The Role of International River Basin Organizations in Facilitating Science Use in Policy

Kelsey Wentling

University of Massachusetts Amherst

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The Role of International River Basin Organizations in Facilitating Science Use in Policy

Kelsey Wentling

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THEROLEOFINTERNATIONALRIVERBASINORGANIZATIONSIN
FACILITATING SCIENCE USE IN POLICY

A Thesis Presented
by
KELSEY J. WENTLING

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

SEPTEMBER 2019

Environmental Policy and Human Dimensions
THE ROLE OF INTERNATIONAL RIVER BASIN ORGANIZATIONS
IN FACILITATING SCIENCE USE IN POLICY

A Thesis Presented

By

KELSEY J. WENTLING

Approved as to style and content by:

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(Curt Griffin, Department Head, Environmental Conservation)
ACKNOWLEDGMENTS

This research was supported by National Socio-Environmental Synthesis Center, which is funded through an award to the University of Maryland from the National Science Foundation. Thank you to Deepti Kamma, Michael Palanshak, Jill Banach, Michael Roberts, Tamee Albrecht and Andrea Gerlak for their help in collecting an abundance of data for the case study background information.

I would also like to extend my gratitude to Dr. Anita Milman whose patient and thorough feedback not only helped me to produce better work, but also taught me the skills of research, critical thinking and careful writing. Thanks are also due to Dr. Charles Schweik for his questions and critical eye which helped to refined and improve my research.

Finally, thank you to my fellow graduate students, friends and my family. Thanks to Francesco Cirillo for understanding that good work comes in batches of 25 minutes and Bart of Bart’s Ice Cream for giving me something good to look forward to at the end of 25 minutes.
ABSTRACT

THE ROLE OF INTERNATIONAL RIVER BASIN ORGANIZATIONS IN FACILITATING SCIENCE USE IN POLICY

SEPTEMBER 2019

KELSEY WENTLING, B.S, UNIVERSITY OF DELAWARE
M.S.UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Anita Milman

Transboundary watershed management seeks to reconcile the dichotomy between political lines and the resources that flow freely over such borders. Transboundary waters cover half of the earth’s surface and define the natural communities of over 40% of the global population. Because water plays an integral role in every culture and society, international entities seek to identify the principles and methods that minimize conflict and maximize harmonious water resource management across borders. Successful management practices to date have aimed to incorporate relevant scientific literature throughout the basin using alternate governance structures. International River Basin Organizations (IRBOs), independent governing structures, provide one such method of governance along shared water bodies. In order to determine how science influences policy and management in IRBOs, this research examines five case studies across three IRBOs: The International Joint Commission, the International Commission for the Protection of the Danube and the Mekong River Commission. To understand the gap between science production and its incorporation into IRBO policies, we conducted a comprehensive literature review and
applied the findings from existing scientific literature to understand science-policy process in
the five case studies. Within each case study we traced the story of science production and its uptake into policy by highlighting two types of key information in the process: the role of mandates and IRBO structure, and the IRBO’s relationship with relevant actors. Through this process we identified and explored the gap between science production and policy action, demonstrating which mechanisms are essential for generating policy founded on scientific research.
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CHAPTER 1
INTRODUCTION

Water managers must contend with uncertainty surrounding water quantity and quality, (De Stefano et al. 2010, Drieschova et al. 2010) as well as the shifts in hydrological patterns (Pahl-Wolst 2007, Bates et al. 2008, UN 2008). Such stresses on global water resources are exacerbated by heightened water demand and the resulting potential for conflict over water resources (Bates et al. 2008, Pahl-Wolst 2009). Rapid changes in social and ecological dynamics, in conjunction with increases in extreme water events, such as flooding or drought, contribute to water management challenges (Pahl-Wostl 2009, Bates et al. 2008).

Globally, over half of the Earth’s freshwater resources flow across political borders, accounting for 276 lake and river basins, which are home to 40% of the world’s population (UN 2008, Munia 2016). Shared water between nations can create interdependencies, but differences between riparian countries such as political leanings, infrastructure, economy and water resources present further challenges to cooperative transboundary water management (UN 2008).

The production of scientific knowledge can be instrumental in reducing water-related risks and mitigating stressors in transboundary river basins. Scientific knowledge can help identify the root causes of water challenges and their potential solutions by allowing natural resource managers to track emerging concerns (Armitage et al. 2015) and identify possible policy outcomes and their consequences, thereby helping decision-makers select scientifically-supported responses to policy issues (Steel et al. 2004, Karl et al. 2007,
Additionally, sharing scientific knowledge and data among riparian countries builds trust between countries, bolstering international cooperation, reducing uncertainty, and strengthening the adaptive capacity of the ecosystem (Thu and When 2016). Data sharing can also lead to cooperation through aiding the development of norms and shared understandings (Jasanoff 2004 pg 3, Soomai 2017). Transboundary cooperation is enhanced by this exchange of information across international boundaries, (Timmerman and Langaas 2003, 2005) as it allows for riparian countries to communicate across borders. However, the effective production and use of science is not a straightforward or linear process. A large body of scholarship examining the relationship between science and policy indicates, that, as often as not, science is not used in policy-making (Owens 2005, Young 2008, Beck 2010 Koetz 2012). The reasons for this are many, but often related to the manner in which the science was produced, the fit between that science and decision-making processes, as well as the socio-political factors influencing perceptions of science and how decision-making occurs (White et al. 2008, Beck 2010, Sarkki et al. 2015, Dunn et al. 2018).

In the transboundary river basin context, International River Basin Organizations (IRBOs) are the primary actors responsible for addressing water issues and facilitating science production and its use in policy on the basin scale; therefore, they serve as an important means to understanding common characteristics for balancing ecosystem and human needs in transboundary river basins. IRBOs include 81 formal governing organizations set up by countries to help coordinate shared water management; succinctly, IRBOs are, “institutionalized means for international water resources governance” (Schmeier et al. 2016). In their role as basin coordinators, IRBOs govern as representatives
of riparian countries in the basin, contributing expert opinion as well as management and moderating conflict (Heikkila et al. 2013). As such, IRBOs facilitate a system-wide governance approach and promote adaptive and integrated water management (Bouckaert et al. 2018, Blomquist 2005, Huitema and Meijerink 2017). In addition to the roles of balancing interests among member countries and stakeholders and minimizing conflict, IRBOs also oversee the production of science and its eventual use in suggesting or drafting policy recommendations for member countries.

Scholars have identified and examined the broad ways in which IRBOs work to achieve a number of basin goals, including: conflict resolution, risk mitigation, data sharing, resources management and cooperation between nations (De Stefano et al. 2010, Heikkila et al. 2014, Lemos 2015, Plengsaeng et al. 2014). Likewise, previous research has also sought to understand the more narrow role IRBOs play in the promoting the use of science in policy through agenda setting based on scientific analysis (Uitto and Duda 2002). While prior research has examined this specific role of IRBOs, (Plengsaeng et al. 2014, Lemos 2015) this body of research has yet to examine how IRBO mandates and stakeholders, both individually and together, influence the production and uptake of science in transboundary river basins. This thesis seeks to address this gap by exploring how and IRBOs mandates influence science production as well as the ways in which basin stakeholders and member countries characterize the integration and use of science in policy under IRBO jurisdiction.

To do so, this research will analyze five case studies across three IRBOs to understand role of IRBOs in various stages of the creation and use of science as it informs policy. The use of science in policy in each case study encapsulates a different transboundary
water challenge and a different IRBO science to policy narrative. Additionally, each process unfolds over a differing time-span, with differing end results, yet each was considered by the IRBO to be a success.

Examining across these five case studies serves to illuminate common factors influencing the relationship between science and policy in transboundary waters; thereby aiding in developing a theoretical understanding of the process, identifying innovative approaches to producing science and examining at what stage IRBOs are seeking to involve science in the policy cycle. Looking across these case studies will identify innovative approaches to producing science in the transboundary basin context by identifying common factors influencing the uptake of science into policy across the case studies and provide researchers and decision-makers involved in IRBOs information for when and how to involve science in the policy process.

**Literature Review**

**Barriers to Use of Scientific Knowledge in the Policy-Making**

Creating and implementing scientific knowledge usable in policy faces several challenges, which create barriers to the uptake of science in policy. Gaps between scientists and decision makers, uncertainty, and politics present barriers to the use of science in policy. However, while such gaps may impeded the uptake of science into policy, bridging these gaps through science co-production with stakeholders and policy makers may serve to facilitate the use of science in policy.
Notably, the gap between science producers (researchers, scientists) and users (decision-makers) due to misunderstandings between the political and scientific communities about the role the other plays, has garnered scholars’ attention as a prominent roadblock to the uptake of science into policy (Borowski and Hare 2007). This misunderstanding stems from the goals and audience of each group: policy-makers must answer to constituents while balancing public interests and scientists must answer to institutions while providing accurate information. As a result of this misunderstanding, the gap between producers and users inhibits the flow of knowledge between the two and, ultimately, may determine if the information produced is actually used (Cash et al. 2003). Scholars have investigated this “knowledge gap,” identifying discrepancies in the communication among relevant actors and identifying institutional roadblocks (Weiss 1978, Timmerman and Langaas 2005, Weichselgartner and Kasperson 2010, Kirchhoff et al. 2013).

Similarly, the strategic production and use of science for political purposes ultimately creates barriers to the final uptake of science in policy. Such a dichotomy between the perceived purpose of science production may exacerbate the gap between knowledge producers and users. Whereas policy-makers may use science for strategic purposes “so that political and ethical choices masquerade as technical ones,” (Owens 2005) scientists may likewise produce knowledge explicitly for political use. While scientists are eager to prove the credibility of their work, they are often beholden to patrons who fund research (Guston 2000). As a result, researchers may be pressured to produce results that could benefit the patron. Ultimately, the costs and benefits associated with a given policy action, along with
the values of the policy-makers, and the nature of a problem may influence the outcome (Sarewitz 2004).

Mechanisms for Promoting Scientific Knowledge in Policy

Overview

Whether or not science informs policy is influenced by a multiplicity of factors, namely: its usability, credibility, legitimacy and saliency, the engagement of stakeholders in the science production, scientific uncertainty, politics, and the problem context.

Scholars emphasize the importance of scientific knowledge as useable, relevant and legitimate so as to more easily incorporate science into policies. Usable knowledge is easy to understand, relevant and tailor-made to meet the needs of the public, but usability is influenced by a myriad of factors and is contingent upon the perspective of relevant actors (Dunn and Laing 2017). For example, information is more likely to be usable if it shows a direct connection between ecological conditions and economic or social conditions (Timmerman and Langaas 2005). In order create usable knowledge, technical information must translated into a common language between producers and users, such that these two groups can understand the information and use it appropriately (Roll 2004).

