia where funding was not provided until nearly 7-12 months after the initial request (GHA 2013). In 2005, nearly three quarters of all UN contributions for natural disasters arrived within a month of their appeal; the comparable figure for complex emergencies was only seven percent (IFRC 2007). While differences exist among slow-onset and sudden-onset disasters, they can create cumulative impacts to the community that increase vulnerability and lead to larger disasters in the future – precipitation deficiencies in soil and water lead to drought and when combined with high temperatures and dry conditions, this can lead to wildfires (e.g., extreme fire hazard situations in the eastern US and south-east Australia) (Smith 2013).

The growing size and diversity of international responders to disasters can have ramifications for the facilitation, coordination, and quality of response efforts (IFRC 2007). Diverse systems of response are implemented among the Danube basin countries due to the variety of disasters experienced. Some utilize a single Civil Protection Mechanism, while others rely on multiple parties among Ministries of the Interior, Ministries of Rural Development, Water Directorates, and a variety of additional local protection committees [4, 5]. Interviews indicated that not all responders/parties are sufficiently trained, and many lack managerial or technical capacity to manage specific disasters appropriately [4]. There is also large compartmentalization of tasks at lower levels – both regional and local – where integration among the various types of disaster, as well as increased cooperation is needed [2, 3]. Other than the fact that these diverse actors are providing certain types of disaster assistance, there is nothing uniting them – no international or regional disaster response system. Given the increased frequency of natural and man-made disasters and the growing number of actors involved in disaster response efforts, ensuring effectiveness of aid should not detract from response and assistance (IFRC 2007).

Besides the diverse ensemble of international organizations with a mandate and capacity for responding to natural disasters and/or specific types of technological or industrial accidents, there

are also agencies experienced in particular types of international disasters, but which may not necessarily have the mandate or capacity for response. In 1994, the United Nations Environment Programme (UNEP) and the UN Department of Humanitarian Affairs (DHA, the predecessor of OCHA), developed an administrative arrangement through an exchange of letters (Bruch et al. 2016). The arrangement relies on the environmental mandates of UNEP and the humanitarian mandates of the DHA. Through UNEP's Governing Council Decision UNEP/GC.26/15 on "Strengthening International Cooperation on the Environmental Aspects of Emergency Response and Preparedness", the Joint UNEP/UN OCHA Environment Unit (JEU) plays a leading role in facilitating coordination among international organizations in the event of natural and man-made disasters, including natech accidents, which are more broadly termed environmental emergencies (UNEP 2011). The JEU has a number of existing agreements and interface procedures in place with these organizations, in order to facilitate response, particularly because there is a lack of familiarity among UN member states regarding existing regional and international systems for response to the various types of disasters, as well as the coordination between them. For example, the JEU facilitated international agreements and interface procedures to aid with response between UN Disaster Assessment and Coordination (UNDAC) and the EU Civil Protection Mechanism to the 2014 Serbian landslides following Cyclone Tamara (NERC 2014). During the 2000 Baia Mare natech accident in the Tisza River sub-basin, sixteen experts from seven countries deployed for response to the natech accident, and the JEU assisted to coordinate response efforts among UNDAC, the European Commission, the Military Civil Defence Unit, the World Health Organization, and a variety of other actors (JEU 2000).

At the regional level, the European Union's Civil Protection Mechanism (EU CPM) is an instrument for disaster response that protects people, the environment, property, and cultural heritage in the event of natural or man-made disasters, occurring within or outside of the European

Community (European Commission 2016a). Disasters are monitored internationally through the Emergency Response Coordination Centre (ERCC) in cooperation with the JEU and with participating states.

The European Union's Seveso Directives (I enacted in 1982, II enacted in 1996, and III enacted in 2012) are some of the earliest pieces of legislation to address disaster risk (European Community 1982; European Community 1996; European Community 2012). The various iterations of the Directive govern the establishments where dangerous substances are present, and require the establishments to classify and report the amounts, types, and locations of dangerous substances present. The majority of the Directives' focus is on notification requirements and accident prevention, including notification to the public due to the increased risk by natural disasters associated with the location of the establishment and associated risks from natech accidents (European Union 2012). The responsibility for response under the Directives falls on the establishment for developing preparedness response measures in advance of an accident, and notifying the competent authority in case of a major accident (European Union 2012). However, a 2012 study by the European Commission indicated that industry in nearly half of the EU countries is believed to insufficiently consider natech risks in their preparedness response measures (Krausmann and Baranzini 2012).

The EU Floods Directive provides a framework for addressing risk from natural disasters, specifically floods. While inspired not only by the damaging effects of floods, but also by increasing flood risks as a result of climate change, the main objective of the Directive is to require member states to assess and manage risks of flooding within their territories and to develop flood risk management plans. Though the plans are restricted to areas considered at high risk of floods, these are not integrated into other types of plans and maps available – such as the Inventory of

Potential Accidental Risk Spots in the Danube⁶ – nor are they used for developing preparedness response measures in advance of an accident or natural disaster, such as in the case of the Seveso Directive. Though the Flood Directive was expected to reduce flood risk, interviewees voiced disappointment regarding the limitations of integrating disaster risk more broadly, particularly in relation to water quality and accidental pollution [3]. These present as policy limitations to the Water Framework Directive and Flood Directive, as neither of the two directives require the integration of disaster risk of both floods and accidental pollution.

The European Union also developed a set of macro-regional strategies for the Adriatic and Ionian, Alpine, Baltic Sea, and Danube regions (European Commission 2010). While the intent from the EU was to not provide new EU funding, these integrated frameworks are supported by EU Structural and Investment Funds in order to address common challenges faced in each defined area in order to strengthen cooperation and achieve greater economic, social, and territorial cohesion. In the Danube Strategy, risks from floods and industrial accidents are reflected as having substantially negative transnational impacts, and are listed as requiring preventive and disaster management measures that are implemented jointly, with the understanding that work undertaken in isolation in one place (e.g., to build levees) displaces the problem and places neighboring regions at greater risk of flooding (European Commission 2010). Other man-made disasters are integrated in the discussion of risks, as well as the need to account for climate change by taking a regional focus at the basin level (European Commission 2010, p. 8). In a 2015 European Commission Communication report following implementation of the Danube Strategy, several limitations were highlighted, including: the need to improve efforts to reduce the Danube region's

⁶ Pursuant to the 2001 Baia Mare natech accident in Romania, the ICPDR conducted a qualitative evaluation of the hazardous locations in the Danube catchment area, with reference to location of possible water pollution. The report of Inventory of Potential Accidental Risk Spots was released in 2001, and has not been updated since (ICPDR 2001; ICPDR 2015a).

risk of exposure to major floods and accidental hazardous material releases; limited political commitment, funding, and capacity among countries and institutions in the Danube; lack of staff, funding, and expertise impeding participation, particularly in lesser-developed areas of Danube – the report also acknowledged that these challenges are more acute in non-EU countries (EPRS 2015). The limitations in funding, technical expertise, and capacity were confirmed in interviews with experts at various levels, who also noted how this leads to uneven implementation of EU Directives within the basin that can create pockets of vulnerability to both flood risk and risks from industrial accidents [2, 3, 4].

While the Danube Strategy does not provide a framework for response to natural and man-made disasters, it does highlight the EU’s continued support for managing multi-hazard response at multiple levels, particularly through Priority Area 5 “To Manage Environmental Risks”. Specifically, it requests that the countries “strengthen operational cooperation among emergency response authorities in the Danube countries and improve the interoperability for risks that are common to an important number of countries in the region (i.e., floods and risks of other natural and man-made disasters)”, and advises that each country’s civil protection mechanism have an updated understanding of neighboring country’s systems so that response teams can function smoothly in case of emergencies involving bilateral, European, or international response (EUSDR 2015). Experts also expressed the need for formal agreements with specific language on integrated mapping of complex disasters, as well as provisions addressing response to both natural and man-made disasters, particularly if additional grants could be given from the EU to support these activities [2, 3, 4, 5]. Some interviewees reflected that the regional Strategy depended on stronger countries helping the weaker ones, but limitations with funding and capacity are difficult to overcome [2]. In the 2015 Annual Report on implementation of the Danube Strategy produced by the Danube countries, all projects focused on implementation of the Floods Directive. The only

mention of industrial accidents was to reflect the failure to include an updated Inventory of Potential Accidental Risk Spots along the Danube, which is also discussed in the 2015 Danube River Basin Management Plan (DRBMP) (EUSDR 2015; ICPDR 2015b). Given past issues with mine tailing collapses and other pollution disasters associated with flooding, the 2015 DRBMP acknowledged the need to update the Inventory of Potential Accidental Risk Spots promptly (ICPDR 2015b). Unfortunately, this recommendation from the 2015 DRBMP, and initially expressed in first Danube River Basin Management Plan of 2009 has yet to be realized.

Through the Danube River Protection Convention, Article 17 provides for mutual assistance “where a critical situation of riverine conditions should arise”. While “critical situation” is not defined, Article 17 indicates that the ICPDR will elaborate procedures for mutual assistance including the facilities and services to be rendered by the contracting party, the facilitation of border-crossing formalities, arrangements for compensation, and methods of reimbursement (ICPDR 1994). These elaborations have not occurred through the ICPDR, but rather in the form of bilateral agreements regarding transboundary flood measures among Danube countries; however virtually no bilateral agreements exist regarding response to man-made disasters in the basin (see Table 3.4).

To bridge the gap regarding man-made accidents, some Danube basin countries have engaged in such agreements. Bulgaria, Moldova, Romania, Serbia, and Ukraine are Parties to the DRPC, but have separately engaged in the BSEC Agreement on Response to Natural and Man-made disasters (Bruch et al. 2016). Furthermore, the Danube Delta countries (Moldova, Romania, and Ukraine) are working together with the UNECE Industrial Accidents Convention due to the large concentration of oil-related industries in the area in order to improve hazard management, increase transboundary cooperation, and strengthen operational response [1].

Table 3.4. Bilateral agreements on transboundary watercourses and disasters among Danube countries (Adapted from ICPDR 2009a; ICPDR 2015a; UNEP 2002).

Countries	Transboundary Watercourses	Disasters / Emergencies
Austria – Czech Republic	1967**	1994 (Floods Only)
Austria – Germany	1987	1991 (Floods Only)
Austria – Hungary	1956	1959 (Floods Only)
Austria – Slovakia	1967**	1994 (Floods Only)
Austria – Slovenia	1956*	1956* (Floods Only)
Bosnia and Herzegovina – Croatia	1996	1996 (Natural/Manmade Disasters)
Bosnia and Herzegovina – Serbia and Montenegro*	-	2011 (Flood EWS)
Bulgaria – Romania	2004	2004 (Floods Only)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Croatia – Serbia	-	-
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Czech Republic – Slovakia	1999	-
Hungary – Romania	1986	2003 (Floods Only)
Hungary – Slovakia	1956**	2014 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Moldova – Ukraine	1994	-
Serbia and Montenegro – Hungary	1955*	1955*
Serbia and Montenegro – Romania	1955*	Under Discussion
Ukraine – Romania	1997	1952*** (Floods Only)
Ukraine – Slovakia	1995	2000 (Floods Only)

*Agreement formed with Yugoslavia

**Agreement formed with Czechoslovak Socialist Republic

***Agreement formed with Union of Soviet Socialist Republics

At the Danube basin level, the countries have engaged in a series of non-binding Memoranda of Understanding (MOU) referred to as the Danube Declarations, first in 2004, revised in 2010, and updated in 2016. The Declarations reinforce the language of the 1996 Danube River Protection Convention to sustainably manage the waters of the Danube, and reinforce the

countries' commitment to continue the work of the WFD and Floods Directive. The 2016 Declaration recognizes the need for increased investment and improved warning systems for flood protection and contamination, as well as improving the exchange of information throughout the Danube (ICPDR 2016). The Danube River basin countries engage currently in two separate systems for flood monitoring and monitoring pollution from man-made accidents – the Emergency Flood Alert System and the Principal International Alert Centres (PIACs) of the Danube Accident Emergency Warning System (Danube AEWS), respectively. The Emergency Flood Alert System has been functioning since 2003 at the Joint Research Centre, a Directorate General of the European Commission, and works in collaboration with the national authorities of the member states and with a variety of meteorological services. The Emergency Flood Alert System provides two medium-range flood forecasts each day, with 3-10 day advance warning for flooding in the main stem of the Danube. An MOU has been signed with several, but not all of the Danube countries (Austria, Bulgaria, Czech Republic, Germany, Hungary, Moldova, Serbia, Slovakia, Slovenia, and Romania, and negotiations are underway with Bosnia and Herzegovina and Croatia), and information is available 24 hours a day through an online service managed by the Joint Research Centre (ICPDR 2010b). The Emergency Flood Alert System gives national authorities the ability to prepare response measures, including opening temporary flood retention areas, building temporary flood protection structures such as sandbag walls, and adopting civil protection measures such as closing down water supply systems (ICPDR 2009b). These responses reduce further threat of flooding downstream, and prevent loss of lives and infrastructure. The MOU does not include tributaries draining areas less than 4,000 km², therefore the Emergency Flood Alert System does not address flood risks in the Tisza, nor in certain basin countries where significant flood concerns arise, such as Ukraine [1]. Transboundary floods typically affect larger areas, can be more severe, result in a higher number of deaths, and cause increased economic loss than non-

transboundary rivers (Baaker 2009). Therefore, the repeated occurrence of such large, costly flood events (Table 3.3) highlights the ongoing need for improved strategies for flood preparedness and response, particularly in the absence of coordinated, multi-hazard bilateral and multilateral agreements among basin countries.

The Principal International Alert Centres of the Danube Accident Emergency Warning System monitor accidental water pollution incidents in the Danube River basin. Unlike the Emergency Flood Alert System, which is linked to monitoring conducted by the European Commission and is transmitted to national authorities (without involving the ICPDR in the monitoring process); the Danube AEWS system is managed by the ICPDR, but does not involve the European Commission. While all contracting parties of the DRPC cooperate with the Danube AEWS, they also are expected to have national policies regarding response to accidental pollution in the Danube that connects to the Principle International Alert Centres. The PIACs are expected to operate on a 24-hour basis within each country, and are in charge of all international communications. When a message regarding potentially serious accidental pollution occurs, the PIAC is responsible for communicating the accident to the ICPDR, and decides whether it is necessary to notify downstream countries, engages experts to assess the impacts of the pollution, and decides what response activities need to be taken at the national level (ICPDR 2014).

Challenges to the Danube AEWS monitoring include territorial gaps (several areas along the Danube and Tisza are not monitored) [3, 4, 5], a limited number of bilateral agreements for response in case the accident exceeds national capacity (Table 3.4), and even though a variety of natural and man-made accidents occur (Table 3.2), not all types of man-made accidents are monitored. Increasing pressures are felt by downstream countries from the failure to monitor pollution events in a consistent and effective manner [4]. Furthermore, in order to keep the AEWS operational there is increasing reliance on citizen reporting of pollution events in some countries

[4, 5]. This is particularly problematic in the Tisza countries where the lack of monitoring of both flood and accidental pollution events, combined with limited bilateral agreements raise concern among several countries [4, 5].

In the most recent Tisza River sub-basin MOU (from 2011), the Tisza countries agreed, among other things, to “take coordinated steps to prevent accidental risks, and develop harmonized mitigation and response measures, with the aim to present an updated Inventory of Potential Accidental Risk Spots by the end of 2012” (ICPDR 2011a). This complements the 2009 request in the Danube basin (but as reflected above, has yet to be updated) (ICPDR 2015b). To date, this has not occurred for the Tisza sub-basin, but the language in the MOU does reflect an interest at the sub-basin level to prioritize not only the mapping and development of the Inventory of Potential Accidental Risk Spots, but also the development of harmonized response measures among floods and man-made hazards.

Questioning the Distinction

While “natural” disasters may be a commonly used term, no disaster can be regarded as entirely natural if people have the capacity to avoid, mitigate, or reduce the risk from an entirely natural hazard (Picard 2016). However, the vulnerability to lives and livelihoods can be avoided with proper disaster preparedness and response, such as the proper placement, function, and use of early warning systems, flood maintenance, and mitigation works such as levees and controlled flood outlets and properly timed dam releases.

There is an additional shift in what is considered truly a natural disaster as well – not only from the perspective of mitigation or vulnerability, but in acknowledgement of the anthropogenic influences on natural disasters. Climate change is one aspect, but there are also induced earthquakes occurring as a result of slipping faults from fluid injection in hydraulic fracturing (Legere 2016) and from the weight of shifting water impoundments from Three Gorges (Stone

2008), landslides from subsidence and increased land use activities including urbanization (Smith 2013), and pandemics from deforestation and habitat conversion (Greger 2007), to name a few. Holistic frameworks that include multiple types of disasters are needed in order to respond effectively.

Human intervention in the physical environment exposes populations to natural hazards from the built environment, such as housing and associated infrastructure, including industrial facilities, drainage works, and planning—especially when the built environment is not appropriately designed or built to account for the risks. Human, economic, and environmental losses can be worse in highly populated, urbanized areas; with increased urbanization and climate change, they are placed at increased risk to natural and man-made hazards (Huppert and Sparks 2006; Bruch and Goldman 2012). For this reason, natech accidents and other cascading disasters are particularly problematic types of disasters. Simultaneous response efforts are required to attend to both the industrial, chemical, or technological accident as well as the triggering natural disaster. Therefore, broad definitions of disaster, as well as broad frameworks for response to multiple types of disaster are needed in order to recognize that many disasters can arise from multiple hazards—and to take the necessary measures to reduce the risks of those hazards.

While distinctions among disasters are still claimed for liability in some cases (including in determining deliberate conduct or negligence), the distinction between natural and man-made disasters is largely irrelevant from the perspective of humanitarian response and the humanitarian consequence of multi-hazard events and those that are caused by natural or technological hazards. Furthermore, in the event that disasters are slow-onset, or when the ability to mitigate or respond to risk is not timely or effective, the long-term effects of the disaster can be magnified and lead to further vulnerability, such as famine, malnutrition, or mortality (IFRC 2006).

The 2011 Fukushima nuclear disaster in Japan, triggered by the Great East Japan

Earthquake and resultant tsunami, illustrated the complex relationship of natural hazards and the built environment and human factors, resulting in natech vulnerabilities. In part as a response to the earthquake, tsunami, and nuclear accident at Fukushima and as a more general approach to providing a comprehensive, multidimensional and multi-sectoral approach to reducing disaster risk, the United Nations member states adopted the Sendai Framework for Disaster Risk Reduction in 2015. To some experts, the preceding 2005 Hyogo Framework for Action focused too much on disaster risk reduction from natural disasters, and ignored industrial accidents and complex accidents like natech accidents [6]. In fact, in a 2011 study by the European Commission, out of 14 EU countries that experienced natech accidents, more than half of the accidents resulted in the release of toxic substances, fires, or explosions (Krausmann and Baranzini 2012).

The Sendai Framework places unprecedented emphasis on the interaction between hazards (natural and man-made), exposure levels, and pre-existing vulnerability (Aitsi-Selmi and Murray 2016). It calls to action for improving decision making through a stronger science-policy-practice interface, with four priority areas for action –including strengthening disaster governance with regard to shared resources and at the basin level (UNISDR 2015).

The Organization for Economic Cooperation and Development (OECD) also provides guidance for the planning and operation of facilities where hazardous substances are located through the use of their 2003 Guiding Principles for Chemical Accident Prevention, Preparedness, and Response. Recognizing the gaps in natech risk management and methodologies, the OECD developed an addendum in 2015 to the Guiding Principles that include 1) an investigation of the prevention of chemical accidents, as well as preparedness for and response to chemical accidents resulting from natural hazards that are not a part of national chemical accident programs; and 2) recommendations for best practices with respect to prevention of, preparedness for, and response to natech accidents (OECD 2015).

Regional frameworks for response to natural and man-made disasters have been developed by member states of the Black Sea Economic Cooperation (BSEC) and the Association of South East Asian Nations (ASEAN). These regional agreements have also progressed to include national efforts, such as the coordination of technical assistance and resource mobilization during response to natural and man-made disasters (ASEAN 2010; BSEC 1998).

Building Holistic Approaches for Integrating Multilevel Disaster Response

The transition toward a multi-hazard approach for response to natural and man-made disasters, and the acknowledgement of the risks of natech accidents is occurring at many levels. It is present in the work of the United Nations and the multilevel response frameworks of the EU Civil Protection Mechanism; some regional agencies are also adopting similar agreements (i.e., ASEAN, BSEC). However, there remains a disparity in managing natural and man-made disasters in a holistic manner at the national level, as well as in the monitoring of these types of events at the Danube basin and Tisza sub-basin levels. The challenges are not insurmountable; this section proposes two sets of options for reducing and eventually eliminating the historic dichotomy among approaches to disaster response and monitoring.

Multi-Hazard Approaches

The process of building holistic approaches to planning, preparedness, and response can strengthen systems for responding to natural and man-made disasters in a more integrated manner. Building holistic disaster risk management processes may be done at the global (e.g., Sendai), regional (e.g., BSEC), bilateral, and national levels.

The review of legal and policy frameworks and interviews reflected that while some planning and preparedness activities take place regarding flood hazard, this generally is not the case for accidental pollution (at least in the Danube and Tisza context), and natech accidents are largely removed or ignored [2, 3, 4, 5, 6] (European Commission 2010; ICPDR 2015a). Gaps in

monitoring were cited along the length of both the Danube and the Tisza in regard to both flooding and accidental pollution, which should also be improved in future planning efforts. The Tisza sub-basin and smaller water bodies are beyond the scope of the WFD, consequently, no holistic monitoring or response measures are in place; regional agreements at the basin or sub-basin level could aid in developing improved response frameworks [2, 3] (McClain et al. 2016).

Improving the mapping of hazards to reflect not only flood hazard, but also risks from man-made disasters and natech events – and integrating these risks into a holistic map of vulnerability to disaster – would provide a foundation for more holistic policies and programming to manage disaster risks. It would also aid in improving measures for preparedness at the national and local levels. Multi-hazard response frameworks provide the opportunity to intervene and mitigate the size of future disasters. Interviews indicate that harmonized approaches to natural and man-made disasters offer additional opportunities to strengthen capacity among transboundary actors [1, 4].

Multi-Hazard Response Modalities

In order to empower, guide, and facilitate the institutional arrangements and mandates necessary to improve monitoring of and response to natural and man-made disasters, the legal and policy frameworks need to provide the necessary mandates and procedures. In regard to the Danube basin, this could be done in a variety of ways. The Danube River Protection Convention has not been updated or amended since it was originally drafted in 1994, but it unites all countries of the Danube basin and its tributaries under a formal, legal agreement. Cooperation among Danube countries was generally reported as good [3]; therefore, continuing the use of the ICPDR and its expert groups as a mechanism to gain cooperation among the countries on a regional framework for improving monitoring and response could be considered [3, 4, 5]. Another possibility would be to expand the numerous bilateral agreements among the Danube and Tisza countries regarding flooding to also include man-made disasters and natech events. Working on

agreements at a regional level improves communication, breaks down barriers (particularly in transboundary situations), and aids in the development of a common legal language among participating parties [1, 2].

Updating conventions and other hard law can be difficult; countries often find soft law to be more flexible, they are sometimes unwilling to adopt binding obligations, particularly in the face of uncertainty (e.g., climate change), or when they feel there might be a need to act quickly to changing circumstances. In this regard, updating the Danube Declaration and the corresponding Tisza MOUs can provide particularly viable options. Through the Declarations and MOUs, the Danube or Tisza countries could decide whether to engage in a particular action through a separate strategy, or pilot project, or whether to incorporate the issue into the broader basin or sub-basin management plan (e.g., improvement of accidental pollution and flood monitoring, integrated accidental pollution and flood maps). Improved vertical and horizontal cooperation was a request of several interviewees, particularly in regard to the risks posed from man-made accidents and how to respond to these accidents [4, 5].

Conclusions

The historic distinction between natural and man-made disasters is outdated, counterproductive, and ultimately flawed. Natural disasters have the potential to trigger simultaneous technological or chemical accidents from one or multiple sources. With anthropogenic climate change influencing the frequency and intensity of disasters, the distinctions in preventing, monitoring, and responding to disasters from either natural or man-made sources are further called into question. Moreover, increased urbanization and shifting populations are placing more people at greater risk in times of disaster (whether natural or man-made). As a result, it is increasingly clear that there are no purely natural disasters.

Recognizing that the historic distinctions between natural and man-made disasters are no

longer relevant, there is increasing recognition of the need to address disasters holistically, regardless of the contributing causes and aggravating factors. This trend is noted in the Sendai Framework, which adopts a multi-hazard risk approach for disasters that are both natural and man-made. While the current policy frameworks in the Danube basin and Tisza sub-basin do not address preparedness and response holistically across types of disasters, the basin countries have several options for more integrated response. A key opportunity is the development or amendment of agreements governing response to natural and man-made disasters. This could be negotiated through updates to the Danube Convention or through bilateral treaties between the basin countries. Improving planning and preparedness through more integrated monitoring and mapping of natural and man-made disasters, such as combining the flood risk areas with the Inventory of Potential Accidental Risk Spots, could be elaborated upon in Declarations and MOUs at the basin and sub-basin levels.

A coordinated approach to natural and man-made disasters, including natech accidents, is currently taken through the European Union Civil Protection Mechanism and BSEC. This is not unique to Europe alone, and other similar regional approaches exist from which to draw lessons (including the ASEAN agreement). The Danube and Tisza countries are well versed in the transboundary impacts from natural and man-made disasters, and natech accidents; climate change is likely to increase the frequency and severity of these events in the foreseeable future. Nevertheless, while approaches for integrating holistic frameworks for disaster response are recognized at multiple levels, implementation within the Danube basin and Tisza sub-basin remains distinct and fragmented.

CHAPTER 4
RESILIENT INTEGRATED WATER RESOURCES MANAGEMENT:
IMPLICATIONS OF A NEW PARADIGM FOR THE DANUBE AND RHINE
RIVER BASINS

Introduction

The Danube and Rhine River basins continue to experience a number of natural and man-made disasters that provide reminders of the vulnerability of communities to these events. These include the 1986 Sandoz fire and chemical spill in the Rhine, the 2000 Baia Mare floods that led to mine tailing collapses and the release of heavy metals in the Tisza and Danube Rivers, and the 2010 red sludge chemical spill in the Danube. The 2014 Cyclone Tamara in Serbia triggered an estimated 1,000 landslide events, including significant flooding that led to high expenditures to meet unexpected post-disaster demands (NERC 2014). Natural hazards become disasters as they impact populations and the environment; these include earthquakes, floods, and cyclones. Man-made disasters include industrial, technological, or nuclear accidents; they can also include cascading events such as natechs, where natural disasters trigger technological accidents. The scale of the impact from these disasters depends on the policy choices made related to prevention, preparedness and response.⁷ These decisions can make communities more vulnerable to disasters or more resilient to them.

While sudden-onset disasters such as Hurricane Katrina in 2005 or the Great East Japan earthquake and tsunami in 2011 affected large numbers of people and attracted global attention, slow-onset disasters related to climate change, including drought, pandemics, coastal erosion and other “silent disasters” often go unnoticed or are overshadowed by other events (IFRC 2013).

⁷ This paper focuses on strengthening international frameworks governing prevention, preparedness and response to natural and man-made disasters. It should be noted however that fire, police, and other local level responders will respond regardless of what type of disaster has occurred.