Usable information; however, does not ensure its use. Usable scientific knowledge is relevant, credible, and legitimate, a group of characteristics also known as “CRELE,” a
comprehensive collection of “concepts of scientific information utility, which researchers describe as “usable”. CRELE concepts are defined as follows (McNie 2007):

- Credible knowledge is authoritative and dependable and understood by its users as reliable.
- Relevant information refers to that which is salient to the context in which it is used.
- Finally, legitimate information is regarded as such if it is produced in a transparent way and those who produce it are considered free from bias.

Ultimately, the way in which science is used or received often depends on this set of attributes (Sarkki et al. 2015, Dunn et al. 2018).

**Mandates**

Additional tensions, such as those arising from geographic location, may affect countries’ perceptions and use of science. The upstream-downstream dynamic sets up the classic externality problem, and debates over who is responsible, including the extent of impacts. While such a dynamic may make room for potential cooperation between riparian countries, it can also create challenges, such as determining power imbalances based on geographic positioning; upstream countries tend to have more power (Munia et al. 2016).

Upstream countries have a tendency to restrict information exchanges unless it is in their benefit, (Timmerman and Langaas 2005) thereby creating an information bottleneck in which downstream countries may not have access to all available science. Even where water problems are reciprocal, debates over which country is responsible for taking action may affect the use of science. These tensions may lead to disputes over the science or over how policies should take the science into consideration.
Complicating this is that IRBOs were created by the countries for certain purposes, have specified authorities, and generally need member country permission to undertake activities beyond their mandates, or to approve decisions within their mandates. The institutional design and the mandate of an IRBO influences the mechanisms an IRBO has available for translating science into policy. For example, IRBOs with an organization structure requiring interactions between scientists and policy-makers can lead to greater uptake of science into policy (Schmeier 2014). Science-policy integrationismore likely when these interactions are institutionalized in the IBRO structure (Armitage et al. 2015).

Narrowly defined mandates can impose limitations on organizations by limiting the organization’s ability to create and promote innovative policy due to a constrained scope of power (Toope and Brunee 2005, Vignola et al. 2013). Conversely, a broad mandate allows for an organization to identify a broad range of management needs, allowing for adaptation to basin challenges (Kistin and Ashton 2008). If an institution’s role as a provider of knowledge is clear, the science knowledge will bear more weight in policy (Mukharov and Gerlak 2013, Schmeier 2014, Soomai 2017). Accordingly, an IRBO’s mandate can influence decisions regarding what science to produce, how to produce it, and how to use the science to inform policy; those decisions are highly intertwined with the member country oversight.

**Stakeholders**

One way to increase the likelihood that science is seen as CRELE, and subsequently usable, for policy, is by including a diversity of actors in the production of the science. Knowledge co-production includes stakeholders and policy-makers in information production, thereby increasing the likelihood of producing usable, salient, credible and
legitimate science (Cash et al. 2003, Timmerman and Langaas 2004, 2005, Buizer et al. 2010, Grizetti et al. 2010, Sommerwerk et al. 2010, Duncan 2017, Dunn 2018). Such joint knowledge production by experts, decision-makers and stakeholders allows for the integration of different perspectives and helps to define what CRELE means to the relevant actors (Joyce 2003, Weichselgartnet and Kasperson 2010). For example, stakeholder participation in the initial science-production stages is critical for both ensuring the science produced address stakeholder priorities and that their local water-use and knowledge and data is incorporated into the process (Grizetti et al. 2010). Ultimately, an integrated, reflexive co-production model leads to increased output of usable science (Wyborn 2005, Karl et al. 2007, Dillings and Lemos 2011, Kirshoff 2013, Lemos 2005, 2015, Roll 2004).

In transboundary waters, the production of science and its incorporation into policy must contend with the above factors in a context that includes multiple policy actors with different priorities, and tensions among countries, which may have different perceptions about the purpose and use of science.

In a transboundary river basin, what counts as useful, usable, credible, relevant, and legitimate likely varies across countries. This is because within and across countries there exist a diversity of policy perspectives; each member country has unique social, economic and political goals related to water resource management in the basin (Ganoulis et al. 2008). Because riparian countries have different priorities, the science produced by the IRBOs must be seen as legitimate across varied actors. The challenge of satisfying these diverse priorities is compounded by the multiplicity of stakeholders who also create different demands for science and/or policy to address disparate issues (Armitage 2015, Carr 2015). Furthermore,
while IRBOs seek to produce science that meets these standards, the type of information IRBOs provide can influence a country’s perception of the issue and thereby alter their willingness to cooperate (Qaddumi 2008). As a result, IRBOs are made responsible for understanding and creating scientific knowledge that suits the standards of a diversity of actors, while also producing information that will provide a means to cooperation among countries.

**The role of IRBOs in Integrating Science into Policy**

The complexity of science-to-policy processes in transboundary settings raises questions related to how IRBOs produce science and use that information to influence policy within a transboundary basin. Specifically, given the aforementioned challenges of producing and using science in policy in a transboundary context this thesis explores:

I. How do IRBO scope of authority and jurisdiction, as determined by its mandate, inform the production of science and its use in policy and,

II. What is the role of stakeholders in contributing to the process of producing and integrating science into policy in IRBOs?

This research serves to inform decision and policy-makers in IRBOs by identifying mechanisms which augment the production and use of science in IRBOs. The following chapters seek to explore five case studies which demonstrate a range of IRBO participation in science production and policy-making. Chapter two provides an overview of the methods employed throughout this research project including a brief description of each of the selected IRBOs and justification for choosing each of the five case studies and mechanisms for analysis. Chapters three through seven provide detailed explanations of each case study
including Nutrient Loading in the Red River Basin (Case Study #1), Fluctuating Water Levels in the Lake Ontario - St. Lawrence River Basin (Case Study #2), Development of the Joint Danube Surveys (Case Study #3), Climate Change Adaptation in the Danube River Basin (Case Study #4), and Sustainable Hydropower Development in the Mekong River Basin (Case Study #5). Following description of each case study, Chapter eight seeks to address research question I by analyzing the role that mandates play in the IRBOs decisions to produce science and use it to inform policy. Similarly, Chapter nine addresses research question II through examination of the role stakeholders play in the science-to-policy process in IRBOs. Finally, Chapter ten relates the findings from chapter eight and nine to the larger body of relevant literature in order to highlight the how this thesis fills information gaps in the literature along with its practical use for managers while suggesting future research topics that this thesis did not address.
Works Cited


https://doi.org/10.2166/wp.2004.0019


https://doi.org/10.1017/CBO9780511571480

https://doi.org/10.1016/j.envdev.2014.04.005


CHAPTER 2

METHODS

Research Design

The following project serves to enhance the growing body of literature surrounding the creation of science and its use in policy in International River Basin Organizations (IRBOs). To do so, this research examines five case studies from three IRBOs— the International Joint Commission, the International Commission for the Protection of the Danube River and the Mekong River Commission. These three IRBOs were selected due to their well-established roles within the respective river basins. Each of the IRBOs has produced a wealth of scientific information and are acknowledged as examples of institutional leadership in transboundary water governance. Additionally, the IRBOs each have responsibilities to make recommendations of provide policy decisions to their member countries. As such, the IRBOs serve as effective examples of how IRBOs have produced science and how the science produced was incorporated into policy decisions.

Within the three IRBOs, case studies were selected to depict the process of science generation and its uptake into policy. The case studies were identified through a preliminary search on the IRBOs website to identify specific scientific processes taking place within the IRBOs jurisdiction. This search included all science products and reports available on the website from 2010 until 2018. Following a broad search of science products, IRBO representatives participating in a workshop in 2017 narrowed the case study selection to case studies they considered examples of science production and integration into policy.
Following case study selection, the IRBO websites, along with academic journal
articles, reports, white papers and websites, provided information to construct a thorough
understanding of the IRBO’s involvement in producing scientific information and
integrating it into policy decisions. Where information gaps existed, personal
communications through phone calls and workshops with IRBO representatives served to
provide a complete understanding of the relevant processes in each case study. Together, the
literature search and interviews created an account of the IRBO’s involvement in science
production and its uptake into policy, thereby contributing to an understanding of IRBO’s
overall role in scientific production and subsequent use in policy.

**The Three IRBOs**

**The International Joint Commission**

The International Joint Commission (IJC) serves as a particularly suitable research
focus in that it is one of the most well-established and highly regarded IRBOs with a
reputation for accomplishing many tasks (Clamen and Macfarlane 2015). In 1909, the
Boundary Waters Treaty between the U.S. and Canada established the International Joint
Commission to act as a mediator between the two countries and serve as an independent
advisor to best protect the transboundary environment. As an independent organization, the
IJC has the authority to issue orders of approval for projects and recommend solutions to
watershed problems; however, the IJC does not initiate projects, but member countries may
submit a reference for IJC action (IJC 2017). The IJC also follows a fairly common IRBO
structure: high-level decision-makers, intermediate employees who convert policy directives
into achievable projects and a secretariat to perform administrative duties (Schmeier 2015). In the case of the IJC, the high-level decision-makers include six chairs, three appointed by the Prime Minister of Canada and three appointed by the President of the United States.

The IJC’s authority is divided into two primary functions: orders of approval and reference. In terms of approval, the IJC oversees application and operation of projects, such as dams, diversions, and bridges, which have transboundary impacts or relate to the apportionment of waters in transboundary river systems. In its reference role, the IJC acts as an objective advisor, dedicated to the common good of both involved countries. It provides advice to and conducts studies at the request of governments on issues of joint concern; alerts the governments to emerging issues that might have negative impacts on the quality or quantity of boundary waters or that may possibly lead to conflicts; and assesses progress of projects and efforts to protect the shared waters. The recommendations provided to the US and Canadian governments by the IJC in its reference role are non-binding (IJC n.d.).

The International Commission for the Protection of the Danube River

The International Commission for the Protection of the Danube River (ICPDR) is a transnational river basin organization that works to ensure the sustainable and equitable use of waters and freshwater resources in the Danube River basin. The ICPDR is composed of fourteen countries which depend, to varying extents, on water sources from the Danube River basin (ICPDR n.d.a). The ICPDR structure follows a top-down approach, or a vertical governance process, in which actors operate under a clear hierarchy of power (Rosenau 2002). At the top, Delegations of Contracting Parties and the Permanent Secretariat lead the
organization and oversee technical experts and task groups. The ICPDR supervises the entire Danube River basin, including more than 300 tributaries and connected ground water resources, making the ICPDR one of the largest and most active international river basin management commissions in the world (ICPDR n.d.a).