Building resilience to disasters includes reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, improving preparedness and early warning for disasters, while also promoting measures that focus on adapting to a changing climate and environment. The Sendai Framework for Disaster Risk Reduction (2015-2030), is considered the leading framework for resilience and aims at reducing risk from natural and man-made disasters in all sectors and aspects of human society and development by 2030 (UNISDR 2015).

Integrated water resources management offers a global framework for the coordination of water and land management, adopted by many basin organizations and resource management authorities (GWP 2000). Due to the flexibility of integrated water resources frameworks, the incorporation of resilience mechanisms for more holistic, multi-hazard risk management is currently being considered at many international and regional governance levels (European Commission 2016a; UNSIDR 2015). The Sendai Framework for Disaster Risk Reduction (Sendai Framework) is an international agreement adopted by United Nations member states and built on lessons learned from the implementation of the Hyogo Framework for action 2005-2015 (UNISDR 2015). The Sendai Framework underscores the need to reduce risk to natural and technological hazards and build resilience through the integration of specific actionable measures during areas of prevention, preparedness, and response throughout multiple levels of governance (European Commission 2016a).

The complexities of integrating community mechanisms of resilience into national and international policy and practice can sometimes pose challenges, but what is important is understanding the ability to not only cope with, but to also adapt to adverse conditions and to focus any interventions at building on these strengths (IFRC 2004). This is particularly true as the terminology and associated words used within disaster risk reduction and the building of resilience

can vary across continents, and within multiple levels of governance. For example, what is often referred to as mitigation (the lessening of adverse impacts of hazards and related disasters, including engineering techniques, hazard-resistant construction, and emergency warning systems) is encapsulated, along with recovery, in the language of preparedness in the Sendai Framework and in the laws and policies of the European Union.

We argue there are four issues constraining the implementation of resilience (as exemplified by the Sendai Framework) in the Danube and Rhine River basins: 1) focus on flood hazard versus multi-hazard approaches to risk management, 2) focus on sudden-onset disasters versus slow-onset disasters, 3) failure to integrate vulnerability,⁸ and 4) limited integration of preparedness measures. This article begins with an overview of the study area and a description of the methodology. Next is an examination of the Sendai Framework and the conceptual domains of integrated water resources management and resilience. Then a review of the international laws and policies governing resilience in transboundary European waters and the relevant practices of the Danube and Rhine basin are explored. The final section highlights the challenges to resilience in the Danube and Rhine basin, drawing on expert interviews and document analysis. The article concludes with lessons to be drawn from these experiences.

Overview of Study Area and Methodology

The Danube and Rhine basins are intensively used watercourses with historic incidents of natural and man-made disasters, including coastal waters that may be susceptible to rising sea levels (Figure 4.1). The Danube basin is the most international basin in the world; it is home to 80.5 million people, encompasses 807,827 km², and portions of 19 countries (14 countries with sub-basins exceeding 2,000 km²). The Rhine River is home to approximately 58 million people, encompasses

⁸ For the purposes of this paper, as described by the Sendai Framework vulnerability is the condition determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards (UNISDR 2015).

197,100 km² and lies within portions of six countries.



Figure 4.1. The Danube and Rhine River basins, and Tisza River sub-basin.

River regulation measures in the Danube were first undertaken in 1882 for flood protection and navigability. The construction of flood protection dams, low water regulation, and the later construction of a chain of hydropower plants on the Upper Danube removed most of the character from the Danube and its floodplain. Here, most floodplains and wetlands were converted into agricultural and urban areas, or were isolated by dams and levees, and only 12 natural areas, each only 1 km in length, remain untransformed (Schneider 2010). In the Middle and Lower Danube, the river bed was dredged to aid with navigability, and while 2,000 km² of the floodplain still exists, over 72 percent of the original floodplain area was lost. The Rhine first began regulation for navigation and settlement in 1817, where the majority of the river meanders were cut off, it was

narrowed, 10 dams were constructed, and over 83 percent of the inundation area was lost. The loss of floodplains from this area led to the degradation of habitats, loss of biodiversity and of ecological function, but it also increased the risk of floods (Schneider 2010). Prior to 1955, the flood peaks of tributaries reached the Rhine before the flood peak of the main river, but now the flood peaks of both tributaries and the Rhine coincide. This flood-peak coincidence, combined with significant loss of flood-retention areas dramatically increases the probability of high and catastrophic floods along the Rhine (Schneider 2010).

The lack of spawning areas for sturgeons, and increased eutrophication caused by wastewater discharge from agricultural and industrial production on the Danube create increasing problems for the basin (Schneider 2010). Large floods have had severe impacts on property, human health and safety in recent years, but missing and insufficient wastewater treatment facilities in the Middle and Lower Danube, combined with increasing agricultural pollution, present significant transboundary impacts (UNECE 2011). Mining activities, thermal and heavy metals pollution, and changes in groundwater flow have also caused adverse impacts to aquatic and terrestrial ecosystems in the basin (ICPDR 2009a). Similar problems occur in the Rhine, and over 950 major industrial point pollution sources have been identified. Nitrogen, phosphorus and other pesticides originate from diffuse pollution sources in agriculture and as run-off in rural areas (UNECE 2011).

Methodology

The examination of policy and institutional frameworks regarding integrated water resources management and resilience in the Danube River and Rhine River basins were conducted through a combination of primary and secondary data collection and analysis. The primary data collection and analysis consisted of semi-structured interviews, while the secondary data analysis included an analysis of laws, policies and institutions within the Danube and Rhine River basins.

Semi-structured interviews were conducted during an eight-month period from January to August 2013. The interviews were held throughout various locations in Europe; 26 interviews were completed in total. The interviews took place with experts working at the United Nations Office for the Coordination of Humanitarian Affairs, the United Nations Economic Commission for Europe, the European Commission, and with experts from the Ministries and Water Directorates working in the Danube and Rhine River basins. Given public roles, the interviews are intentionally kept anonymous to ensure candidness in response (Table 4.1). The questions focused on how the Danube and Rhine River basin policies and laws were implemented in practice, as well as the perceptions of the experts regarding the interplay of implementation as it concerned resilience, and the ability to integrate resilience into existing basin management plans of the Danube and Rhine River basins.⁹

Table 4.1. Governance levels of experts interviewed regarding resilience.

International	United Nations, United Nations Economic Commission for Europe, and United Nations Office for the Coordination of Humanitarian Affairs [1]
Regional	European Commission, Directorate General [2]
National	National Ministries of Environment, Rural Development, Interior, Environment Agency [3] Water Directorates [4]

*Numbers in brackets refer to interview citations in text.

Shifting Paradigms from IWRM to Resilience Using the Sendai Framework

Law and policy have the ability to facilitate a paradigm shift – and transition multiple levels of governance toward a new way of thinking. In the context of supporting resilience in an integrated manner, innovative approaches to drive broader governance reform have not yet been

⁹ Questions relevant to this research included: 1) What are the constraints or opportunities regarding the various institutions managing disasters (including preparedness, response, resilience and risk reduction) working at the basin level versus working only at the national level? 2) What gaps exist between policies and practice in regard to these areas at various levels of governance? 3) What constraints or opportunities exist for including preparedness, prevention and response to natural and man-made disasters in existing policies, and which policies would be most effective for their inclusion? 4) How do international basins prepare for natural and man-made disasters? 5) Is there an increasing role for a) preparedness b) response c) building and strengthening resilience, and d) disaster risk reduction?

fully realized at the basin level. Globally, human populations are increasing in their vulnerability to climate change impacts and to multiple hazard events, such as natural and man-made disasters. By incorporating a resilience framework into existing basin management plans, substantive ideas of change can be implemented in a decentralized manner. The Sendai Framework for Disaster Risk Reduction supports measures that are actionable at various levels to improve resilience – these measures are considered below.

Integrated Water Resources Management

Integrated water resources management is a coordinated process for the development and management of water, land and related natural resources in order to maximize economic and social welfare without compromising the sustainability of ecosystems (GWP 2000). Since the inclusion of integrated water resources management as a formal concept in Agenda 21 and the 1992 Dublin Conference, integrated water resources management consists of specific approaches including water policy and laws established at the basin level (UNECE 1992; ICWE 1992; Pahl-Wostl et al. 2011). Common themes in integrated water resources management include the incorporation of multilevel governance structures, adaptable principles and strategies that can be used in virtually any basin, and the ability to use disasters as an opportunity for policy change (Medema et al. 2008; Pahl-Wostl 2011; Pahl-Wostl et al. 2013; Varis et al. 2014). The presence of language regarding integrated water resources management in the policies and laws of basin countries offers the occasion for a new paradigm, such as the incorporation of a resilience framework into existing management plans (Hassing et al. 2009; Giordano and Shah 2014). Large system transformations such as these usually require a great deal of time without corresponding institutional support, such as that from a basin commission and corresponding national authorities (Pahl-Wostl et al. 2013). Integrated water resources management frameworks allow for the management of complex, unpredictable arrangements, which can be used to integrate planning strategies for adaptation to

climate change, as well as the various stages of prevention, preparedness, and response to natural and man-made disasters which are analogous with building resilience (Barchiesi et al. 2014).

Resilience

Climate-related disasters, and the interplay between natural and human agency in the manifestation of disaster, blur the distinctions between what is purely a natural or man-made disaster. Cascading events and complex disasters (e.g., where the effects of disasters are multiplied, or where they are composite or concurrent) further undermine these distinctions. For example, in reflecting on the Nepal earthquake of 2015 where over 9,000 people were killed – it is not the event itself that kills, but the poor infrastructure, social vulnerabilities, population density, and limitations in response to the event – this can be said for other disasters as well, such as the 2008 cyclone Nargis in Myanmar and the Haiti earthquake in 2010 (Cutter and Emrich 2006; Peel and Fisher 2016). Similar disasters have occurred throughout the Danube and Rhine basins (Table 4.2).

Table 4.2. Natural and man-made disasters in the Danube and Rhine basins, by country (2000-2012) (Adapted from European Commission 2016b).

Year	Type of Event	Country
2000	Mine tailing failure/cyanide and heavy metal pollution (natech)	Romania, Hungary, Bulgaria, Macedonia
	Landslide/avalanche	Austria, Slovenia
	Extreme temp./drought	Bulgaria, Croatia, Slovenia
	Flooding	Croatia, Hungary, Romania, Slovenia
	Severe ice storms	Moldova, Ukraine
	Wildfires	Croatia, Slovakia
	Factory fire	Slovenia
	Chemical explosion	Netherlands
	2001	Mining accident (natech)
Fertilizer explosion		France
Landslide from floods		Liechtenstein
Flooding		Croatia, Hungary, Romania, Slovakia, Ukraine
2002	Industrial fire at waste dump	Slovenia
	Flooding	Belgium

2003	Mining accident (natech)	Slovenia
	Extreme temp./drought	Austria, Croatia, Germany, Slovenia, Bosnia and Herzegovina
	Flash floods/severe storms	Hungary
	Wildfires	Slovenia
2004	Heat wave	Luxembourg, France
	Drinking water pollution (natech)	Hungary
	Dam failure/flood	Romania
	Earthquake	Slovenia
	Flooding/severe storms	Hungary, Slovakia
	Drought	Bosnia and Herzegovina
2005	Gas explosion (natech)	France, Belgium
	Landslides with floods	Slovenia, Liechtenstein
	Heavy snow/electric outages	Netherlands
2006	Flooding/severe storms	All Danube Countries, except Ukraine
	Avian (H5N1) flu pandemic	Hungary, Romania, Slovenia
	Earthquake	Hungary
	Extreme temp./heat waves	Bulgaria, France
	Wildfires	Slovenia
2007	Wildfires/forest fires	Bulgaria, Croatia
	Hurricane	Germany
	Extreme temp./drought	Austria, Bulgaria, Croatia, Hungary, Romania, Slovakia, Bosnia and Herzegovina, Montenegro, Serbia, Moldova
	Flash floods/severe storms	Bulgaria, Germany, Hungary, Romania, Slovenia, Montenegro, Serbia, Ukraine
2008	Cyclone Klaus	France
	Extreme temp.	Bulgaria
	Forest fires	Bulgaria
	Flash floods/severe storms	Hungary
	Flooding	Romania, Slovakia, Slovenia, Serbia, Moldova, Ukraine
2009	Swine (H1N1) flu pandemic	All Danube and Rhine Countries Croatia, Romania, Bosnia and Herzegovina, Ukraine
	Ice storms/blizzard	
2010	Chemical accident (natech)	Hungary
	Earthquake	Serbia
	Cyclone Xynthia	France
	Gas explosion	Belgium
2012	Ice storms/blizzards	Bulgaria, Hungary, Romania, Montenegro, Serbia, Moldova,
	Extreme temp./drought	Ukraine Moldova

While the definition of resilience can have varying connotations, approaches, and methods for implementation across disciplines, when referring to social and economic systems resilience is defined as ‘the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, identity, and feedbacks’ (Walker et al. 2004; OECD 2014). Building resilience is not focused solely on the return of a particular state or function – multilevel governance systems consist of nested, dynamic states that operate at particular organizational scales – therefore, it is whether and how these systems are able to interact and regain function (while adapting to climate change, or in preparing for or recovering from a disaster) that becomes important. If policies to avoid, prepare for, respond to and recover from the risks of disaster are adopted at multiple levels, the resilience of people exposed to both climate change, and to extreme events can be increased (Lyster 2016).

With a goal to reduce the drivers of global disaster risk, particularly climate change, the Sendai Framework represents an integration of the natural resources management community with those engaged in disaster risk prevention, preparedness and response (UNSIDR 2015). This requires communication and cooperation towards long-term investments in capacity and governance at multiple levels – thus, using existing frameworks of integrated water resources management to adopt dynamic approaches to resilience.