The ICPDR consists of the Delegations of Contracting Parties and the Permanent Secretariat. Delegations meet twice a year, including meetings with observer organizations, and an exclusive meeting of the Heads of Delegation. These meetings are chaired by the ICPDR President, a position that is annually passed on from one country to the next in an alphabetical order. All executive decisions are made by the Heads of Delegations. The Secretariat of the ICPDR carries out general management and supervisory functions of the organization. The Secretariat works in close relation with the President of the ICPDR, as well as Technical Working Groups, Expert Groups(EG) and Task Groups. Expert groups are panels of specialists and external observers, and contain at least one national expert for each contracting party. While the national experts have the power of voting in the EG meetings, the observers are not given a formal vote. The ICPDR mandates specific contracts and Terms of Reference for each Expert Group. Task Groups are temporary committees established to address a specific objective and are also composed of national experts from contracting parties and external observers, though it is not required that each country be represented in those groups; task groups report to the Expert Groups relevant to their studies and focus (ICPDR n.d.b).
The Mekong River Commission

The Mekong River Commission (MRC) is an intergovernmental organization that works to support the sustainable management and development of water and related resources of the Mekong River, while reducing any potentially harmful effects on people, the economy, and the environment. The MRC acts as a facilitating and advisory organization and seeks to guide regional cooperation. Like the IJC, the MRC does not make decisions on behalf of member countries, nor does it have enforcement or sanctioning jurisdiction. The MRC is comprised of four member countries: Cambodia, Vietnam, Thailand, and Lao PDR. While China and Myanmar, upstream countries that share the Mekong River, are not members of the MRC, they engage with the MRC through regular communication (MRC n.d.).

The MRC’s organization structure consists of the Council of Ministers, the Joint Committee, and the Secretariat. The Council of Ministers is the highest decision-making body, comprised of the environment and water ministers from each of MRC’s four member countries. The Council reviews, discusses and reaches mutual conclusions on emerging management and development issues. The Joint Committee, which is composed of senior officials from each of the Member Countries, then steers implementation of the decisions of the Council. The Secretariat serves as the administrative and technical arm of the MRC, facilitating meetings and provides technical and advisory support. Each member country also has a National Mekong Committee (NMC). These agencies work with ministries within that
country to implement MRC objectives and policies on national, regional, and local levels (MRC n.d.).

**The Case Studies**

Following the selection of the three IRBOs, we collected a comprehensive list of all science products produced in each IRBO between 2010-2016. Each of these science products was found on the respective IRBO website and briefly synthesized. Drawing on this comprehensive list of scientific products, we worked in conjunction with IRBO representatives to select case studies that IRBO representatives considered an example of IRBO science production and the use of science to inform a policy decision. Each of the case studies includes fully completed scientific processes, though some are on-going, as well as an existing policy document as the result of the scientific processes. These case studies are described in Table 1.

IRBO websites served as a primary source of information regarding the case studies. Websites provided scientific reports, meeting minutes, mandates, legal frameworks, and IRBO press releases and publications. News articles and third-party opinion pieces served to supplement this information and provide a comprehensive understanding of the case study narratives. When IRBO websites and other media sources did not provide sufficient information, IRBO representatives and actors familiar with the case studies provided first-hand knowledge of the case studies, allowing for a detailed retelling of each case. This information was gathered through a combination of phone interviews as well as through two separate workshops, which focused on collaboration and information sharing between
researchers and IRBO representatives. This information was organized into separate drafts, each with the same structure to allow for comparison, and then verified by IRBO as accurate by IRBO representatives.

Table 1: Summary of five case studies

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Case Study #1: Nutrient Management in the Red River Basin (IJC)</th>
<th>Case Study #2: Water Levels in the Lake Ontario–St. Lawrence River (IJC)</th>
<th>Case Study #3: Joint Danube Survey (ICPDR)</th>
<th>Case Study #4: Climate Change Adaptation Strategy (ICPDR)</th>
<th>Case Study #4: Design Guidance for Sustainable Hydropower (MRC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>This case study chronicles the development of a nutrient management strategy</td>
<td>This case study examines plans to regulate water levels and restore natural flow patterns in the Lake Ontario–St. Lawrence River Basin.</td>
<td>This case study examines the process through which surveys were designed to help assess the basin’s overall water quality by providing a basin-wide dataset of water quality parameters.</td>
<td>This case study examines a study of the latest available information on climate change and adaptation to develop a climate adaptation strategy.</td>
<td>This case study examines sustainable hydropower development based on guidelines for hydropower development.</td>
</tr>
<tr>
<td>Relevant Actors</td>
<td>IJC, advocacy groups, state/provincial and federal government</td>
<td>IJC, advocacy groups, study and technical groups, public</td>
<td>ICPRD, EU and national governments, university researchers, NGOs</td>
<td>ICPDR, NGOs, national governmen ts, university</td>
<td>MRC, consultants, member countries, NGOs, donor organizations, hydropower</td>
</tr>
</tbody>
</table>

26
<table>
<thead>
<tr>
<th>Ecological Issue</th>
<th>Nutrient pollution from runoff</th>
<th>Fluctuating water levels changed the ecological structure of the area</th>
<th>Chronic water quality issues</th>
<th>Persistent climate change impacts across environmental sectors</th>
<th>Impacts of dams on ecosystems &amp; fisheries, sediment etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy Issue</td>
<td>Development of water quality standards for nutrients.</td>
<td>Revision of the regulation plan for operating a dam to address fluctuating water levels</td>
<td>Development of river basin management plans to achieve good ecological status</td>
<td>Development of a climate change adaptation strategy for the basin</td>
<td>Development of guidelines for developers when designing and countries when evaluating the impacts of hydropower dam development</td>
</tr>
</tbody>
</table>

**Case Study Analysis**

Within each case study I traced the story of the science product by highlighting two types of key information: i) the IRBO structure and mandate and ii) the influences of actors and stakeholders. To best tell the narrative of the uptake of science into policy, I used these steps to highlight key factors contributing to the integration of science into policy. In this case, IRBO structure and mandate refer to the formal and informal design and authorities of
IRBOs, as laid out by the member countries. Actors and stakeholders are those individuals, coalitions, agencies and organizations which have a vested interest in the one or more of the basin resources, the science production surrounding it and the integration of science into policy.

This analysis process delineates the ways in which science is created and used to inform decisions within the context of IRBOs and international water governance. Using an in-depth literature review of the science production and uptake in policy in water governance, I analyzed the case studies in order to illustrate the role of mandate and stakeholders in this process. This research serves to identify and explore the gap between science production and policy action, demonstrating which mechanisms are essential for creating policy founded on scientific research.
Works Cited


CHAPTER 3

NUTRIENT LOADING IN THE RED RIVER BASIN

Red River Case Study Background

Overview

This case study chronicles IJC involvement the development of a comprehensive nutrient management strategy for the Red River Basin. Within the Red River Basin, water quality governance is decentralized. While the IJC has authority to monitor water quality at the border, development and implementation of water quality management policies is not within its jurisdiction. National-level governments provide regulatory frameworks and guidance, while state and provincial level-governments set water quality standards and policies for achieving water quality standards. Through the production of knowledge and through facilitation of communication and coordination across sub-national agencies and stakeholders, the IJC has sought to help develop harmonized water quality standards across the multiple agencies in the basin.

Geographic Setting

The Red River originates in the United States in South Dakota, flowing north and forming the border between Minnesota and North Dakota, crossing the international border into Canada and emptying into Lake Winnipeg in Manitoba (Encyclopedia Britannica). The Red River Valley sits at what was once the floor of Glacial Lake Agassiz, creating a flat lake basin with rolling uplands, lakes and wetlands along the basin margins. Prairie potholes and
wetlands are particularly abundant, influencing the amount of sediment and biota in the waters of the Red River (Stoner et al. 1993). The Red River basin extends between 10 and 40 miles on either side of the Red River, while the drainage area covers 40,200 square miles. Within the basin, roughly 60% of agricultural land is cropland, producing, potatoes, cereals sugar beets and wheat (River Keepers 2015, Encyclopedia Britannica).

![Figure 1: The Red River Basin (IJC n.d.)](image)

**Concern: Nutrient Loading in the Red River**

High nutrient (phosphorus and nitrogen) loads have led to degraded water quality in the basin. Nutrient loading in the basin is largely the result of agricultural use of fertilizers, compounded by land use changes including waterway channelization, hydrology modification, and a lack of riparian cover near many streams in the watershed (Olm et al. 2017). Throughout the past thirty years nutrient loading increased significantly in Lake Winnipeg, with the Red River contributing 68% of the phosphorus annual total load and
34% of the nitrogen annual total load. This, in turn, has led to eutrophication and greater occurrences of cyanobacteria in Lake Winnipeg (Levesque and Page 2011).

**Chronology of MRC Efforts**

Regulation and management of nutrients in the Red River Watershed is decentralized. The 1909 Boundary Water Treaty (BWT), which addresses the shared waters of the United States and Canada, commits both countries to pursuing the common good and created the International Joint Commission (IJC), as an agency charged with preventing and resolving disputes and advising the two governments on the use and management of their shared waters. While under this mandate the IJC monitors water quality and facilitates coordination and planning across the two countries, the IJC does not have implementation responsibilities, but provides advice (IJC 1909). Each country, instead develops water quality objectives, and the policies and practices to be used to achieve them, independently.

In the United States, the Clean Water Act primarily addresses water quality. Under this law, states are required to set water quality standards for each water body and to identify water bodies which do not meet those standards. The U.S. Environmental Protection Agency (EPA) provides guidance and oversees states as they set and implement their water quality standards. Where a water body does not meet state determined water quality standards (i.e., the water body is impaired), states are required to develop a plan to restored the waterway (EPA 2014). In Minnesota and North Dakota, responsibility for setting and enforcing water quality standards, monitoring water quality and issuing permits for water use
lie with the Minnesota Pollution Control Agency and the North Dakota Department of Health Division of Water Quality, respectively (Minnesota 2009, North Dakota 2018).

As with the U.S., in Canada, jurisdiction over water is distributed. The Canada Water Act of 1970 established a federal-provincial partnership for water resource management, putting in place joint consultative arrangements and federal funding for provincial water resource management (Booth and Quinn 1995). The federal government has jurisdiction over fisheries, navigation, waters in federal lands and water along the US-Canada border. Provinces and the federal government share jurisdiction over agriculture, health, interprovincial water issues and significant national water issues. With respect to water quality, the Canada Water Act and Canada Environmental Protection Act of 1999 require water monitoring by the Environment Canada, though the federal government is allowed to enter into shared monitoring with provinces. Environment and Climate Change Canada carries out and shares science in order to inform decision-making for Manitoba, but ultimately, the provinces are responsible for setting pollution objectives and for regulating pollution (Canada 2007, Griffin 2018). In Manitoba, the Water Protection Act sets water quality standards, objectives and guidelines, managed under the Water Science and Management Branch (Shippam n.d.).

The management of water quality does not occur in isolation of other water resources management considerations, and, in addition to the aforementioned agencies specifically tasked with water quality monitoring, planning and permitting, a number of other governmental and non-governmental organizations also address water quality in the Red River Basin. Those organizations fall into three categories: (i) local-level governmental
entities with broader water resources management authorities, including flood management and water resources planning, (ii) nonprofits focused on environmental and watershed science, and (iii) cooperative organizations engaging in broader cooperation across jurisdictions within the watershed.

Of particular importance is the Red River Basin Commission (RRBC), a not-for-profit organization formed as grassroots effort to address land and water issues in a basin-wide context. The RRBC provides a forum for stakeholders to communicate, facilitates basin-wide planning, and conducts outreach and education. The RRBC is a partnership between all of the jurisdictions in the Red River Basin Watershed, including, on the Manitoba, Minnesota, North Dakota, South Dakota, First Nations and Tribal affiliations. The RRBC’s 41-member board of directors, includes representatives from cities, counties, rural municipalities, watershed boards, water resource districts and joint powers boards, as well as representation from First Nations, a water supply cooperative, a lake improvement association and environmental groups (RRBC 2018).

**IRRBB Involvement**

In 1964, the governments of the United States and Canada requested the IJC study the extent and causes of pollution in the Red River at the boundary and recommend remedial measures (IJC 1964). In response to this reference, the IJC conducted a study in 1968, “*Report of the International Joint Commission Canada and United States on the Pollution of the Red River*” (Heeney et al. 1968). Though the study found levels of pollution in water crossing the boundary were not sufficiently high to cause injury to health or property in Canada, the
IJC identified the need for mutually acceptable water quality objectives at the international boundary and for continuous supervision to attain compliance with such objectives (IJC 1964). Subsequently, the IJC recommended the United States and Canada develop a set water quality standards and establish a board to supervise the efforts to meet objectives (IJC 1968).

The two countries agreed to these recommendations, and, in 1969, the IJC established the International Red River Pollution Board (IRRPB) and tasked it with monitoring and reporting on five water quality parameters: dissolved oxygen, total dissolved solids, chloride, sulphate, and fecal coliform bacteria (IRRB n.d., IRRB 2015A).

In 1997, the IJC recommended to the governments of the United States and Canada the establishment of watershed boards; this change would enable the IJC to examine at the level of the ecosystem. In 1998, the United States and Canada agreed to this change, and the IJC formed its International Watershed Initiative (IWI n.d., Koop et al. 2005).

In 2001, the IJC combined the International Souris-Red Rivers Engineering Board and the International Red River Pollution Board into a single board, the International Red River Board (IRRB) in order to streamline IJC operations (IRRB 2018). The newly formed IRRB was directed to monitor trends and exceedances of water quality objectives (those objectives did not include standards for nutrients), to document discharge of pollution and pollution control measures, to establish a spill contingency plan, and to identify potential future water quality issues, and to recommend appropriate strategies to maintain ecosystem health. To achieve its mandate, the IRRB established the Committee on Hydrology (COH)
and the Aquatic Ecosystem Committee (AEC) in 2001 (IRRB 2015A). The COH is responsible for developing recommendations for water quantity; likewise, the AEC is responsible for developing and implementing recommendations for biological monitoring in the watershed and maintaining a centralized water quality database (RRBC 2006).

In 2003, the IJC requested the IRRB to develop an ecosystem approach to managing environmental and water-related challenges and identified the Red River basin as one of three pilot watersheds within the IJC’s International Watershed Initiative (IRRB 2015A).

Throughout this time period, numerous organizations in the region were also seeking to improve water management. In 1995, local and state interests proposed formation a comprehensive organization that would develop and oversee guidance for the Red River Basin— the Red River Basin Board, which was comprised of representatives from local cities, municipalities, watershed boards, counties, First Nations, provincial, state, and federal representatives (RRBC 2006, Harris et al 2001).

In 2002, the Red River Basin Board joined with existing councils to form the Red River Basin Commission (RRBC) with the explicit objective of producing an integrated water management plan for the basin. This “Natural Resources Framework Plan,” which was completed in 2005, includes a comprehensive inventory of reports on the basin’s resources and challenges, set 13 basin-wide goals, and developed an action agenda for achieving those (RRBC 2005, RRBC 2006).

Meanwhile, nutrient loading in Lake Winnipeg, the Red River’s outlet, increased significantly, accompanied by greater occurrences of algal blooms. This drew the attention of
recreational users of the lake and Canadian water quality protection agencies (Levesque and Page 2011). Local mayors and Canadian leaders from nine communities in the Lake Winnipeg area came together to address the deteriorating water quality in the lake and, in 2009, launched the Lake Friendly Initiative, a grassroots initiative that aims to reduce nutrients in waterways and reduce the frequency and severity of algal blooms (Lake Friendly n.d.).

In 2003, Manitoba expressed concerns over eutrophication in Lake Winnipeg and requested that the IRRB set nutrient objectives for nitrogen and phosphorus pollution at the international border in addition to pre-existing nutrient objectives (for total dissolved solids, chloride, sulfate, dissolved oxygen, and fecal coliform bacteria) (IRRB 2004). Following this request, in 2004 the IRRB AEC highlighted the need to take joint action to address the problem and suggested a two-step approach to nitrogen and phosphorus management: first, to gather nutrient data and second, to analyze the data for trends so as to develop appropriate nutrient objectives and parameters (IRRB 2006).

Beginning in 2006, the RRBC began worked with the IRRB AEC to complete the second step of evaluating the data and appropriate parameters. The AEC recommended that agencies in the basin work to reduce nutrient loading in Lake Winnipeg by 10% over five years as an interim goal while the AEC continued to develop longer-term nutrient targets and goals (IRRB 2007). In 2008, the IRRB developed its new 5-year work plan, which included plans to establish nutrient targets and continue ongoing monitoring programs. The work plan sought to establish water quality objectives for phosphorus and nitrogen and establish an integrated water quality database for the basin (IRRB 2008).
The RRBC also recognized the need to improve basin-wide cooperation and collaboration on water quality management, in particular with respect to nutrients. Through the support of the RRBC, North Dakota, Minnesota, and Manitoba presented a draft approach for developing a nutrient management strategy to the IRRB. The proposed approach includes six components for developing the nutrient management strategy with a focus on (IRRB 2012). In 2011, the IRRB endorsed the proposed approach for the development of a comprehensive nutrient management strategy.

At this time, the IRRB and RRBC combined their respective water quality committees to centralize the work within the IRRB, as the IRRB was considered a better host for this work due to its mandate (pers. comm. 26 June 2018). The IRRB then established a Water Quality Committee, which is comprised of state, provincial and federal agency representatives as well as members of the RRBC. The Water Quality Committee agreed to a set of guiding principles for the nutrient management strategy, emphasizing that the strategy should be outcome based (IRRB 2012).

In 2013, the IRRB, after reviewing multiple water quality models, selected the U.S. Geological Survey (USGS) SPARROW model to identify and quantify nutrient loading in the basin. The SPARROW model had undergone extensive peer review and was appropriate for large basin use, making it a suitable choice for the Red River basin. In order to apply the SPARROW model to the Red-Assiniboine River, the USGS and the IJC mapped water quality stations across the Red River watershed and harmonize the data (IRR 2016).
In 2013, the IRRB requested and received funding from the IJC’s IWI and contracted RESPEC Consulting & Services to review of methods for developing water quality targets. This report recommended two integrated approaches to developing water quality targets, namely to (1) develop a stressor-response model that identified nutrient targets for the Red River and (2) that downstream water quality targets for Lake Winnipeg should be considered in parallel to the stressor-response-model-derived nutrient targets for setting overall water quality targets.

Following these recommendations, the IRRB issued a call for consultants to develop a stressor response model. RESPEC was again awarded the contract. To develop an appropriate biological stressor-response model, the IRRB Water Quality Committee, RESPEC, and the larger project team quickly determined that supplemental data were needed; specifically, reach-wide algal community assessment and associated nutrient concentration data. The summer growing season was also determined the most pertinent period to discern an algal response to nutrients. Subsequently, an interagency collaborative sampling approach was quickly designed and implemented. The Minnesota Pollution Control Agency, Manitoba Sustainable Development, Environment and Climate Change Canada, North Dakota Department of Health and the Buffalo-Red River Watershed Management District, as well as water quality professionals collected the necessary information on algae and water chemistry through the cooperative effort with RESPEC (Miller et al. 2016). The final stressor-response analysis report was shared with the IRRB at the September 2016 meeting.
Table 2: Key Red River science products

<table>
<thead>
<tr>
<th>SPARROW Model Development</th>
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<tr>
<td>The IRRB led an international team of government agencies and organizations in building on the USGS application of the SPARROW model. In order to implement the SPARROW model, the study team developed a continuous stream network with a delineate catchment area for each segment of the stream and defined the topography in order to conduct calculations on the stream segments. The study team used the SPARROW model to estimate channel slope, flow, streamflow velocity and hydraulic load. The study team used the model to estimate a number of water quality variables including load estimation, flow and water quality data and load estimation using Fluxmaster (Jenkinson and Benoy 2015).</td>
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<tr>
<th>Setting Nutrient Targets 2013</th>
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<tr>
<td>The IRRB contracted RESPEC to assess available scientific methods for setting nitrogen and phosphorus water-quality targets in the Red River. RESPEC conducted a literature review of existing water quality documents and papers. Using this data, RESPEC made a recommendation for the Red River Basin for how to set targets, including data needs, advantages and disadvantages, geographic considerations, level of effort, and applicability to the Red River.</td>
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<tr>
<th>Stressor-Response Model 2017</th>
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<td>The stressor-response model, which was developed by the consulting firm RESPEC, investigates the relationships among nutrients, suspended sediment, and the biological response of algal communities in the Red River. RESPEC first determined a relationship between algal communities and nutrients and analyzed water quality data to determine the nutrient gradient. RESPEC then used multivariate analysis to determine the relationship between algae to varying nutrient concentrations, pointing to where field sites were least influenced by high nutrient concentrations. Lastly, RESPEC determined the roles various basin characteristics on algal biomass. Throughout the study, RESPEC drew on SPARROW modeling to identify point-sources of nutrient loading and land-use data (Miller et al 2016).</td>
</tr>
</tbody>
</table>
Direct Influence on Basin-Wide Policies

The most direct outcome of the IJC efforts in the Red River Watershed has been the development of proposed water quality standards for the border. These standards were developed by the IRRB Water Quality Committee and are the direct outcome of the SPARROW modeling combined with the Stressor-Response model (Miller et al. 2016). The IRRB Water Quality Committee determined that, when looking at mandate of the IRRB and the 1909 BWT, the countries shall not harm one another, and therefore, determination of water quality standards should be based on an analysis of harm, without consideration of economics or politics. The Water Quality Committee was thus comprised of scientists conducting a scientific analysis and their resulting recommendation is thus clear that, while it lays out a set of water quality targets, it does not dictate how those standards and does not affect jurisdictional authority (pers. comm. 26 June 2018).