The Sendai Framework for Disaster Risk Reduction

The trend to preemptively reduce the risks of natural and man-made disasters, including exposure to hazards, lessening vulnerability of people and property, improved land and environmental management, and increased preparedness and use of early warning systems is reflected at the international level in the 2015 Sendai Framework. Adopted by United Nations (UN) member states at the third UN World Conference on Disaster Risk Reduction, and endorsed by the UN General Assembly, the Sendai Framework is the successor instrument to the Hyogo

Framework for Action 2005-1015 (HFA, UNISDR 2015). While the HFA focused primarily on disaster loss from natural hazards, the Sendai Framework focuses on disaster risk from multiple types of hazard (European Commission 2016a). The Sendai Framework is a voluntary instrument that provides a multilevel governance approach to enhancing the resilience of the global community to the slow-onset effects from climate change and sudden shocks from multiple types of disasters.

There is no end-state to achieving resilience, it is a continuous set of actions that are modified and improved as populations increase, environments and economies change (OECD 2014). For this reason, resilience is often tied to adaptation measures so there is opportunity for monitoring of activities and to incorporate learning into future plans (Barchiesi et al. 2014). Within the Sendai Framework, four Priorities for Action (PFAs) have been developed and consist of multiple activities that provide recommendations for focused action within and across multiple sectors at specific levels of governance; these are “global/regional”, and “national/local”. The four PFAs include “1) understanding disaster risk; 2) strengthening disaster risk governance to manage disaster risk; 3) investing in disaster risk reduction for resilience; and 4) enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation, and reconstruction” (UNISDR 2015).

In each of the four PFAs categorized above, the Sendai Framework provides further elaboration to reveal elements related to policy design, institutional mechanisms, fiscal components, and capacity development. These can be areas of weakness in multilevel governance, but can also lead to the identification of tradeoffs and facilitate communication among the various sectors if coordination of these elements can be achieved (Troell and Swanson 2014; McClain et al. 2016).

The first of the four PFAs draws attention to understanding risk from multiple dimensions, including vulnerability, capacity, exposure of people and assets, and the hazard characteristics of

the environment. It promotes the collection, analysis and management of data and multi-hazard risk assessments and maps, including climate change scenarios, and the use of multi-hazard early warning systems to promote and strengthen disaster communication among multiple levels of governance, including local communities (UNISDR 2015).

Among the targets of the second PFA, emphasis is placed on mainstreaming elements of disaster risk reduction to multiple hazards into all institutions and sectors, including regional and transboundary organizations. It promotes the development of frameworks, laws, regulations and public policies to enable improved policy and planning aimed at addressing transboundary disaster risks, exchanging good practices, and increasing training initiatives and reporting requirements related to transboundary disaster risk, while also integrating awareness for climate change (UNISDR 2015).

Understanding the role of private and public investment in supporting resilience through structural and non-structural measures, the third PFA underlines the need to allocate the necessary resources at all levels for the development and implementation of disaster plans, policies, laws and regulation in all relevant sectors. Financial investment is a driver of innovation, growth, and job creation, but it also helps protect the economic, social, environmental, and cultural resilience of individuals, communities and assets during different phases of disaster.

The fourth PFA focuses on preparedness and ‘building back better’, which highlights the integration of linkages in reducing vulnerability, strengthening the resilience of infrastructure and other areas of development, and improving multi-hazard, multi-sectoral forecasting, warning and communication systems, and promoting the link between effective relief, rehabilitation, and development. Ensuring that this is done at multiple levels, inclusive of multiple sectors, and taking into account multiple hazards, including future threats of climate change, are also indicated as necessary for building disaster resilient communities (UNISDR 2015).

Using river basin treaties and their institutions as instruments for cooperation in disasters is not in opposition to other water treaty objectives of resource use and environmental management. Rather, it promotes greater integration in managing the competing human and environmental needs associated with transboundary river basins, including both long and short term resilience measures and sustainable development – it is also complementary to the concept of integrated water resources management, as well as objectives reflected in the Sendai Framework PFAs (Picard 2016).

Analyzing Implications for Resilience using the Sendai Framework

The development of European Union legislation on the environment is quite broad and covers many areas – impact assessment (e.g., Environmental Impact Assessments, Strategic Impact Assessments), protection measures (e.g., Water Framework Directive and daughter directives, Floods Directive), environmental themes (e.g., Birds Directive, Habitats Directive), and environmental liability. While several mechanisms and directives lay the groundwork for risk management, there are limitations to the development of a systemic approach to disaster risk reduction, and no directive explicitly mentions resilience as envisioned in the Sendai Framework. Even though advances supporting resilience occur in both the Danube and Rhine River basins, the language used to manage these elements, the mechanisms for implementation, and whether resilience is currently integrated in existing basin management plans varies considerably by basin.

Management of the Danube and Rhine River Basins

The European Union's Water Framework Directive (WFD) adopts a basin level approach to water governance and provides a framework for integrated management of inland surface, coastal and transitional waters, and groundwater at the basin level (European Community 2000). The WFD manages both water quality and quantity throughout European rivers, and involves both diffuse and point-source pollutants. The WFD also allows for the member states of each basin to decide on the

management initiatives to be integrated into each six-year basin management cycle. For example, if the member states of the Danube or Rhine basin decide that particular management issues are of concern to the basin (e.g., elements related to the PFAs of the Sendai Framework), they can agree to incorporate plans for managing these concerns at the basin level into future basin management plans. This is the case for the Danube and the Rhine basins, where climate change adaptation, water scarcity and drought, floodplain reconnection strategies, and problems concerning sedimentation have been integrated into basin management plans (ICPDR 2015a, ICPR 2015b). The EU's 2007 Floods Directive (EU FD) is the first directive aimed at managing risk, and requires member states to identify river basins and associated coastal areas at risk of flooding, as well as to develop flood maps for the areas at high risk, and establish flood risk management plans focused on prevention, protection, and preparedness (of flood risk) in coordination with the six-year basin management plans governed by the WFD (European Community 2007).

While the directives highlight incorporating features of integrated water resources management and of resilience – such as following a basin level approach to governance, including the management of water quality and quantity, and the risks associated from flood hazard – the 2013 Decision on a European Union Civil Protection Mechanism went further to link elements reflected in the Sendai Framework. Articles on prevention, preparedness, and response to natural and man-made disasters are connected to specific actions within the document, along with financial support to the EU member states (European Community 2013).

Rising from the collective territorial response to challenges within various regions of Europe that associated with one or more common hazards, macro-regional strategies were adopted for the Adriatic and Ionian region, the Alpine region, the Baltic Sea region, and the Danube region (European Commission 2013a). Though the macro-regional strategies do not always reflect the basin areas that exist as part of the WFD, (i.e., the Danube River basin and the Danube macro-

regional strategy) most of the member states to the Rhine basin participate in the strategy for the Alpine region (with the exception of Luxembourg, Netherlands, and Belgium). The aim of the macro-regional strategies is to mobilize new projects and initiatives, and enhance territorial cooperation. Nevertheless, this must be done within the limits of ‘no new funds, no new institutions, and no new legislation,’ in order to develop a bottom-up process for consultation, with political leadership in each newly developed priority area managed by participating countries (European Commission 2013a). Having a common purpose and being supported by existing organizations that function at multiple levels are the often-cited strengths to the macro-regional strategies; however, obstacles to implementation include lack of coordination, insufficient capacity and funding, as well as redundancies among priority areas of the macro-regional strategies and basin management plans (European Commission 2014b) [1, 2, 3]. Macro-regional strategies have included priority areas that address multi-hazard environmental risk; therefore, providing the opportunity to implement resilience strategies at the macro-regional level (European Commission 2014b).

Finding the appropriate level to address resilience and disaster risk systematically is proving challenging within the EU. It is clear that it is most effectively implemented at the national and local level, but transboundary risks that transcend political boundaries appeal to the need for careful coordination at regional levels such as the basin level (Jones et al. 2011; Nanni 2012). River basin institutions provide substantial comparative advantages in the implementation of integrated policies, including building resilience to disaster risk through pre-existing treaties, partnerships, and capacities (UNEP 2014b). They also offer the benefit of short and long term planning through pilot projects and basin management plans, which complements the temporal planning cycles of resilience approaches (e.g., preparedness, prevention, response).

Policies on Resilience in the Danube Basin

Basin management within the Danube involves cooperation among 14 EU member states – this can be a daunting task – yet the countries have collaborated on a number of innovative projects through the coordination of the International Commission of the Protection of the Danube River (ICPDR). The Danube member states have engaged in a series of non-binding Memoranda of Understanding (MOU) referred to as the Danube Declarations, first in 2004, revised in 2010, and updated in 2016. The declarations reinforce language of the 1996 Danube River Protection Convention to sustainably manage the waters of the Danube River, and develop commitments by the countries to continue the work of the WFD and the EU FD. The 2016 declaration recognizes the need for increased investment in improved emergency warning systems for flood protection and contamination, as well as improved exchange of information throughout the Danube (ICPDR 2016). The declaration also expresses the need to expand the knowledge base regarding climate change adaptation, and facilitate the exchange of best practice examples regarding water scarcity and drought in future basin management plans. Further, the declaration emphasizes the need to continue cooperation with the agricultural sector, and to bear in mind the ‘manifold pressures from different sectors that can be addressed through integrated water resources management in the Danube River basin’ (ICPDR 2016).

Following elements contained in the EU Strategy on Adaptation to Climate Change, the ICPDR developed a Climate Change Adaptation Strategy for the Danube Region in coordination with the Danube member states (European Community 2000; European Commission 2013b; ICPDR 2013). While the adaptation strategy provides a broad overview of the impacts of climate change to the Danube basin, there are no actionable measures to adapt to climate change at the basin level. Additionally, the 2015 Danube River Basin District Management Plan (DRBMP) indicates that because climate change affects multiple sectors, further clarity is needed regarding

the effects of climate change in order to integrate actionable measures into specific activities (e.g., exchange with flood risk management, inland navigation, hydropower or agriculture); this would therefore be elaborated in future DRBMPs (ICPDR 2015a). In 2013, similar to the management of climate change, the member states began considering water scarcity and drought as a challenge to water and land management in the basin, and in 2015 water scarcity and drought was integrated into the DRBMP (ICPDR 2015a). Though not connected to specific implemented actions, as other concerns in the DRBMP (i.e., nutrient and hazardous substances pollution, and hydromorphological alteration), water scarcity and drought are mentioned as requiring further consideration in future DRBMPs. Through the coordinated efforts of the ICPDR, the EU FD requirements were met through the development of the basin-level Flood Risk Management Plan for the Danube (ICPDR 2015b). However, limitations to the EU FD exist in that the directive only requires member states to assess and manage risks of flooding within their territories and to develop flood risk management plans for areas considered to be at ‘high risk’ of flooding – ruling out areas that could be at an increasing risk of flooding over time due to climate change. Furthermore, the flood risk maps are not integrated into other available maps, such as the Danube Inventory of Potential Accidental Risk Spots.¹⁰ Further limitations include the absence of maps reflecting populations vulnerable to these multiple types of risk, as well as the ability to integrate the maps into measures for developing preparedness, prevention and response (ICPDR 2015a).

While the management of activities towards resilience remains in a nascent stage at the basin level, it is nevertheless included in the annex to the Danube Flood Risk Management Plans. Here, each country is listed for its contribution to specific areas related to 1) Emergency Warning Systems; 2) Institutional Response and Planning; 3) Enhancement of Public Awareness and

¹⁰ Subsequent to the 2000 Baia Mare natech in Romania, the Danube member states developed an Inventory of Potential Accidental Risk Spots in the Danube River Basin. The information is based on a quantitative evaluation of hazardous locations in the Danube catchment area, but has not been updated since 2001 (ICPDR 2001; ICPDR 2015a).

Preparedness; 4) Other Measures; 5) Clean-up & Restoration (of infrastructure and buildings; i.e., recovery); and 6) Lessons Learnt (ICPDR 2015b). Several of these areas align with those of the Sendai Framework, though the focus lies with flood hazards alone.

In the area of emergency warning and preparedness, the Danube member states engage in two separate systems for flood monitoring and accidental pollution; the emergency flood alert system and the Danube accident emergency warning system. The flood alert system is part of a coordinated effort with the Joint Research Centre of the Directorate General of the European Commission, and works in collaboration with national authorities and with a variety of meteorological services. An MOU has been signed by some, but not all Danube countries (Austria, Bulgaria, Czech Republic, Germany, Hungary, Moldova, Serbia, Slovakia, Slovenia, and Romania, and negotiations are taking place with Bosnia and Herzegovina and Croatia), and flood information is available 24-hours a day through an online service managed by the Joint Research Centre (ICPDR 2010b). The MOU does not include tributaries <4,000 km², therefore the Tisza sub-basin is not included in the flood alert system, nor are certain countries where significant flood concerns arise, such as Ukraine [2, 3] (McClain et al. *in review*).

The Danube accident emergency warning systems monitor accidental water pollution incidents in the Danube River basin. Unlike the flood alert system, which is connected to monitoring conducted by the European Commission and transmitted to national authorities, the accident emergency warning system is managed by the ICPDR and national authorities. While all Danube member states cooperate with the accident emergency warning systems and have their own national level policies regarding response to accidental pollution in their country, each country is also expected to have a fully operational principal international alert center to operate on a 24-hour basis and conduct international communications. Challenges to the principal alert center monitoring include territorial gaps (i.e., several areas along the Danube and Tisza are not

monitored) [2, 3, 4], lacking bilateral agreements for response in case the accident exceeds national capacity, and the monitoring conducted is related to particular types of hazardous materials alone (ICPDR 2010b; McClain et al. *in review*).