At the basin-level, in April of 2018, Red River Basin Comprehensive Watershed Plan was completed (USACE 2018). This plan was developed the US Army Corps of Engineers collaboratively with all government agencies and stakeholders within the basin. While the IJC had no formal role in the formation of this plan, the plan builds from the efforts of the RRBC and the IRRB. The Comprehensive Plan is well coordinated across agencies and jurisdictions, in part because many of the same people who developed the comprehensive plan are part of the RRBC and the IRRB. While the Comprehensive Plan itself is a vision and a framework, the hope is that having an agreed upon vision and strategy for
implementation will provide agencies within the basin with greater opportunities to apply for and to receive federal funding.

**Summary**

The Red River case study demonstrates the role the IRRB and IJC played in providing a coordinating platform for addressing nutrient pollution in the Red River Basin across jurisdictions. Throughout the case study, the IRRB drew on policy frameworks, including the 1909 Boundary Waters Treaty and the IRRB mandate, to understand its role in coordinating governance and stakeholders efforts to reduce nutrient loading in the Red River and eutrophication in Lake Winnipeg. In addition to this policy framework, the IRRB also relied heavily on cooperation with stakeholders in the basin, especially the RRBC. Following analysis sections demonstrate how both the mandates and stakeholders relevant to this case study may have influenced the ways in which the IRRB was able to carry out scientific studies and work with stakeholders to develop nutrient targets.
Works Cited


https://doi.org/10.1017/CBO9781139150811


Personal communication with IRRB Member. 26 June 2018.


CHAPTER 4

FLUCTUATING WATER LEVELS IN THE LAKE ONTARIO-ST. LAWRENCE RIVER BASIN

Lake Ontario-St. Lawrence River Basin Case Study Background

Overview

This case study examines the process through which the IJC developed plans to regulate water levels and restore natural flow patterns in the Lake Ontario-St. Lawrence River Basin. As part of its jurisdictional authority and institutional mandate, the IJC issues orders of approval for infrastructure projects affecting the apportionment of water or having transboundary impacts on the transboundary waters shared by the USA and Canada. The IJC was thus charged with developing a plan for how to operate a dam regulating outflows from Lake Ontario in a way that best served the interests of stakeholders in the basin.

Fluctuating water levels have been a concern since the dams construction due to their social, environmental and economic impacts. Yet differences across stakeholders, in terms of preferred water flows have been a challenge for decision-making. The IJC conducted two large studies, both of which entailed multi-criteria analyses that combined scientific information on expected impacts of regulation with a trade-off analysis in order to evaluate potential regulation plans. In each instance, gaps in knowledge and differences in preferences impeded adoption of a new regulation plan. After additional analysis and development of an adaptive management approach, a new regulation plan was decided upon in 2014.
Geographic Setting

Lake Ontario serves as drainage for the four other Great Lakes, Lakes Superior, Michigan, Huron, Erie, and Ontario, as well as its own watershed. From Lake Ontario, water flows north into the St. Lawrence River, where, 100 miles downstream of Lake Ontario, the Moses-Saunders Power Dam regulates outflows from the lake into Lake St. Lawrence. Ontario Power Generation and the New York Power Authority jointly operate the dam and when outflows are too large for capacity, the Long Sault Dam in NY serves as a spillway (IJC n.d.). From Lake St. Lawrence, water flows into Lake St. Francis where it is used for hydroelectricity generation. The St. Lawrence River eventually joins with the Ottawa River in Montreal and lets out into the Atlantic Ocean (IJC 2014).

Figure 2: Lake Ontario-St. Lawrence basin (IJC n.d.b)
Concern: Fluctuating Water Levels in the Great Lakes- St. Lawrence Basin

Throughout the 1970’s and 1980’s, above average precipitation led to extensive flooding in the basin, contributing to loss of life, energy production, property and recreational boating, while significant drought events contributed to economic and recreational downturn in the 1990’s (IJC 1993, Library and Archives of Canada 2006). Continuing through the 1990’s and early 2000’s, water fluctuation continued to damage shoreline properties and degrade the environment; Plan 2014 promises to return the water levels to a more natural flow (IJC 2014).

Chronology of IJC Efforts to Regulate Water Levels

In 1952, the IJC issued an Order of Approval for the construction and operation of the Moses- Saunders hydropower dam. Construction on the dam, which is jointly owned and operated by New York and Ontario power authorities, was completed in 1958 (IJC n.d. (A), NYPA 2009).

Since construction of the dam, the topic of Lake Ontario water levels has been an ongoing concern. Operations of the dam are the primary determinant of Lake Ontario outflows, and thus dam operations are an important mechanism for controlling lake water levels. In 1955, Canadian engineers developed a regulation plan, which specified a systematic process for determining how flows would be regulated (IJC 1956). Since then, the IJC has modified the dam’s Order of Approval several times and tasked the International Lake Ontario - St. Lawrence River Board (ISLRBC) with monitoring to ensure outflows meet those requirements (IJC n.d. (A)). Plan 1958-D, which was put into operation in 1963, was
the regulation plan in place up until the IJC replaced it with Plan 2014 in 2017 (IJC 1963, IJC 2014).

In the 1970’s and 1980’s, high water levels damaged the US and Canadian shores of Lake Ontario, prompting the US and Canadian governments to ask the IJC to investigate how damages could be mitigated. This reference, *Docket 111: 1986 Reference on Fluctuating Water Levels in the Great Lakes*, requested that the IJC propose measures the governments could take to alleviate problems created by fluctuating levels, evaluate alternative regulation schemes, develop information programs to better inform the public about lake fluctuations, and examine past and future changes in land use practices on the shoreline (IJC 1986). In response to this reference, in 1990 the IJC issued a directive that created a Levels Reference Study Board and tasked it with conducting the Levels Reference Study.

The Levels Reference Study adopted a multi-objective multi-criteria evaluation process that used four evaluation criteria (economic impact, environmental impact, distribution of impacts, and feasibility) to compare across the proposed actions (measures) the countries could take to address fluctuating water levels. The Levels Reference Study was completed in 1993 and recommended 42 practical actions the governments could take, resulting in regulation Plan 1998, which met the conditions of the order of approval with a greater range of water supply conditions (IJC 1993).

In 1995 the IJC informed the governments of the U.S. and Canada that, due to continuing concern about the Order of Approval, the ISLRCB was undertaking two tasks: 1) developing a scope of work to determine if the Levels Reference Study Board’s
recommendations are appropriate and 2) reviewing alternative regulations plans for Lake Ontario outflow. In 1996 the IJC requested the governments of the U.S. and Canada advise if the IJC should continue with its proposed scope of work to undertake further studies, but received no substantive reply. The IJC directed the ISLRCB to proceed with the studies when and if funding became available, yet the scope of work was halted when the IJC concluded funding would not become available and that incremental funding was not suitable for the scope of the proposed studies.

In 1997, the ISLRBC completed its review of alternative regulation plans and again recommended that Plan 1998 be adopted, albeit with some revisions. However, after a period of public comment, the IJC rejected Plan 1998 due to insufficient information on the potential environmental impacts of Plan 1998 and due to the fact that it did not sufficiently deviate from Plan 1958-D. In 1999, the IJC again asked for funding to carry out the studies proposed in the scope of work it had outlined in 1995, and, prior to receiving funds, moved forward with the creation of a bi-national work group (Galloway 1999). The bi-national study team translated the proposed scope of work into a Plan of Study (hereafter 1999 Plan of Study). A month after publishing the 1999 Plan of Study, the IJC requested specific funds from the U.S. and Canada, which then agreed to fund the study (Galloway 1999).

In 2000, the IJC issued a directive to undertake the scope of work included in the 1999 Plan of Study (IJC 1999). A new International Lake Ontario-St. Lawrence River (LOSLR) Study Board was formed to conduct the study, entitled Lake Ontario and St. Lawrence River Water Levels and Flows (The LOSLR 2006 Study) (IJC n.d. (A), IJC 2006). In undertaking the study, the LOSLR Study Board was directed to evaluate the existing
findings from the 1993 Reference Study as well as expand to account for other interests, such as recreational boaters and the environment. The LOSLR Study Board was also directed to include outreach and participation from a variety of stakeholders and experts in regulation development and research (IJC 1999, Wescoat et al. 2006). To address this requirement, the IJC created a bi-national Public Interest Advisory Group (PIAG), which included 20 members appointed based on their knowledge and experience. The PIAG provided a venue for selected members of the public to act as an internal peer-review group and to communicate with the public.

The LOSLR Study Board evaluated numerous iterations of Plan 1958-D to create three candidate plans, which were presented for public comment and IJC recommendation. In the final year of The LOSLR Study, the PIAG hosted 14 public meetings to receive comments on the proposed plans in addition to other correspondence and a survey used to collect comments. While most public comments expressed a desire to achieve environmental restoration, many property owners opposed plans due to the potential damage it would incur to coastal properties (Barletta et al. 2005). Following consideration of public comments on the proposed plan, technical working groups and stakeholders evaluated the proposed plans to come up with a plan to restore the environment while maintaining other interests, which resulted in a plan referred to as Plan 2007, which was subsequently opened for public comment (Furber et al. 2016).

The IJC opened public comment on Plan 2007 and held information sessions and public hearings. The public submitted 1,200 comments in addition to public hearing statements. Some comments expressed mild support Plan 2007 for its minimized cost to
coastal property owners, yet comments by environmental interests expressed strong opposition. The concern of environmentalists was the plan did not go far enough to restore natural flows. As a result, Plan 2007 was withdrawn, and, as a next step, the IJC proposed forming a small working group to research and develop a new regulation plan (Brooks 2008).

In 2009, the IJC requested the governments nominate officials (two each from the United States, Canada, Quebec, New York and Ontario) for a working group (hereafter Working Group 2014). Once formed, the Working Group 2014 considered 60 variations of Plan 2007. Based on their research, they selected and proposed a final plan in 2012, called Bv7 (the seventh variation of Plan B). Further refinements, considering comments and stakeholder input, led to the development of Plan 2014, which was then opened for public comment; Plan 2014 returns flows to a more natural level. Plan 2014 is a combination of Bv7 release rules and discretionary decisions made by the LOSLR Bard to deviate from Bv7 in extreme conditions. Plan 2014 also includes the development of an adaptive management strategy, including the formation of an adaptive management committee. Finally, Plan 2014 recommended the creation of a new LOSLR board to provide regular public engagement opportunities through meetings, electronic updates, and timely responses to questions and comments received through its website or via social media (IJC 2014).

Public and local politicians responses to Plan 2014 were polarized. South shore property owners in New York strongly opposed Plan 2014 due to concerns about potential flooding and erosion during periods when lake levels would be higher and boating difficulties during periods when lake levels would be lower (Plan 2014 would result in both higher and lower levels). Commercial navigation interests and companies operating along the
shoreline voiced concern that Plan 2014 prioritized environmental interests because it would allow lower lake levels, which would force ships to carry reduced loads. Other local and state politicians and government leaders and environmental organizations voiced strong support for Plan 2014. Despite discordant public opinions, the IJC approved Plan 2014, which went into force in 2017 (pers. comm. 20 April 2018).

Part of what enabled the IJC to move forward with Plan 2014, was that while Plan 2014 was under consideration, the IJC decided adopt an adaptive management approach to regulation of all of the Great Lakes. In 2012, the IJC issued a directive to create the International Great Lakes – St. Lawrence River Adaptive Management (GLAM) Task Team and for that team to develop a detailed Adaptive Management Plan. Plan 2014 incorporated this adaptive management plan and uses it a mechanism for regular evaluation and adjustment if the plan is resulting in undesirable impacts (IJC 2013).

Building on the work of the GLAM Task Team, in 2015 the IJC issued a new directive, establishing the Great Lakes – St. Lawrence Adaptive Management (GLAM) Committee and tasking it with monitoring and assessment of the Lake Superior, Niagara River, and St. Lawrence River Boards’ regulation plans and activities, as well as coordinate with the Water Quality and Science Advisory Boards on issues of common interest. The GLAM Committee reports to the three existing IJC Boards of Control (Superior, St. Lawrence & Niagara) and is supported by technical experts from the jurisdictions of the Boards of Control. If the Boards of Control find that an Adaptive Management Committee report warrants action or revisions, the Boards of Control communicates to the IJC, which would then request further evaluation or modification (IJC 2013, IJC 2015).
Development of a regulation plan is predicated on understanding, predicting, and evaluating the effects of fluctuating water levels in the Lake Ontario – St. Lawrence River Watershed. To this end, the IJC has produced, funded, compiled, and analyzed a large degree of scientific knowledge about the watershed. Prior to 1993, the IJC conducted several studies focused on water levels and flows. In response to a 1990 IJC Directive, the Levels Reference Study Board began the Levels Reference Study, completed in 1993 (IJC 1993). However, recommendations from the Levels Reference Study were not adopted, and in 2000, the IJC issued another directive, which lead to the five-year LOSLR study, completed in 2006 (IJC 2006). Each study itself relies on multiple scientific studies and technical reports.

Studies are produced by a combination of in-house research, partnerships and consultancies. The IJC hires consultants when they do not have the expertise or even if they have expertise, if do not have the in house capacity at the time to conduct the science (pers. comm. 20 April 2018). How the terms of studies are determined has changed over time. For the Levels Reference and LOSLR study, the process was more open and consultants had greater ability to determine the scope of the work. Yet as understandings of and uncertainties about the Lake Ontario – St. Lawrence River system have improved, the terms of studies has been more well defined in advance and consultants are given a very specific scope of work.

Table 3: Key Lake Ontario - St. Lawrence science products

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<th>Levels Reference Study</th>
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of the Levels Reference Study was to evaluate potential measures to alleviate the adverse consequences of fluctuating water levels and how those measures might affect involved interests. The Study team developed a list of potential measures for reducing impacts on a wide range of activities to select the most fitting measures. Public forums were held to discuss the options for action and then the options further refined based on public input. Lastly, the Levels Reference Study developed a communication framework for the use of the governments and suggested management and operational improvements (IJC 1993).

The 2006 LOSLR Study

Late into the first year of the LOSLR Study, the LOSLR Study Board recognized the need for forming, evaluating, and structuring the research and decided to adopt the Shared Vision Planning method (IJC 2008). The Shared Vision Planning method integrates a structured planning process, a collaborating negotiating process with stakeholders and the use of a Shared Vision Model (SVM), which is a coupled-systems computer model that represents the watershed (IJC 1999, Wescoat et al. 2006). The SVM can be used to evaluate the expected impacts of potential regulation on water levels and flows throughout the system, as well as the implications of those for hydropower production, recreational boating, commercial navigation, water supply, flooding, ecosystem, and erosion.

LOSLR Study Peer Review

Toward the end of the LOSLR Study, the IJC determined it should have the study peer-reviewed and, in 2005, asked the U.S. National Research Council (NRC) and the Royal Society of Canada (RSC) to independently peer-review selected studies, reports, and models used development of, along with the shared vision model. The peer-review committee concluded that the inclusiveness and breadth of the study was impressive, yet the study lacked consistency, did not present enough information to understand tradeoffs of the various regulation plans and that ongoing analyses was needed in order to provide a stronger scientific basis to make informed decisions (Wescoat et al. 2006). While the Study Board acknowledged the NRC may not have had sufficient time to adequately carry out the peer review task set forth by the IJC, the Study Board expressed frustration that the NRC should have considered the effect peer review comments and conclusions would have on crafting a new regulation plan and included explanation of their peer review so that its critiques would not to mislead readers who then may doubt the usefulness of the overall study (IJC 2006a).

Science to Support Adaptive Management

Following adoption of Plan 2014, new science has primarily been conducted under the auspices of the Adaptive Management Committee. Members of the Adaptive Management Committee jointly determine priorities and how or where to focus their efforts. Decisions are made via consensus and, once consensus is reached, the IJC is approached for funding. To date, the Adaptive Management Committee has been focused on monitoring and on improving the knowledge base. The immediate focus (post Plan 2014) has been on wetland and coastal science, in part because those impacts are less well understood. However, with the
Direct Influence on Basin-Wide Policies

The IJC and subsidiary boards conducted several iterations of studies in order to determine the impacts of various regulation plans on sectors within the basin. The primary outcome of the studies is the implementation of Plan 2014, which returns waters to more natural levels, while still accounting for other interests in the basin. The 1993 Levels Reference Study, 2006 LOSLR Study and the work of the 2014 Working Group all contributed to refining the final regulation plan. Each study contained within it, various studies specifically analyzing the impacts to a range of stakeholders in the basin. Drawing on the methods and results of the preceding studies, each study built on IJC efforts to determine a regulation plan that incorporates stakeholder interests while protecting the environment.

Included in Plan 2014 are provisions for adaptive management, to reassess and evaluate Plan 2014 as the environment and stakeholder interests change over time. This policy measure is the direct result of other IJC activities in the Great Lakes, namely the Upper Great Lakes Study and the Great Lakes Adaptive Management Committee. While adaptive management builds on existing scientific information, it ensures that the 2016 LOSLR Board will continue to monitor and assess the ecological status of the basin, while considering stakeholder needs. In this way, one of the farthest-reaching influences on policy is

2017-2018 floods, the Adaptive Management Committee has been focusing on trying to gather flood impact data (pers. comm. 20 April 2018).
the continued policy change in response to emerging ecological and social conditions in the basin.

Summary

Throughout this case study, the IJC sought to develop a regulation plan that both satisfied a range of stakeholders while also working to restore natural flows so as to curb harms to the ecosystem. The 1909 Boundary Waters Treaty created a framework for the IJC to work within, while stakeholders in the basin actively participated in science production to shape the final regulation plan. The analysis sections highlight key aspects of the Lake Ontario - St. Lawrence case study that demonstrate the role of mandates and directives as well as stakeholders in shaping the science production process and how the influence of these two characteristics affected the final policy outcome — Plan 2014.
**Works Cited**


Personal communication with IJC Representative 20 April 2018.

Personal communication with IJC Representative. 14 June 2018.

https://doi.org/10.17226/11481
CHAPTER 5

DEVELOPMENT OF THE JOINT DANUBE SURVEYS

Joint Danube Surveys Case Study Background

Overview

This case study examines the process through which the Joint Danube Surveys were conceived, designed and implemented. The Joint Danube Surveys (JDS) are the product of broad international cooperation on data collection throughout the Danube River basin, facilitated by the International Commission for the Protection of the Danube River (ICPDR)—the region’s transboundary river-basin organization—and made possible by the Danube River Protection Convention (DRPC) legal framework. Despite a legacy of political division and economic transformation in the region, significant cooperative research efforts have been carried out in the Danube River basin over the past two decades, garnering participation from 14 riparian nations, and additional external parties such as the European Union (EU) (Feldbacher et al., 2016). Cooperation on basin-wide water management of the Danube River basin was initially prompted by growing concerns about the river’s water quality. The Joint Danube Surveys were designed to help assess the basin’s overall water quality by providing a homogenous, basin-wide dataset that includes a broad scope of water quality parameters. Data gathered from the JDS play a key role in EU member state efforts to comply with the EU Water Framework Directive (WFD). Overall, the cooperative efforts led by the ICPDR are seen as a success of coordination, knowledge production and collective action in transboundary water cooperation. Most recently, the member nations reaffirmed the Danube Declaration in 2016, committing to conduct a fourth JDS in 2019.
Geographic Setting

The Danube River Basin comprises of an area of 801,463 km² and is considered to be the world's most international river basin, as it extends into the territories of 19 countries. More than 81 million people live in the basin. All countries sharing over 2,000 km² of the Danube River Basin and the EU are contracting parties of the ICPDR.

Figure 3: The Danube River Basin (ICPDR n.d.a)

Concern: Water Quality Issues

In 1977, the World Health Organization formally recognized water quality issues on the Danube River as a critical concern and warned that better pollution controls were needed. The main causes of degraded water quality on the Danube were rapid industrial development, combined with a lack of sufficient wastewater treatment facilities in upstream locations particularly prior to 1990 (Shmueli, 1999).
While the region is cooperative, the historical political divide in the region has led to persistent disparities in socioeconomic development among upstream and downstream nations and different national legal systems for water and environmental management. Upper Basin countries, including Germany and Austria, have long used the Danube for wastewater discharge and hydropower. Downstream, in the Lower Basin, the river serves the uses of drinking water, irrigation, and fishing. Urban development and industrial activities have posed threats to the river’s water quality, particularly from Upper basin countries (Shmueli, 1999). Conflicting uses of the Danube River between upstream and downstream nations, in addition to the risk of accidental releases of hazardous substances, have historically comprised the main water-quality challenges for the river basin. Other challenges, such as different monitoring protocols and water quality standards employed by national monitoring programs made evident the need for cooperation (Shmueli, 1999; Feldbacher et al., 2016).

**Chronology of ICPDR Efforts to Address Water Quality Concerns**

In 1991, Danube nations, along with NGOs, international organizations and financial organizations, established the Environmental Programme for the Danube River Basin (ERDRB). Participants agreed to harmonize their environmental monitoring systems, address liability for cross-border pollution, define rules for protecting wetlands and lay out guidelines for conservation of areas with ecological or aesthetic value (ICPDR, n.d. a). The EPDRB was set up to enable Danube countries to begin improving river management through practical actions such as monitoring, data collection, emergency response and institutional and capacity building (International Waters, n.d.). As part of the ERDRB, an
interim task force was setup to develop a Strategic Action Plan (SAP) to guide implementation and help coordinate monitoring efforts.