Financing of the Danube measures to meet the obligations of the WFD and the EU FD are supported through national commitments from the basin countries, from EU funding mechanisms (e.g., Common Agricultural Policy, Cohesion Fund, Structural and Life Fund, and Neighbourhood Fund), from international funding institutions (e.g., European Investment Bank, European Bank for Reconstruction and Development, and World Bank), and from other external organizations (e.g., Global Environment Facility and World Wildlife Fund) (McClain et al. 2016). While the Danube basin is meeting the obligations of the WFD and EU FD, the ability to integrate resilience at the basin level would need to expand beyond the measuring and mapping flood risk alone, to include multi-hazard aspects such as the Inventory of Potential Accidental Risk Spots and improved emergency warning systems.

Policies on Resilience in the Rhine Basin

Rhine River basin management involves coordination among the ‘parties’ of France, Germany, Luxembourg, Netherlands, and Switzerland, and the ‘states’ of Austria, Belgium, and Liechtenstein, all which are organized through the International Commission for the Protection of the Rhine (ICPR). The parties are signatories to the Convention on the Protection of the Rhine (Rhine Convention), but the states who hold an observer status and who also share a portion of the watershed, are given equal rights to those of the parties in the Rhine Convention (ICPR 1999). The Rhine parties and states coordinate their work through MOUs referred to as Rhine conferences. The most recent Rhine conference of 2013 underlines the commitments of the Rhine countries to implement the WFD and EU FD and improve integrated water resources management through the consideration of new and cross-sectoral challenges, including the effects of climate change (ICPR

2013). In 2015, the ICPR and Rhine member states developed the Rhine Strategy for Adapting to Climate Change, which specifies key and future activities in relation to climate change. Within the strategy, effects on low flow, water temperature, discharge, and socio-economic development are considered (ICPR 2015a). Climate change was also integrated into various management programs of the 2015 Rhine Basin Management Plan (RBMP) (specific measures include fish migration, flood management, socioeconomic parameters) with a view to explore it further in future RBMPs (ICPR 2015b).

The efforts of the ICPR and Rhine member states meet the objectives of the EU FD by taking comprehensive measures to consider ‘high risk flood events’ and mapping these areas. The Floodrisk Management Plan for the Rhine exceeds the requirements of the EU FD by outlining measures of avoidance, protection and prevention, and considering probabilities of extreme events, in addition to supra-regional flood risk management measures (e.g., flood-prone areas free from further use, and creating more flood retention areas “room for the river”) (ICPR 2015c). Additionally, though none of their flood management is framed as resilience, they underline the importance of strengthening national policies and awareness for 1) flood-adapted construction and restoration (building back better), 2) improving flood insurance connections throughout the basin (financing); 3) enhancing preparedness and prevention actions through the establishment of partnerships and training (ICPR 2013).

A great deal of attention has been placed on integrating monitoring and response to multiple types of hazards within the Rhine River basin, particularly following the Sandoz chemical fire in 1986. Beginning with the Rhine Action Programme (RAP) for the prevention of accidents and security of industrial plants, and an inventory of warehouses and production sites of hazardous substances was developed within the Rhine basin (ICPR 2003). Recommendations and activities were developed in relation to fire prevention concepts, licensing procedures for industrial

installations regarding hazardous incidents, the transportation of substances within and along pipelines, and on-site alarm plans with a precise list of rescue measures during accidents. The RAP successfully concluded in 2000 and was followed by a new program of interventions, the Rhine 2020 Vision, which focuses on sustainable development, nature conservation, flood risk reduction and groundwater protection (IUCN 2015). The Rhine Warning and Alert Plan (WAP) is used in conjunction with the maps and recommendations to monitor accidental pollution in the Rhine, and allows for communication to local authorities and to water distribution companies (ICPR 2003). Monitoring stations are located throughout the basin, and reports on pollutant discharges are compiled annually. Similar to the Danube, floods are monitored by separate warning systems located throughout the main stem of the Rhine River; however, flooding in the Rhine is not supervised directly by the emergency flood alert system of the European Commission as in the Danube and is therefore not directly connected to an international system of response in times when national capacity is exceeded. It is the decision of the basin states to engage in flood monitoring with the European Commission; currently the Danube basin is the only one to engage in this practice (ICPDR 2010b). Flood warning, the conditions of floods (i.e., flood forecasts and exchange of real-time hydrologic conditions), and the media are regulated in detail.

Financing for the ICPR is subsidized by national commitments through the basin countries, as well as from EU funding mechanisms (e.g., Common Agricultural Policy). Given the prosperity of most Rhine countries, only 2.5 percent of the annual budget is taken from European Community funds, the remainder is financed by Switzerland (12 percent), Germany (32.5 percent), France (32.5 percent), Luxembourg (2.5 percent), and the Netherlands (2.5 percent) (IUCN 2015). Access to European Community funds remain available to the Rhine countries to develop future projects related to resilience, improving and updating mapping capabilities that include vulnerable populations and pollution installations since the completion of the RAP, for example. While the

current Rhine 2020 plan will be in effect for the next four years, it is interesting to note that it does not operate in conjunction with the Rhine Basin Management Plans. The RAP and the Rhine 2020 signify long-term planning for the Rhine basin, and therefore represent opportunities to integrate a long-term vision of resilience for the Rhine into future programs.

Integrating Resilience in Basin Management

An established interest exists in implementing resilience-oriented programs within integrated water resources management of the Danube and Rhine River basins, where climate change and other changes to the natural system affect management responses [1, 2, 3, 4]. Harmonized approaches develop resilience through improved capacities and strengthened cooperation across sectors and at regional levels, particularly where transboundary issues are concerned [1, 2] (European Commission 2016a). Activities at the Danube and Rhine basin level have proven innovative and capable of integrating a variety of aspects beyond water management and flood risk alone, and have been discussed previously (i.e., Inventory of Potential Accidental Risk Spots, Rhine Action Programme, climate change adaptation, water scarcity and drought) [4]. However, inefficiencies in multilevel governance, such as limited national intervention to increase resilience at the basin level, emphasize the gaps in implementing holistic multi-hazard risk management.

In consideration of elements highlighted in the four PFAs of the Sendai Framework (Table 4.3), four cross-cutting areas of resilience in need of increased consideration in current Danube and Rhine basin management include: 1) focus on flood hazard versus multi-hazard approaches to risk management, 2) focus on sudden-onset disasters versus slow-onset disasters, 3) failure to integrate vulnerability, and 4) limited integration of preparedness measures.

Table 4.3. Key elements of resilience in the Sendai Framework’s Priority Areas for Action (adapted from UNISDR 2015).

Priority Area 1:	Multi-hazard risk assessments and maps, including climate change scenarios, and the use of multi-hazard early warning systems to promote and strengthen disaster communication among multiple levels of governance, including local communities to determine vulnerability, capacity, exposure of people and assets.
Priority Area 2:	Mainstreaming elements of disaster risk reduction to multiple hazards into all institutions and sectors, including regional and transboundary organization.
Priority Area 3:	Allocate the necessary resources at all levels for the development and implementation of disaster plans, policies, laws and regulation in all relevant sectors.
Priority Area 4:	Reducing vulnerability, strengthening infrastructure and other areas of development, and improving multi-hazard, multi-sectoral forecasting, warning and communication systems, and promoting the link between effective relief, rehabilitation, and development. Ensuring that this is completed at multiple levels, inclusive of multiple sectors, and taking into account multiple hazards, including future threats of climate change

Multi-Hazard vs. Flood Hazard

Multiple international laws and policies are adopting broad definitions of disaster in order to recognize that many disasters arise from multiple hazards (UNISDR 2015; European Community 2013). Human intervention in the environment is increasingly extensive, exposing populations to natural hazards from location of housing and infrastructure, to floodplain and drainage management (Picard 2016). In the Danube and Rhine River basins, resilience is being implemented, but predominantly from a flood-risk perspective [2]. Broader interventions need to be implemented in all areas of preparedness and response, including improved approaches to risk assessment beyond that of just flood hazard [2, 3, 4]. One possibility would be to utilize the European Union Civil Protection Mechanism to develop a risk management plan at the basin level to harmonize management of multiple, transboundary risks [3]. Though intended to be implemented at the national level, the European Union Civil Protection Mechanism decision grants funding towards projects that 1) adopt a multi-hazard approach; 2) are transboundary in nature, and 3) when member states act individually (at the national level) or as a consortium (at the basin level) (European Community 2013). Therefore, while options for prevention, preparedness and response

at the basin level are considered optional, the European Commission accepts this as a possible level for building resilience. Given that the Water Framework Directive regulates the management of water resources at the basin level, including flood risk through the EU FD, the actions of integrating holistic resilience mechanisms at the basin level would be complementary to these directives. The member states of the Rhine and Danube basin would need to consider this a management concern for future basin management plan, and incorporate them into future objectives. Furthermore, in a recent review of the Union Civil Protection Mechanism, it was determined that only 18 of 28 EU member states had submitted risk assessments, and while every country will face different risks, there were no common descriptions or understandings of what should be listed in the risk assessments among member states (European Commission 2014c). Therefore, scaling these activities upward to the basin level could aid in improving national level implementation. The Danube basin has implemented a few flood-oriented resilience measures through their Flood Risk Management Plan, the Rhine through their Rhine Action Program even though not explicitly addressed as resilience; therefore, integrating the management of risks to multiple disasters at the basin level is possible. Developing a roadmap or a common implementation strategy, similar to what was used when implementing the WFD, could prove beneficial to basins looking to improve resilience and use existing legislation, policies and funding to integrate it into existing frameworks.

While the EU macro-regional strategies are in place to ensure coordination on transboundary challenges, there is overlap between activities occurring at the basin level and the EU macro-regional strategies [3,4] (European Commission 2014b). In the Strategy for the Danube region, the priority areas require cooperation towards measures that address multi-hazard risks to the environment, instead they mimic the activities conducted at the basin level on flood risk assessment required by the EU FD [1, 2, 3] (ICPDR 2015b). Reports from the European

Commission on effectiveness of the macro-regional strategies indicate limitations in capacity and coordination; this can be improved when redundancies are removed from multiple regional strategies (i.e., Danube basin and Danube Regional Strategy) [1, 2] (European Commission 2014b). Financial resources are limited; therefore, mainstreaming the management of issues that are connected at a transboundary level aid in establishing integrated management practices among the national and basin levels (McClain et al. 2016). This includes preparedness through emergency warning, established bilateral and multilateral agreements beyond response to flooding alone, and determining the vulnerability to communities through proper mapping [1, 2] (McClain et al., *in review*).

Sudden-onset vs. Slow-onset Hazards

Sudden-onset hazards such as earthquakes, tsunamis, volcanoes and landslides are often managed and responded to differently than events related to climate change, including sea level rise, coastal erosion, water scarcity, and drought. Though equally threatening to the safety, security, economic well-being and natural resources of global populations, determining how to assess and communicate resilience to these events is often approached from a wide array of governance perspectives and can prove difficult to manage. Climate change and slow-onset disasters present a growing transboundary threat to more than water resources, and should be integrated into larger regional or basin-wide frameworks of management [1, 2] (Nanni 2012; McClain et al. 2016). While hard laws in the form of directives and decisions have been used to regulate water quality, quantity and risk via the WFD, the EU FD and the Union Civil Protection Mechanism, soft law via communications from the European Commission is used to suggest particular plans of action. The 2013 EU Climate Change Adaptation Strategy recommends adaptation strategies be implemented along with disaster risk management approaches included in the European Civil Protection Mechanism; however, instead of incorporating risks from natural

and man-made disasters, only flood risk at the national and basin level have been implemented pursuant to the EU FD (European Community 2007). Resultantly a growing dichotomy has erupted among the management of sudden-onset and slow-onset disasters. For example, no systematic drought risk assessment has been implemented at the European level – only EU communications on water scarcity and drought have occurred, which suggest ‘best practices’, but do not apply a cycle for implementation (European Commission 2014c). Therefore, while the Danube basin is beginning to consider implications for water scarcity and drought, they are managing it in a similar manner to climate change and have not developed actionable measures for how to address it (ICPDR 2015a).

The projected impacts of climate change to water resources include a variety of established challenges, such as less water in rivers, more intense and high-river flow, more floods and increased risk of both water pollution and decreased water quality connected to erosion, high rainfall events and increased water temperature (Picard 2016). However, climate change impacts extend beyond water resources and the need to consider their effects on vulnerable people¹¹ and systems is becoming increasingly important. The risks from both high and low temperatures have received much attention in Europe and can negatively affect vulnerable populations and groups (i.e., elderly, children, homeless, and people with respiratory disease and asthma) (Bruch and Goldman 2012; European Commission 2014c).

Failure to Integrate Vulnerability

Hazards, like natural climate variability and anthropogenic climate change, contribute to disasters when they intersect with the exposure and vulnerability of human society and natural ecosystems. Resilience is increased through the integration of disaster risk management and

¹¹ This includes children, elderly, poor, malnourished, immunocompromised and others who might be at elevated risk when a disaster occurs. Poverty and common consequences, such as malnutrition, homelessness, poor housing or destitution, are often major contributors to vulnerability.

climate change adaptation, but vulnerability to disasters must be considered. Vulnerability is determined by physical, social, economic and environmental factors and processes, and increases the susceptibility of a community to the impact of hazards (UNISDR 2015). Currently, there is a lack of planning regarding those vulnerable to risk, and it is often new losses that drives political pressure to better map and manage these insecurities [1]. This is also the case for both the Danube and Rhine River basins. Though in the Adaptation Strategy for the Danube, vulnerability of populations is discussed as it pertains to how populations are broadly affected by a changing climate, their flood risk maps are not integrated with population densities or with Inventories of Potential Accidental Risk Spots– which would reflect multi-hazard management inclusive of those at risk when an industrial accident or natech occurs (McClain et al. *in review*; ICPDR 2015a). Linking hazard areas with populations impacted or at risk of exposure, and instituting mechanisms for assessment (i.e., indicators of risk or vulnerability) can be developed into an action plan for the basin, and eventually assist in building resilient systems [1, 3]. Vulnerability is also an important consideration because of various types of refugees (e.g., climate, conflict), internally displaced persons, and stranded migrants [3, 4]. People can be displaced for a variety of reasons, and it is important to know where risks lie by mapping and developing appropriate preparedness measures [1, 2].