In the early 1990s, Danube nations began negotiating an agreement for addressing transboundary waters (on the basis of the UNECE Convention on Protection and Use of Transboundary Watercourses and International Lakes adopted in Helsinki in 1992). Danube riparians negotiated the Danube River Protection Convention (DRPC), which was signed in 1994 by 11 riparian nations. Since the DRPC and EPDRB were developed concurrently, the SAP aimed to support implementation of the both frameworks (ICPDR, n.d. a).

The DRPC binds agreeing countries to cooperation on monitoring and assessment of water resources in a way that harmonizes data and methods, employs joint monitoring systems where available, implements joint monitoring programs, and assesses progress toward improving the Danube River water quality (ICPDR 1994; ICPDR, 2002). To address the aims of the DRPC, the Monitoring, Laboratory and Information Management (MLIM) Expert Group was established in 1992 as a subgroup to the ERDRB (ICPDR, 2002). The MLIM EG aimed to design a more strategic approach to monitoring, analysis and information management and provide basic data for basin-wide assessment (ICPDR, 2002).

The MLIM EG designed the TransNational Monitoring Network, (TNMN) an international water quality data coordination and monitoring network. The initial objectives of the TNMN were devised based on the results of the EPDRB, and results of monitoring conducted under the EPDRB helped guide the design of the TNMN (Carmen, n.d.). However, the TNMN was limited to a small scope of parameters, in part due to limited capacities in some nations to carry out extensive monitoring programs, (pers. comm. 26 June
2018) and, because it relied on many different technicians and laboratories to collect and analyze water samples, additional measures were needed to further improve the comparability of water quality data throughout the basin (pers. comm. 12 June 2018; ICPDR, 2002). There was still a need for a more homogeneous, basin-wide survey of a broad scope of water quality parameters (pers. comm. 12 June 2018). Noting this, the MLIM EG proposed “a Danube longitudinal survey focusing on chemical and biological determinands” using a single sampling platform, consistent sampling and analysis methods, and a single laboratory to ensure data consistency and comparability. This eventually became the Joint Danube Surveys (ICPDR, 2002).

In 1998, the ICPDR was officially established to implement the DRPC, and, shortly thereafter, the EU Water Framework Directive (WFD) was passed in 2000 (EU 2000). The EU’s WFD, which aligns with ICPDR’s overarching goals, significantly influenced not only the role and function of data collected via the JDS, but the ICPDR’s overall approach to water management (ICPDR, 2002). The ICPDR was designated to coordinate implementation of WFD requirements that were transboundary in nature. Non-EU member countries in the DRPC also endorsed the WFD. The WFD requires monitoring and characterization of surface water and groundwater bodies to determine their water and ecological status, and the use of such data to development River Basin Management Plans (RBMP) to guide the achievement of “good ecological status” on a basin scale by 2015. The period for revision of RBMPs is six years; a review of the WFD is expected to be performed in 2019 to determine if the deadline will continue to be extended or if targets will be adjusted for outstanding waterways (pers. comm. 26 June 2018).
In 2006, the TNMN was revised to accommodate the WFD requirements. Existing monitoring efforts were reorganized into three main types: Surveillance, Operational, and Investigative monitoring. The main objective of the TNMN was revised to reflect the requirements of the WFD: “to provide a structured and well-balanced overall view of the status and long-term development of quality and loads in terms of relevant constituents in the major rivers of the Danube Basin in an international context” (ICPDR, 2015b).

The EU Water Framework Directive operates, in a sense, parallel to the DRPC and thus serves to motivate action among Danube nations that extends to the JDS. The ICPDR member countries use the IRBO’s coordination and facilitation mechanism to comply with the EU WFD, particularly its transboundary requirements (pers. comm. 26 June 2018). The ICPDR serves as a hub for knowledge and learning and a vehicle for transboundary basin cooperation and improving water quality monitoring programs. Non-EU member countries are interested in being involved with ICPDR to improve their regional status and progress toward potential EU membership. EU member countries are able to meet the EU directives more easily by coordinating with ICPDR. Whereas there is not legal mandate to implement the DPRC, because it’s aims also fulfill the transboundary coordination requirement of the EU directives, the obligation to meet the WFD helps to achieve progress toward both DPRC and WFD water quality goals in parallel. Because there are many synergies between the goals of DPRC and the WFD, the WFD has helped speed progress toward DPRC goals, increase participation from non-member countries and expanded options for financial support for non-member countries (pers. comm. 26 June 2018).
The TNMN involves an effort to compile and collate data from national surface water monitoring networks in order to make accessible a basin-wide dataset. To supplement these data yet avoid duplication, the Joint Danube Surveys were designed to provide a homogeneous data set of selected chemical, physical, and biological parameters throughout the entire Danube River basin. To achieve improved comparability and homogeneity, data would be collected throughout the basin via the same methodology and the same team of experts (ICPDR, 2007). The Joint Danube Surveys are considered a component of the TNMN’s Investigative monitoring, and contribute to meeting the WFD requirements by monitoring WFD parameters that are not typically included in the TNMN and investigating the potential impact of newly-recognized contaminants (ICPDR, 2007). The JDS may also contribute to Surveillance by monitoring specific pressures and contaminants (ICPDR, 2007). The JDS have been formally included in the ICPDR’s strategy for WFD compliance (ICPDR, 2008).
### Levels Reference Study

The Levels Reference Study was a multi-faceted study examining water levels and flows as well as the role of consideration of land-based measures, institutions, and policies in influencing the effects of fluctuating water levels in the watershed. Levels Reference Study was managed by an eleven-member board, which appointed 18 citizens to a Citizen Advisory Committee. The goal of the Levels Reference Study was to evaluate potential measures to alleviate the adverse consequences of fluctuating water levels and how those measures might affect involved interests. The Study team developed a list of potential measures for reducing impacts on a wide range of activities to select the most fitting measures. Public forums were held to discuss the options for action and then the options further refined based on public input. Lastly, the Levels Reference Study developed a communication framework for the use of the governments and suggested management and operational improvements (IJC 1993).

### The 2006 LOSLR Study

Late into the first year of the LOSLR Study, the LOSLR Study Board recognized the need for forming, evaluating, and structuring the research and decided to adopt the Shared Vision Planning method (IJC 2008). The Shared Vision Planning method integrates a structured planning process, a collaborating negotiating process with stakeholders and the use of a Shared Vision Model (SVM), which is a coupled-systems computer model that represents the watershed (IJC 1999, Wescoat et al. 2006). The SVM can be used to evaluate the expected impacts of potential regulation on water levels and flows throughout the system, as well as the implications of those for hydropower production, recreational boating, commercial navigation, water supply, flooding, ecosystem, and erosion.

### LOSLR Study Peer Review

Toward the end of the LOSLR Study, the IJC determined it should have the study peer-reviewed and, in 2005, asked the U.S. National Research Council (NRC) and the Royal Society of Canada (RSC) to independently peer-review selected studies, reports, and models used development of, along with the shared vision model. The peer-review committee concluded that the inclusiveness and breadth of the study was impressive, yet the study lacked consistency, did not present enough information to understand tradeoffs of the various regulation plans and that ongoing analyses was needed in order to provide a stronger scientific basis to make informed decisions (Wescoat et al. 2006). While the Study Board acknowledged the NRC may not have had sufficient time to adequately carry out the peer review task set forth by the IJC, the Study Board expressed frustration that the NRC should have considered the effect peer review comments and conclusions would have on crafting a new regulation plan and included explanation of their peer review so that its critiques would not to mislead readers who then may doubt the usefulness of the overall study (IJC 2006a).
Science to Support Adaptive Management

Following adoption of Plan 2014, new science has primarily been conducted under the auspices of the Adaptive Management Committee. Members of the Adaptive Management Committee jointly determine priorities and how or where to focus their efforts. Decisions are made via consensus and, once consensus is reached, the IJC is approached for funding. To date, the Adaptive Management Committee has been focused on monitoring and on improving the knowledge base. The immediate focus (post Plan 2014) has been on wetland and coastal science, in part because those impacts are less well understood. However, with the 2017-2018 floods, the Adaptive Management Committee has been focusing on trying to gather flood impact data (pers. comm. 20 April 2018).

Direct Influence on Basin-Wide Policies

The ICPDR decided to conduct the basin-wide water quality surveys via a consensus process among member countries. The DPRC countries that member countries can jointly or separately conduct monitoring in the river (Article 5, DPRC), but requires that domestic monitoring programs use comparable methods (Article 9) and that nations should share information (Article 12). The ICPDR is designated as the decision-making body and implementer of the Convention. It is also the vehicle for horizontal cooperation and coordination among Danube nations; however, does not have enforcement capacities (pers. comm. 26 June 2018).

As previously described, the Monitoring and Assessment Expert Group (MA EG), who are nominated by their country at that country’s discretion (pers. comm. 12 June 2018) is fully-responsible for planning and design of the JDS, which gives the Expert Group control to design methods and procedures. Because the ICPDR Expert Groups represent
the cooperating nations, the member countries generally accept the collected data as reliable and legitimate (pers. comm. 12 June 2018).

The data collected in the JDS played a key role in helping ICPDR and its member countries implement the DRPC and meet the requirements of the EU WFD. Specifically, the information gained was used in developing the first Danube River Basin Management Plan in 2009, as well as the second Danube River Basin Management Plan (and the first Danube River Basin Flood Risk Management Plan) in 2015 (ICPDR 2015a). For example, the results obtained in JDS2 contributed to identifying water quality problems and potential pollution-abatement solutions related to the four primary risk categories specified in the WFD for assessment: organic pollution, hazardous substances, nutrients and hydromorphic alterations (ICPDR 2008). JDS3 produced a list of priority pollutants specific to the Danube River as an initial step for targeting management efforts toward the greatest improvements in Danube water quality and ecosystem health (ICPDR 2008). Because the EU Commission makes frequent changes to their overall WatchList and priority pollutant lists, having a Danube-specific list of priority pollutants helps Danube nations streamline their water management efforts (pers. comm. 26 June 2018). The Danube priority substances will be integrated into the DRBMP and the Danube nations’ RBMPs as well.

The Joint Danube Surveys also resulted in a unique dataset that is available to external organizations, such as the regional, national, intergovernmental and academic institutions, who wish to use them for analysis and research. For example, the EU Joint Research Center has utilized the JDS results in modeling to evaluate pollution sources and potential effects of source control measures (pers. comm. 12 June 2018). The JRC also
utilized the results of JDS2 to evaluate their own list of 33 priority pollutants (ICPDR 2008). Academic researchers also leveraged the JDS expeditions to collect data on parameters related to microbiology, environmental DNA and radiochemistry for research and analysis (pers. comm. 12 June 2018).

Increasing public awareness has also become a large part of the Joint Danube Surveys. JDS3, in particular, placed heavy emphasis on public events and promoting a sense of collective concern for the river’s health. Public events were conducted in 10 cities along the route of JDS3. The motto, “Watch Your Danube”, was adopted in JDS2. The second and third surveys were touted as the “biggest river expedition of the World”. Media coverage and a blog helped the public stay involved in the survey’s day-to-day progress and many corporate partners became involved. By sharing scientific information with the public and increasing public awareness about river health, the JDS promotes a transparent process and engages the public in encouraging commitments by policy-makers (pers. comm. 26 June 2018).