Limited Integration of Preparedness Measures

The European Commission’s Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030, discusses how EU policies and directives (e.g., WFD, EU FD, Climate Change Adaptation Strategy, Union Civil Protection Mechanism) support the Sendai Framework and provide a strengthened role for regional organizations to promote a disaster risk-informed and resilience-based agenda (European Commission 2016a). However, translating the Sendai Framework into tangible actions involves implementing coherence among the various directives,

decisions and communications, while also ensuring that these laws and policies are performed at the appropriate administrative level.

The EU macro-regional strategies reflect the ability to manage environmental risks, such as in the Danube strategy, but ensuring actions are multi-hazard in scope and inclusive of preparedness actions (i.e., integrated emergency warning systems) would need to take priority over redundancies among the macro-regional and basin level strategies [2, 3, 4]. Preparedness is recognized as a critical issue for disaster risk reduction, but it hinges on planning for uncertainties related to timing of future extreme weather events (Bruch and Goldman 2012). Efforts to strengthen regional capacity and resilience to prepare and respond to recurring natural and man-made disasters are crucial, and therefore should integrate consideration for actionable measures on climate change.

The concept of ‘building back better’ in the Sendai Framework contains distinct areas in need of addressment, but can also prove quite challenging. For example, explosive growth in some areas is leading to the development of communities in less desirable and environmentally vulnerable areas, including along steep and unstable hillsides, over high-volume pipelines, and in floodplains. Increased growth in urban areas has also amplified vulnerabilities to natural and man-made disasters, including fires, explosions and the dispersal of toxic substances (Bruch and Goldman 2012). Additionally, the number of people living in the 100-year floodplain is predicted to grow from 40 to 150 million over the next century (UN Habitat 2011). When a disaster in these areas occurs, and the risk of the disaster to occur again is high, deciding to rebuild instead of choosing to relocate communities can prove difficult. Climate change can exacerbate these interactions, especially when not integrated into existing management plans. Economic limitations during the time a disaster occurs can also take precedence over issues of ‘building back better’ and the environment [2, 3]. This can prevent an area from being financially or economically capable of

rebuilding (i.e., forcing populations to be relocated), or capable of rebuilding in a capacity that is improved prior to when the disaster occurred (i.e., they cannot ‘build back better’) (Johnson and Olshansky 2016). Fiscal limitations can also reduce the development of measures to mitigate existing risk (i.e., improve structures to regulate floods, build reservoirs for flood retention, develop hydraulic corridors) [1, 2] (Smith 2013). The Rhine basin has a long history of adapting to floods and has included elements of building back better into current Floodrisk Management Plans, but this element is not present in current Danube basin plans. Creating a platform to share knowledge with other basins and improve upon existing preparedness, prevention and development for disaster risk management provides another mechanism for building resilience within the region.

Conclusions

Integrated water resources management, along with basin treaties and their institutions promote cooperation and integration of environmental and natural resource management. The Sendai Framework emphasizes the mainstreaming of resilience into all sectors of human society and development, including laws and policies, and incorporates climate change concerns as an integral element of the approach. The transboundary impacts from disasters can be affected by increased uncertainties of climate change, climatic variation, rapid population, environmental degradation and pollution; therefore, finding the most appropriate levels and mechanisms for cooperation should be established through basin management plans that can be made operational at multiple levels (Nanni 2012). While the frameworks for managing natural and man-made disasters should contain elements of prevention, preparedness, and response at multiple levels, the types of risks being managed in each area will be unique to each basin area.

Experiences in the Danube and the Rhine reflect four key challenges with incorporating resilience into current frameworks structured around integrated water resources management. As conceptualized and implemented, integrated water resources management has difficulties in

acknowledging and managing multiple types of disaster, slow-onset disasters, vulnerability, and preparedness.

The WFD and European Union Civil Protection Mechanism provide possibilities for implementing resilience at higher levels of governance. Accordingly, options for achieving resilience as envisioned by the Sendai Framework include 1) integrating and improving multi-hazard risk into emergency warning systems, risk assessments and maps, and including actionable climate change programs at the basin level; 2) improving risk assessments and maps to include consideration of vulnerability to multiple types of disaster; 3) promoting the linkages between effective preparedness, response and development for multiple types of disaster at the basin level; 4) investigating future cooperation with macro-regional strategies to share the management of risks to natural and man-made disasters and improve overall multi-hazard management at the regional level; and 5) providing opportunities to share lessons learned among basins commissions to support resilience at the basin level.

The nature of integrated water resources management allows for regional responses, including basin commissions, to take a leading role in building resilience. These responses can be improved through the long-term planning approaches used by basin level management (and basin management plans). The Sendai Framework and European policies, directives, and laws support the incorporation of resilience into basin-level management. Achieving these goals of improved resilience will require coordination and integration, both among national governments and between national governments and basin-level institutions; only then, will it be possible to make the necessary institutional and regulatory advances.

CHAPTER 5

SUMMARY

Globally, there are increasing threats from natural and man-made disasters, and natech accidents (natural disasters that trigger technological accidents). Anthropogenic climate change is increasing the frequency and intensity of these disasters. Adaptive strategies aim to reduce vulnerability to long-term changing conditions and improve adaptive capacity (WWF 2009). International frameworks for disaster response that include holistic approaches to natural and man-made disasters, natech accidents, and cascading disasters help to ensure consistent and effective provision of aid (IFRC 2007).

Building resilience to multiple hazards requires focusing not only on reducing vulnerability, but also on managing uncertainties related to climate change. Multilevel governance presents an existing policy framework for adapting to changing environments and therefore higher resilience in river basins and large, complex systems by integrating and implementing adaptive and resilient frameworks among various levels of governance. With this in mind, this dissertation examines the role of multilevel governance in European River basins and sub-basins, particularly in regard to climate change adaptation in the Tisza sub-basin, developing holistic frameworks for responding to natural and man-made disasters in the Danube basin and Tisza sub-basin, and integrating resilience into existing IWRM policies, institutions and practices of the Danube and Rhine River basins.

The first paper explores the elements limiting adaptive governance in the Tisza sub-basin, and considers policy options available to the sub-basin. The Tisza is the largest sub-basin in the Danube River basin and faces increasing water management pressures, which are exacerbated by climate change. The Tisza countries have experienced difficulties with managing climate change in a nested, consistent, and effective manner pursuant to the European Union Water Framework Directive. This is due, in part, to inefficiencies in climate change adaptation, including weakened

vertical coordination. This paper argues there are four key challenges constraining adaptation at the sub-basin level in the Tisza: policy, fiscal, institutional, and capacity. The article concludes that more attention must be paid to frameworks governing adaptation in transboundary sub-basins where resources are limited.

The second paper discusses the distinctions between natural and man-made disasters – how and why they have historically been treated differently and how recent developments in international law and practice are raising questions about the merits of these distinctions. The paper suggests that the distinctions between response to natural and man-made disasters are counterproductive, outdated, and ultimately flawed. The paper concludes that while options for more integrated response to natural and man-made disasters are available, including regional approaches from which to draw examples, current disaster responses remain fragmented in the Danube basin and Tisza sub-basin.

The third and final paper examines the desirability and feasibility of integrating a new approach – resilient IWRM – into the Danube and Rhine River basin management strategies. These basins are intensively used watercourses with historic incidents of natural and man-made disasters, and these incidents are expected to increase due to pressures from climate change. As conceptualized and implemented, IWRM has difficulties in acknowledging and managing multiple types of disaster, slow-onset disasters, vulnerability, and preparedness. This is reflected in the case studies of the Danube and Rhine River basins. This article concludes with a discussion of resilient IWRM as a new conceptual framework, including how it can be applied to other transboundary river basins and multiple levels of governance.

These three studies illustrate the variability of multilevel governance in transboundary river basins, particularly in regard to adaptive governance, response to natural and man-made disasters, and resilient IWRM. The concepts explored and lessons learned can be applied and adapted to

other natural resource issues, as well as other governance systems within various vertical levels of governance. While the first paper explores constraints to adaptation in the Tisza sub-basin, it is a reflection of resource limitations that can occur when nested activities are replicated at multiple levels of governance. Second, while pathologies in resource governance can be replicated at multiple levels, such as distinctions among natural and man-made disasters, new paradigms that improve policies and methodologies need to be updated at multiple levels. Finally, even when policies in multilevel governance are not necessarily in need of improvement, new concepts such as the integration of resilience into IWRM frameworks, may require modification of policy frameworks at multiple levels, as well as among the various sectors involved.

In summary, the principles of adaptive governance, transitioning to holistic frameworks for response to disasters, and resilience are internationally recognized and supported. However, it is the integration and implementation of these principles throughout multiple levels of governance, multiple sectors, and among various actors that continues to prove challenging.

REFERENCES

- Aitsi-Selmi, A., & V. Murray. 2016. The Chernobyl Disaster and Beyond: Implications of the Sendai Framework for Disaster Risk Reduction 2015-2030. *PLOS Medicine* 13(4): 1-4.
- Akamani, K., & P.I. Wilson. 2011. Towards the adaptive governance of transboundary water resources. *Conservation Letters* 4:409-416.
- ASEAN (Association of South East Asian Nations). 2010. *ASEAN Agreement on Disaster Management and Emergency Response: Work Programme 2010-2015*. Jakarta: ASEAN.
- Baaker, M.H.N. 2009. Transboundary River Floods: Examining Countries, International River Basins, and Continents. *Water Policy* 11: 269-288.
- Barchiesi, S., J.C. Sanchez, K. Cross, M. Pérez de Madrid, & A.M. Onencan. 2014. *Adaptation planning: Views towards resilience and up-scaling success to enhance transboundary water governance*. IUCN Environmental Policy and Law Paper No. 75. Gland, Switzerland: IUCN.
- Becker, G. 2005. *Transboundary river basin management regimes: The Tisza Basin case study*. Background Report to Deliverable 1.3.1. Amsterdam: NeWater.
- Bruch, C. 2009. Adaptive water management: Strengthening laws to cope with uncertainty. In *Water Management Beyond 2020*, A.K. Biswas, C. Torjada, & R. Izquierdo, Eds., 89-113. Berlin: Springer.
- Bruch, C., and L. Goldman. 2012. Keeping Up with the Megatrends: The Implications of Climate Change and Urbanization for Environmental Emergency Preparedness and Response. Geneva: Joint UNEP/OCHA Environment Unit.
- Bruch, C., & J. Troell. 2011. Legalizing adaptation: Water law in a changing climate. *Water International* 36(7): 828-845.
- Bruch, C., L. Janksy, M. Nakayama, & K. Salewicz (Eds.), 2005. *Public participation in the governance of international freshwater resources*. Tokyo: UNU Press.
- Bruch, C., R. Nijenhuis, & S.N. McClain. 2016. International Frameworks Governing Environmental Emergency Preparedness and Response: An Assessment of Approaches. In *The Role of International Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David Fisher eds. Leiden: Brill Nijhoff.
- BSEC (Black Sea Economic Cooperation). 1998. *Agreement among the Governments of the Participating States of the Black Sea Economic Cooperation (BSEC) on Collaboration in Emergency Assistance and Emergency Response to Natural and Man-Made Disasters*. <http://www.bsec->

organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf.

Caponera, D.A. 2007. *Principles of water law and administration: National and international*. London: Taylor & Francis.

Carpathian Convention. 2006. "Framework convention on the protection and sustainable development of the Carpathians". Kyiv, January.

Csagoly, P. 2000. *The cyanide spill at Baia Mare, Romania: Before, during and after*. Szentendre: Regional Environmental Centre.

Cutter, S.L. & C.T. Emrich. 2006. Moral Hazard, Social Catastrophe: The Changing Face of Vulnerability along the Hurricane Coasts. *American Academy of Political and Social Science* 604:102-112.

Del Moral, L., & A. Do Ó. 2014. Water governance and scalar politics across multiple-boundary river basins: States, catchments, and regional powers in the Iberian Peninsula. *Water International* 39(3): 333-347.

Dellapenna, J. W., & J. Gupta. 2009. The Evolution of Global Water Law. In *The Evolution of the Law and Politics of Water*, J. W. Dellapenna and J. Gupta, Eds., 3–19. Delft, Netherlands: Springer. http://link.springer.com/chapter/10.1007/978-1-4020-9867-3_1.

Dietz, T., E. Ostrom, & P.C. Stern. 2003. The struggle to govern the commons. *Science* 302: 1907-1912.

Dunai, M. 2010. Hungary Declares Emergency after Red Sludge Spill. *Reuters*, October 5. <http://in.reuters.com/article/idINIndia-51952420101005>.

Ekstrom, J.A., & Young, O.R. 2009. Evaluating functional fit between a set of institutions and an ecosystem. *Ecology and Society* 14(2): 16.

EPRS (European Parliamentary Research Service). 2015. The EU Strategy for the Danube Region: Briefing. PE 557.024. [http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557024/EPRS_BRI\(2015\)557024_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557024/EPRS_BRI(2015)557024_EN.pdf).

European Commission. 2010. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions: European Strategy for the Danube Region*. COM (2010) 715 Final.

European Commission. 2013a. *Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions Concerning the Added Value of Macro-Regional Strategies*. COM (2013) 468 Final.

http://ec.europa.eu/regional_policy/sources/docoffic/official/communic/baltic/com_add_ed_value_macro_region_strategy_en.pdf.

- European Commission. 2013b. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An EU Strategy on Adaptation to Climate Change*. COM (2013)216FINAL.
- European Commission. 2014a. *Links Between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC)*. Technical Report – 2014-078.
- European Commission. 2014b. *Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Concerning the Governance of Macro-Regional Strategies*. COM (2014) 284 Final. http://ec.europa.eu/regional_policy/index.cfm/en/policy/cooperation/macro-regional-strategies/.
- European Commission. 2014c. *Overview of Natural and Man-made Disaster Risks in the EU*. SWD (2014) 134 Final. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0134&from=es>.
- European Commission. 2016a. *Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030: A Disaster Risk-Informed Approach for all EU Policies*. SWD (2016)205 Final/2. http://ec.europa.eu/echo/sites/echo-site/files/1_en_document_travail_service_part1_v2.pdf.
- European Commission. 2016b. *EU Civil Protection Mechanism*. 2 July. http://ec.europa.eu/echo/what/civil-protection/mechanism_en.
- European Community. 1982. Council Directive of 24 June 1982 on the Major-Accident Hazards of Certain Industrial Activities. *Official Journal of the European Communities* L230, pp. 01-18.
- European Community. 1992. Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna. *Official Journal of the European Communities*, L206, pp. 007-50.
- European Community. 1996. Council Directive of 9 December 1996 on the Control of Major-Accident Hazards Involving Dangerous Substances. *Official Journal of the European Union*. L010, pp. 13.
- European Community. 2000. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Communities* L327, pp. 01-73.

- European Community. 2003. Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No. 1. *Official Journal of the European Communities* L2985, pp. 01-270.
- European Community. 2007. Directive 2007/60/EC on the assessment and management of flood risks. *Official Journal of the European Communities*, L288, pp. 27-34.
- European Community. 2009. Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the Conservation of Wild Birds. *Official Journal of the European Communities*, L20, pp. 07-25.
- European Community. 2010. Consolidated Versions of the Treaty on European Union and the Treaty on the Functioning of the European Union. *Official Journal of the European Communities* 2010/C83/01 and 2010/C83/02, pp. 01-403.
- European Community. 2012. Council Directive of 4 July 2012 on the Control of Major-Accident Hazards Involving Dangerous Substances, Amending and Subsequently Repealing Council Directive 96/82/EC. *Official Journal of the European Union* L197, pp. 01-37.
- European Community. 2013. Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism. *Official Journal of the European Union* L347, pp. 924-946.
- European Parliament. 2004. *The Principle of Subsidiarity*. European Parliament Fact Sheets. http://www.europarl.europa.eu/facts_2004/1_2_2_en.htm.
- European Union. 2012. Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the Control of Major-Accident Hazards Involving Dangerous Substances, Amending and Subsequently Repealing Council Directive 96/82/EC. *Official Journal of the European Union* L197, pp. 01-37.
- European Union Member States. 2012. Consolidated Version of the Treaty on European Union and the Treaty on the Functioning of the European Union. *Official Journal of the European Union* C326, pp. 01-390.
- EUSDR (European Union Strategy for the Danube Region). 2015. *Danube Region Strategy Priority Area 5: To Manage Environmental Risks*. Coordinated by Hungary and Romania. June.
- Finger, M., L. Tamiotti, & J. Allouche Eds. 2006. *The multi-governance of water: Four case studies*. Albany: State University of New York Press.
- Fisher, D. 2008. The Law of International Disaster Response: Overview and Ramifications. *International Law Studies* 83: 293-320.

- Folke, C., T. Hahn, P. Olsson, & J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environmental Resources* 30: 441-473.
- GHA (Global Humanitarian Assistance). 2013. Global Humanitarian Assistance Report. Bristol: GHA.
- Giordano, M. and T. Shah. 2014. From IWRM back to Integrated Water Resources Management. *International Journal of Water Resources Development* 30(3): 364-376.
- Gleick, P. 2000. The changing water paradigm: A look at twenty-first century water resources development. *Water International* 25(1): 127-138.
- Greger, M. 2007. The Human/Animal Interface: Emergence and Resurgence of Zoonotic Infectious Diseases. *Critical Reviews in Microbiology* 33: 243-299.
- Greiving, S., S. Pratzler –Wanczura, K. Sapountzaki, F. Ferri, P. Grifoni, K. Firus, and G. Xanthopoulos. 2012. Linking the actors and policies throughout the management cycle by “Agreement on Objectives” – a new output-oriented approach. *Natural Hazards and Earth Systems Sciences* 12: 1085-1107.
- Griggs, N.S. 2015. Misalignment of watershed and jurisdictional boundaries: The importance of scale. *Water Policy* 17(6): 1079-1092.
- Grünewald, U. 2008. Voraussetzungen für eine erfolgreiche Flussgebietsbewirtschaftung: Klare einzugsgebietsbezogene Ursachen-Wirkungs-Analysen und klares einzugsgebietsbezogenes Handeln [Conditions for successful river basin management: Catchment-based cause-effect analysis and clear catchment-related action]. *Korrespondenz Wasserwirtschaft* 1(8): 423-426.
- Gupta, J., C. Termeer, J. Klostermann,, S. Meijerink, M. Van den Brink, P. Jong, S. Nooteboom, & E. Bergsma. 2010. The adaptive capacity wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science & Policy* 13: 459-471.
- GWP (Global Water Partnership). 2000. Integrated Water Resources Management. TAC Background Paper No. 4. Stockholm: GWP.
- GWP (Global Water Partnership). 2005. Catalyzing Change: A Handbook for Developing Integrated Water Resources Management (IWRM) and Water Efficiency Strategies. Stockholm: GWP. http://www.unwater.org/downloads/Catalyzing_change-final.pdf.
- Hassing, J., N. Ipsen, T.J. Claussen, H. Larsen, and P. Lindgaard-Jørgensen. 2009. Integrated Water Resources Management in Action. The United Nations World Water Assessment Programme Dialogue Paper. Paris: UNESCO.
- Huitema, D., E. Mosert, W. Egas, S. Moellenkamp, C. Pahl-Wostl, & R. Yalcin. 2009. Adaptive water governance: Assessing the institutional prescriptions of adaptive (co-)

- management from a governance perspective and defining a research agenda. *Ecology and Society* 14(1): 26.
- Huntjens, P., C. Pahl-Wostl, & J. Grin. 2010. Climate change adaptation in European River basins. *Regional Environmental Change* 10(4): 263-284.
- Huppert, H.E., & R.S.J. Sparks. 2007. Extreme Natural Hazards: Population Growth, Globalization and Environmental Change. *Philosophical Transactions of the Royal Society* 364: 1875-1888.
- ICPDR (International Commission for the Protection of the Danube River). 1994. *Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Danube River Protection Convention)*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2001. *Inventory of Potential Accidental Risk Spots in the Danube River Basin*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2008a. *Analysis of the Tisza River Basin 2007*. Vienna: ICPDR.
http://www.icpdr.org/main/sites/default/files/Tisza_RB_Analysis_2007.pdf.
- ICPDR (International Commission for the Protection of the Danube River). 2008b. *Analysis of the Danube Floods 2006*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2009a. *Danube River District Management Plan*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2009b. *Sub-basin Level Flood Action Plan Tisza River Basin*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2009c. *Assessment of Flood Monitoring and Forecasting in the Danube River Basin*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2010a. *Danube Declaration Adopted at the Ministerial Meeting, February 16, 2010*. Ministerial Declaration, Vienna.
- ICPDR (International Commission for the Protection of the Danube River). 2010b. *New International System for Early Flood Warning in Danube River Basin Launched*. March.
- ICPDR (International Commission for the Protection of the Danube River). 2011a. *Strengthening of the Tisza River Basin Coordination: Towards the Implementation of the Integrated Tisza River Basin Management Plan Supporting the Sustainable Development of the Region*, April 11th. Memorandum of Understanding, Uzhgorod.

- ICPDR (International Commission for the Protection of the Danube River). 2011b. *Integrated Tisza River Basin Management Plan*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2013. *ICPDR Strategy on Adaptation to Climate Change*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2014. *International Operations Manual for PIACs of the Danube AEWS*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2015a. *Danube River Basin District Management Plan - update 2015*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2015b. *Flood Risk Management Plan for the Danube River Basin District*. Vienna: ICPDR.
- ICPDR (International Commission for the Protection of the Danube River). 2016. *Danube Declaration: Water Management in the Danube River Basin: Integration and Solidarity in the Most International River Basin of the World*. Vienna: ICPDR.
- ICPR (International Commission for the Protection of the Rhine). 1999. *Convention on the Protection of the Rhine*. Bern: ICPR.
- ICPR (International Commission for the Protection of the Rhine). 2003. *Outcome of the Rhine Action Programme*. Koblenz: ICPR.
- ICPR (International Commission for the Protection of the Rhine). 2013. *15th Conference of Rhine Ministers*. Communiqué of Ministers. Basel: ICPR.
- ICPR (International Commission for the Protection of the Rhine). 2015a. *Strategy for the IRBD Rhine for Adapting to Climate Change*. Koblenz: ICPR.
- ICPR (International Commission for the Protection of the Rhine). 2015b. *International Basin Management Plan for the Rhine*. Koblenz: ICPR.
- ICPR (International Commission for the Protection of the Rhine). 2015c. *Internationally Coordinated Floodrisk Management Plan for the International River Basin District Rhine (Part A)*. Koblenz: ICPR.
- ICWE (International Conference on Water and the Environment). 1992. *The Dublin Statement on Water and Sustainable Development*. <http://www.un-documents.net/h2o-dub.htm>.
- IFRC (International Federation of Red Cross and Red Crescent Societies). 2004. *World Disasters Report: Focus on Community Resilience*. Geneva: IFRC.
- IFRC (International Federation of Red Cross and Red Crescent Societies). 2006. *World Disasters Report: Focus on Neglected Crises*. Geneva: ATAR Roto Presse.

- IFRC (International Federation of Red Cross and Red Crescent Societies). 2007. *Law and Legal Issues in International Disaster Response: A Desk Study*. Geneva: IFRC.
- IFRC (International Federation of Red Cross and Red Crescent Societies). 2013. *Responding to Silent Disasters. IFRC Annual Report*. Geneva: IFRC.
- International Law Commission. 1966. Draft articles on the Law of Treaties with Commentaries. *Yearbook of the International Law Commission*, Vol. II. A/CN.4/SER.A/1966/Add.1. New York: United Nations.
- INSARAG (International Search and Rescue Advisory Group). 2016. *United Nations General Assembly Resolution*. Accessed 17 June. <http://www.insarag.org/en/about/ga-resolution.html>.
- IUCN (International Union for the Conservation for Nature). 2015. The International Commission for the Protection of the Rhine. In *Share Toolkit: Case Studies* Christina Leb Ed. Gland: IUCN.
- JEU (Joint United Nations Environment Programme (UNEP)/Office for the Coordination of Humanitarian Affairs (OCHA) Environment Unit). 2000. *Cyanide Spill at Baia Mare Romania: Spill of Liquid and Suspended Waste at the Aurul S.A. Retreatment Plant*. Geneva: OCHA.
- Johnson, L.A., and R.B. Olshansky. 2016. After Great Disasters: How Six Countries Managed Community Recovery. Policy Focus Report. Cambridge: Lincoln Institute of Land Policy.
- Jones, L., R. Bernknopf, S. Cannon, D.A. Cox, L. Gaydos, J. Keeley, M. Kohler, H. Lee, D. Ponti, S. Ross, S. Schwarzbach, M. Shulters, A.W. Ward, and A. Wein. 2007. Increasing Resiliency to Natural Hazards: A Strategic Plan for the Multi-Hazards Demonstration Project in Southern California. Open File Report 2007-1255. Reston: USGS.
- Krausmann, E., & D. Baranzini. 2012. Natech Risk Reduction in the European Union. *Journal of Risk Research* 15(8): 1027-1047.
- Kuhlmann, S. 2001. Future governance of innovation policy in Europe – Three scenarios. *Research Policy* 30: 953-976.
- Legere, L. 2016. State Seismic Network Helps Tell Fracking Quakes from Natural Ones. *Pittsburgh Post-Gazette*. June 26. <http://powersource.post-gazette.com/powersource/policy-powersource/2016/06/26/State-seismic-network-helps-tell-fracking-quakes-from-natural-ones/stories/201606210014>.
- Linnerooth-Bayer, J., L. Eckenberg, & A. Vári. 2013. Catastrophe Models and Policy Processes: Managing Flood Risk in the Hungarian Tisza River Basin – An introduction.

- in *Integrated Catastrophe Risk Modeling: Supporting Policy Processes*, A. Amendola et al. Eds., 171-179. Dordrecht: Springer Science.
- Lyster, R. 2016. A Capabilities Approach to Defining Climate Disasters. In *The Role of International Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David Fisher Eds. Leiden: Brill Nijhoff.
- Marshall, G.R. 2008. Nesting, subsidiarity, and community-based environmental governance beyond the local level. *International Journal of the Commons* 2(1): 75-97.
- McCaffrey, S.C. 2014. The entry into force of the 1997 watercourses convention. *International Water Law Project Blog*, May 25.
<http://www.internationalwaterlaw.org/blog/2014/05/25/dr-stephen-mccaffrey-the-entry-into-force-of-the-1997-watercourses-convention/>.
- McClain, S.N., C. Bruch, S. Secchi. 2016. Adaptation in the Tisza: Innovation and Tribulation at the Sub-basin Level. *Water International* 0: 1-23.
- McClain, S.N., C. Bruch, and S. Secchi. Under Review. What Does Nature Have to Do With It? Reconsidering Distinctions in Policy Frameworks for Disaster Response in the Danube Basin. *Natural Hazards and Earth Systems Science*.
- Medema, W., B.S. McIntosh, and P.J. Jeffrey. 2008. From Premise to Practice: A Critical Assessment of Integrated Water Resources Management and Adaptive Management Approaches in the Water Sector. *Ecology and Society* 13(2): 29.
- Moss, T. 2012. Spatial fit, from panacea to practice: Implementing the EU water framework directive. *Ecology and Society* 17(3):2.
- Munaretto, S., G. Siciliano, & M.E. Turvani. 2014. Integrating adaptive governance and participatory multicriteria methods: A Framework for Climate Adaptation Governance. *Ecology & Society* 19 (2): 74.
- Munich Re. 2005. Topics Geo Annual Review: Natural Catastrophes 2005. *Geo Risks Research*. Munich: Munich Re Group.
- Munich Re. 2007. From Knowledge to Action: Microinsurance Aspects in Agriculture. Munich: Munich Re Group.
- Munich Re. 2016. Group Annual Report 2015. Munich: Munich Re Group.
- Nagy, I., F. Ligetvári, & F. Schweitzer. 2010. Tisza River valley: Future Prospects. *Hungarian Geographical Bulletin* 59(4): 361-370.
- Nanni, M. 2012. Legislation as a tool in support of adaptive water management in response to climate change. *Water International* 37(6): 628-639.

- Nashipili, N.J., R. dos Santos, Z.Y. Noor, K. Schwartz, W. Douven, & F. Jaspers. 2008. *The Performance of River Basin Organizations: A Comparative Study of River Basin Organizations in Namibia, Indonesia and Brazil*. UNESCO-IHE Institute for Water Education, EGU General Assembly, Geophysical Research Abstracts, Vol. 10.
- NDGDM (National Directorate General for Disaster Management). 2010. Red Sludge – Hungary 2010. Ministry of the Interior. Budapest: Ministry of the Interior.
http://www.katasztrofavedelem.hu/index2.php?pageid=szervezet_red_sludge_2010&lang=eng.
- Nekoul, F.M., & A. Drexler. 2016. Do Insurers in Catastrophe-prone Regions Buy Enough Reinsurance? *Chicago Fed Letter* No 360.
<https://www.chicagofed.org/~media/publications/chicago-fed-letter/2016/cfl360-pdf.pdf>.
- NERC (Natural Environmental Research Council). 2014. UNDAC Landslide Advisory Visit to Serbia June 2014. Open Report IR/14/043. P. Hobbs Ed. Keyword: British Geological Survey.
- Newig, J., & O. Fritsch. 2009. Environmental governance: Participatory, multilevel - and effective? *Environmental Policy and Governance* 19: 197-214.
- Nijenhuis, R. 2014. The International Environmental Emergencies Response System: A Case Study of Super typhoon Haiyan (Yolanda), the Philippines. *Asian Journal of Environment and Disaster Management* 6(2): 175-190.
- OECD (Organization for Economic Cooperation and Development). 2014. Boosting Resilience through Innovative Risk Governance. Paris: OECD.
- OECD (Organization for Economic Cooperation and Development). 2015. Addendum No. 2 to the OECD Guiding Principles for Chemical Accident Prevention, Preparedness, and Response (2nd Ed.) to Address Natural Hazards Triggering Technological Accidents (Natechs).
[http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono\(2015\)1&doclanguage=en](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2015)1&doclanguage=en).
- Pahl-Wostl, C., J. Sendzimir, P. Jeffrey, J. Aerts, G. Berkamp, & K. Cross. 2007. Managing change toward adaptive water management through social learning. *Ecology and Society* 12(2): 30.
- Pahl-Wostl, C. 2009. A conceptual framework for analyzing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change* 19: 354-365.
- Pahl-Wostl, C., P. Jeffrey, & J. Sendzimir. 2011. Adaptive and Integrated Management of

- Water Resources. In *Water Resources Planning and Management* R Q. Grafton and K. Hussey Eds. Cambridge: University Press.
- Pahl-Wostl, C., G. Becker, J. Sendzimir, & C. Knieper. 2013. How Multilevel Societal Learning Processes Facilitate Transformative Change: A Comparative Case Study Analysis on Flood Management. *Ecology and Society* 18(4): 58.
- Patton, C., D. Sawicki, & J. Clark. 2013. *Basic Methods of Policy Analysis and Planning*. Geneva: Pearson Education.
- Peel, D. & J. Fisher. 2016. International Law at the Intersection of Environmental Protection and Disaster Risk Reduction. In *The Role of International Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David Fisher Eds. Leiden: Brill Nijhoff.
- Picard, M. 2016. Water Treaty Regimes as a Vehicle for Cooperation to Reduce Water-Related Disaster Risk: The Case of Southern Africa and the Zambesi Basin. In *The Role of International Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David Fisher eds. Leiden: Brill Nijhoff.
- Rose, A. 2009. Economic Resilience to Disasters. *Published Articles & Papers*. Paper 75. http://research.create.usc.edu/published_papers/75.
- Rosenau, J.N. 1992. Governance, Order, and Change in World Politics. In *Governance Without Government: Order and Change in World Politics*, J.N. Rosenau & E.O. Czempiel Eds., 1-29. Cambridge: Cambridge University Press.
- Rozario, K. 2007. *The Culture of Calamity: Disaster & the Making of Modern America*. Chicago: University of Chicago Press.
- Sands, P. 2007. The Development of the 1997 Convention on the Non-Navigational Uses of International Watercourses by the International Law Commission. In *International Environmental Law: Cases, Materials, Problems*, D.K. Anton, J.I. Charney, P. Sands, T. Shoenbaum, and M. Young Eds. 800-801. New Jersey, USA: LexisNexis.
- Schneider, E. 2010. Floodplain Restoration of Large European Rivers, with Examples from the Rhine and the Danube. In *Restoration of Lakes, Streams, Floodplains, and Bogs in Europe: Principles and Case Studies*, 185–223. USA: Springer Science.
- Schneller, K., G. Bálint, A. Chicos, M. Csete, J. Dzurdenik, A. Göncz, Petrisor, T. Jaroslav, & T. Pálvolgyi. 2013. Climate Change Impacts on the Hungarian, Romanian, and Slovak Territories of the Tisza Catchment Area. In *European Climate Vulnerabilities and Adaptation: A Spatial Planning Perspective*, P. Schmidt-Thomé and S. Greiving, Eds., 205-229. Chichester, West Sussex: Wiley Blackwell.
- Sendzimir, J., P. Magnuszewski, P. Balogh, & A. Vári. 2007. Anticipatory modeling of biocomplexity in the Tisza River basin: First steps to establish a participatory adaptive

- framework. *Environmental Modelling & Software* 22: 599-609.
- Sendzimir, J., P. Magnuszewski, Z. Flachner, P. Balogh, G. Molnar, A. Sarvari, & Z. Nagy. 2008. Assessing the resilience of a river management regime: Informal learning in a shadow network in the Tisza River basin. *Ecology and Society* 13(1):11.
- Sendzimir, J., Z. Flachner, C. Pahl-Wostl, & C. Knieper. 2010. Stalled regime transition in the upper Tisza River basin: The dynamics of linked action situations. *Environmental Science & Policy* 13: 604-619.
- Smith, K. 2013. *Environmental Hazards: Assessing Risk and Reducing Hazard*. New York: Routledge.
- Stone, R. 2008. Three Gorges Dam: Into the Unknown. *Science* 321(5889): 628-632.
- Swiss Re. 2016. *Natural Catastrophes and Man-Made Disasters in 2015: Asia Suffers Substantial Losses*. Sigma Report No 1/2016. Zurich: Swiss Re.
- Troell, J., & G. Swanson. 2014. *Adaptive Water Governance and the Principles of International Water Law*. IUCN Environmental Policy and Law Paper No. 75. Gland, Switzerland: IUCN.
- UN (United Nations). 1997. *Convention on the Law of the Non-Navigational Uses of International Watercourses*. Doc. A/51/869.
https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVII-12&chapter=27&lang=en#EndDec.
- UN (United Nations). 2003. *Strengthening the Effectiveness and Coordination of International Urban Search and Rescue Assistance*. Official Records of the General Assembly. Fifty-Seventh Session. A/RES/57/150.
- UNCED (United Nations Conference on Environment and Development). 1992. *Agenda 21: Programme for Action for Sustainable Development*. A/Conf.151/26(1992).
<http://sustainabledevelopment.un.org/index.php?page=view&nr=23&type=400&menu=35>.
- UNECE (United Nations Economic Commission for Europe). 1992. *Convention on the Protection and Use of Transboundary Watercourses and International Lakes*. Helsinki: UNECE. <http://www.unece.org/fileadmin/DAM/env/water/pdf/watercon.pdf>.
- UNECE (United Nations Economic Commission for Europe). 2009. *Guidance on Water and Adaptation to Climate Change*. Geneva: United Nations.
- UNECE (United Nations Economic Commission for Europe). 2010. *Guidance on Water and Adaptation to Climate Change*. Geneva: UN.

- UNECE (United Nations Economic Commission for Europe). 2011. *Second Assessment of Transboundary Rivers, Lakes and Groundwaters*. New York and Geneva: UNECE.
- UNEP (United Nations Environment Programme). 2002. *Atlas of International Freshwater Agreements*. Nairobi: UNEP.
- UNEP (United Nations Environment Programme). 2011. *Enhanced Coordination Across the United Nations System, Including the Environment Management Group*. Twenty-Sixth Session. UNEP/GC.26/15.
- UNEP (United Nations Environment Programme). 2014a. *Freshwater Law and Governance: Global and Regional Perspectives for Sustainability*. Paper presented at the First International Environment Forum for Basin Organizations, Nairobi, Kenya, 26-28 November.
- UNEP (United Nations Environment Programme). 2014b. *Towards Integrated Water Resources Management: International Experiences in Development of River Basin Organizations*. Khartoum: UNEP.
- UNHCR (United Nations High Commissioner for Refugees). 2016. *UNHCR, Displacement and Disaster Risk Reduction*. Geneva: UNHCR.
- UN Habitat. 2011. *Global Report on Human Settlements: Cities and Climate Change*. London: Earthscan.
- UNISDR (United Nations International Strategy for Disaster Reduction). 2015. *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva: UNISDR. http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf.
- Varis, O., K. Enckell, and M. Keskinen. 2014. Integrated Water Resources Management: Horizontal and Vertical Explorations and the 'Water in All Policies' Approach. *International Journal of Water Resources Development* 20(3): 433-444.
- Verchick, R. 2012. Disaster Justice: The Geography of Human Capability. *Duke Environmental Law & Policy Forum* 23: 23-71.
- von Keitz, S., & Kessler, P. 2008. Grenzen des Flußgebietsmanagements. Folgt die Wasserwirtschaft dem Falschen Ansatz? [Limits of water basin management: Is water management following the right approach?] *Korrespondenz Wasserwirtschaft* 1(7): 354-360.
- Walker, B., C.S. Holling, S.R. Carpenter, and A. Kinzig. 2004. Resilience, Adaptability, and Transformability in Social-Ecological Systems. *Ecology and Society* 9(2): 5.
- Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology* 1(2): 1.

- Werners, S.E., Z. Flachner, P. Matczak, M. Falaleeva, & R. Leemans. 2009. Exploring earth system governance: A case study of floodplain management along the Tisza River in Hungary. *Global Environmental Change* 19(4): 503-511.
- Werners, S.E., J. West, R. Leemans, J.D. Tàbara, X. Dai, Z. Flachner, F. Cots, H. Neufeldt, D. McEvoy, & G. Trombi. 2011. Opportunities and Constraints for Climate Adaptation in Regional Water and Land Use Planning. In *The Economic, Social and Political Elements of Climate Change*, W. Leal Filho, Ed., 669–692. Berlin: Springer.
- WWF (World Wildlife Fund). 2003. *Managing Rivers Wisely: Lessons from WWF’s Work for Integrated River Basin Management. Introduction, Synthesis and Case Studies.* Washington, DC: WWF.
- WWF (World Wildlife Fund). 2009. *Shifting Course: Climate Adaptation for Water Management Institutions.* Washington, DC: WWF.
- Wyborn, C.N. 2015. Connecting knowledge with action through coproductive capacities: Adaptive governance and connectivity conservation. *Ecology & Society* 20(1): 11.

VITA

Graduate School
Southern Illinois University

Shanna N. McClain

shannamcclain@hotmail.com

Florida State University
Bachelor of Arts, Environmental Science and Spanish, May 2003

Florida International University
Master of Science, Environmental Studies, August 2010

Awards:

Phi Kappa Phi Love of Learning Scholarship, 2015
University Women's Professional Advancement Award, 2015
NSF IGERT Fellowship, Southern Illinois University Carbondale, 2012-2016
Florida Occupational Merit Scholar, 1996-1997
National Honor Society Scholarship, 1996-1999

Dissertation Title:

Multilevel governance in European River basins: Challenges in the integration of adaptation, disaster response, and resilience

Major Professors: Silvia Secchi and Carl Bruch

Publications:

McClain, S.N., C. Bruch, and S. Secchi. 2016. Adaptation in the Tisza: Innovation and Tribulation at the Sub-basin level. *Water International* 41(6): 813-834.

Bruch, C., R. Nijenhuis, S. McClain. 2016. International Frameworks Governing Environmental Emergency Preparedness and Response. In *The Role of International Environmental Law in Disaster Risk Reduction*, J. Peel and D. Fisher Eds. Leiden: Brill Nijhoff.

McClain, S.N., C. Bruch, S. Secchi, and J.W.F. Remo. Under Review. What does nature have to do with it? Reconsidering distinctions in international disaster response frameworks in the Danube basin. *Natural Hazards and Earth Systems Science*.

McClain, S.N., S. Secchi, J.W.F. Remo, and C. Bruch. In Progress. Resilient Integrated Water Resources Management: Implications for a new paradigm for the Danube and Rhine River basins.

Reports:

Guida, R., S.N. McClain, H. Marler, A. Marshall, J. Paul, T. Swanson, and W. Cherry. 2014. *Tisza River Connectivity: Past losses, present dynamics, and future opportunities*. NSF IGERT Report. Southern Illinois University, Carbondale, IL.

McClain, S.N, R. Guida, A. Marshall, H. Marler, T. Swanson, B. Cherry, and J. Paul. 2012. *Toward an Equitable and Sustainable Management Structure for the Upper Colorado River Basin*. NSF IGERT Report.