Summary

The Joint Danube case study details the ICPDR’s role in facilitating a basin-wide effort to create baseline water quality data. The ICPDR drew on its mandate to establish its role in the basin to coordinate data collection efforts, while also relying on member countries to define relevant information for the JDS. Following analysis sections discuss the role of policy frameworks, the DRPC and EU WFD, in shaping the ICPDR’s activities within the
basin and the influence member countries had in shaping the content and methods of scientific production in the JDS.
Works Cited


Personal communication with ICPDR Representative. 12 June 2018.

Personal communication with ICPDR Representatives. 26 June 2018.

CHAPTER 6

CLIMATE CHANGE ADAPTATION IN THE DANUBE RIVER BASIN

**Danube Climate Adaptation Case Study Background**

**Overview**

This case study examines the process through which the International Commission for the Protection of the Danube River (ICPDR) conducted the Danube Study: Climate Change Adaptation (2012), which collected recent information on climate change and adaptation to develop a climate adaptation strategy. The ICPDR followed a collaborative, two-fold approach that included creating a special expert group on climate change, while also mainstreaming the issue of climate change into existing working groups (UNECE and INBO 2015). The Danube Climate Change Adaptation Strategy (2013), which provides guidance on how to address climate adaptation in the Danube Basin was based off of the information obtained from The Climate Adaptation Study. The Danube Climate Change Adaptation Strategy becomes realized by integrating the suggested actions into the planning activities leading to the 2nd Danube River Basin Plan and the 1st Danube Flood Risk Management Plan. In preparation of an update to the Danube Climate Adaptation Strategy in 2018, a second, updated scientific study — the Revision and Update of the Danube Study — was completed between 2017-2018.
Geographic Setting

The Danube River Basin comprises of an area of 801,463 km² and is considered to be the world's most international river basin, as it extends into the territories of 19 countries. More than 81 million people live in the basin. All countries sharing over 2,000 km² of the Danube River Basin and the European Union (EU) are contracting parties of the ICPDR.

Figure 4: The Danube River Basin (ICPDR n.d.a)

Concern: Climate Change Impacts in the Danube River Basin

Throughout the Danube River Basin, climate change is acknowledged as a driving force in increased threats to the basin resources. Changes in temperature and precipitation will affect various sectors in all Danube Basin countries and the ICPDR highlighted the significance of these changes, stating that climate change is likely “...to cause significant impacts on water resources and can develop into a significant threat if the reduction of greenhouse gas emissions is not complemented by climate adaptation measures” (ICPDR 2013, UNECE and INBO 2015).
Chronology of ICPDR Efforts to Adopt a Climate Adaptation Strategy

Since 2000, the ICPDR has served as the platform for the implementation of the transboundary aspects of the European Union (EU) Water Framework Directive (WFD), which establishes a legal framework to protect and enhance the status of aquatic ecosystems, prevent their deterioration, and ensure the long-term, sustainable use of water resources throughout the EU and the Floods Directive on the basin-wide scale. In 2007, the ICPDR took responsibility for coordinating the implementation of the EU Floods Directive (FD) in the Danube River Basin. So although the climate change science and adaptation work of the ICPDR is mandated by the 2010 Danube Convention, Danube leaders use the EU regulation of the WFD as a vehicle to implement their own convention.

The Danube Climate Change Adaptation Strategy (The Strategy) can be traced to an international conference on Water and Climate Change in the Danube River Basin, held in 2007 (UNECE and INBO 2015). Following the 2007 conference, in 2010, ministers and high-level representatives in the Danube countries endorsed the Danube Declaration 2, expressing the commitment to further reinforce transboundary cooperation on sustainable water resources management and mandating the ICPDR to develop a climate change strategy for the river basin (ICPDR 2013). According to the Danube Declaration 2, the new climate strategy should be “based on a step-by-step approach and encompass an overview of relevant research and data collection, a vulnerability assessment, ensure that measures and projects are climate proof respectively “no regret measures” and ensure that climate adaptation issues are fully integrated in the 2nd Danube River Basin Management Plan in 2015” (ICPDR 2012b). This activity is also supported within the Action Plan of the EU
Strategy for the Danube Region, Priority Area 5 “Environmental Risks” under the action “Anticipate regional and local impacts of climate change through research”.

To inform the development of a basin adaptation strategy, the ICPDR led a study synthesizing the latest available information on climate change and adaptation relevant for the basin. Published in 2012, The Danube Study: Climate Change Adaptation (The Study) helped to create a shared understanding of the expected changes and water-related impacts stemming from climate change. The Study was then used to develop The Strategy in 2013, which provides guidance on how to address climate adaptation in the Danube Basin.

The Strategy was to be updated in 2018, in line with the six-year adaptive management cycles according to the WFD. In preparation of an update to the Strategy, a second scientific study, the Revision and Update of the Danube Study (Revised Study), provides an analysis of projects conducted between 2012 and 2017 and a comparison to the findings of the first Danube study. The final draft of the revised Strategy was expected to be ready for adoption at the ICPDR’s 21st Ordinary Meeting in December 2018.

Danube Study: Climate Change Adaptation

The Danube Study: Climate Change Adaptation (2012) was conducted to provide a review of all the latest available information on climate change and adaptation relevant for the Danube River Basin. The ICPDR nominated Germany to act as the lead country in The Study, allowing them to take charge of The Study direction.
The Study primarily focused on the impacts of climate change on the water sector in the Danube River Basin, including the analysis of impacts on climate elements, water availability, extreme hydrological events, water quality and temperature, different types of water use like agriculture, navigation, and water-related energy production as well as biodiversity and conservation.

The Study involved cooperation from a number of stakeholders in the basin in order to acquire existing information and understand its relevance to basin actors. Universities, countries, international organizations and NGOs provided studies and projects from which The Study team drew on to synthesize existing information (ICPDR 2012a). The creation of The Study involved a close collaboration with researchers, national experts, water managers, and stakeholders in the Danube River Basin through numerous meetings, workshops and conferences to present and discuss the outcomes of the study. National representatives participated through the River Basin Management Expert Group, which was designated as the responsible ICPDR Expert Group for The Study. However, all of the ICPDR Expert Groups (EGs) and Task Groups (TGs) participated in the development of The Study through review and comment periods at regular sessions.

In order to collect data, the ICPDR sought out relevant reports and national communications under the UNFCCC to identify present and future impact of climate change and adaptation measures per country and at the EU level (ICPDR 2012a). Existing information regarding adaptation activities covered only sections of the Danube River Basin, but almost all countries had National Adaptations Strategies in place or in preparation. In acknowledgement of these data findings, all findings in The Study were classified into
statements about the entire Danube River Basin (DRB), the Upper Danube River Basin (UDRB), the Middle Danube River Basin (MDRB), and the Lower Danube River Basin (LDRB).

With respect to the impacts of climate change on the water sector in the Danube River Basin, The Study sought to identify impacts on climate elements, water availability, extreme hydrological events, water quality and temperature, and how those affect waters including agriculture, navigation, and water related energy production, biodiversity and conservation. The majority of the studies and projects synthesized in The Study, used models and/or scenarios to project future temperature, precipitation, and extreme weather events. Because these models and scenarios all describe their projections using different representations of uncertainty, The Study team developed a methodology that compared across certainty statements. Three variables were used to determine a certainty category for climate parameters and impacts, including: (1) certainty of statements; (2) level of agreement between different statements; and (3) number of analyzed studies.

In carrying out its synthesis, The Study team faced several challenges regarding the heterogeneity of available scientific information. The Study Team identified a general lack of scientific information available for the lower Danube River basin, and, in some instances, documents eastern countries did not translate scientific documents into English and, thus, they were not integrated into The Study. Additionally, the availability of information across sectors varied significantly. The Study team recognized that, generally, the higher the economic relevance of a sector (like agriculture and forestry), the greater degree of information was available. Finally, incompatibilities across studies’ reference periods
presented challenges for direct comparison; as a result, the ICPDR decided not attempt to resolve instances of contradictory data where the climate models predicted different outcomes.

**Revision and Update of the Danube Study**

At the Danube Ministerial Meeting in 2016, Ministers asked the ICPDR to update its knowledge base in order to prepare an updated strategy. The ICPDR set out to repeat and revise the study process through an update to the knowledge base and scientific research study, including another Climate Change Adaptation Workshop; these two efforts would lead to an update of The Strategy (ICPDR 2018a).

The University of Munich, who elaborated the first scientific research study in 2011, was tasked with updating the “knowledge base” of The Strategy by including new scientific results in climate change research and the resulting impacts on water availability to revise the existing ICPDR adaptation strategy. The University followed the same collaborative process that characterized the first Study.

The Revision and Update of the Danube Study, finalized in February 2018, synthesizes the findings of 73 research and development projects and studies. The Revised Study provides an analysis of projects conducted between 2012 and 2017 and a comparison to the findings of the first Danube study. The second study is intended to support a Danube wide understanding of the impact of climate change on hydrology and water availability in the light of the new IPCC report AR5 and improved regional climate models (ICPDR 2018). While The Study considered climate change impacts across all sectors, the Revised Study
focuses on key sectors most prone to impacts, including hydropower, drought, floods, and navigation.

The primary findings of the Revised Study include greater certainty in the findings regarding climate change, across all regions and fields of the basin. Additionally, the Revised Study projected increased frequency and intensity of both droughts and flooding with a higher degree of certainty (ICPDR 2018d). However, not all statements could be analyzed to define a certainty level and compare it to the results from the first study and for energy production and navigation, statements were highly contradictory.

**Direct Influence on Policy**

**The Danube Climate Adaptation Strategy**

Following the release of the Danube Study: Climate Change Adaptation scientific study in 2012, and building from the March 2012 adaptation workshop, the ICPDR initiated a process to develop a basin adaptation strategy. The Danube Climate Adaptation Strategy (The Strategy) was adopted in 2013 and served as the “knowledge base” of The Strategy (ICPDR 2018a).

A key part of the process to develop a climate change adaptation strategy was the ‘Danube Climate Adaptation Workshop’, held in Munich, Germany in March 2012. Workshop participants, representing the member countries and other stakeholder groups, helped identify the prioritization of particular national-level and basin-level adaptation actions. In addition, workshop participants helped to construct a vision of The Strategy
which included, among others, the need for interdisciplinary approach and management, coherence between different levels of action (basin-wide, sub-basin, national), and mediation of potential conflicts already from the beginning based on a participatory approach (ICPDR 2012b). The outcome of the workshop was a common understanding of climate change impacts and measures, and expectations towards a basin-wide adaptation strategy (ICPDR 2012c).

All of the ICPDR Expert Groups (EGs) and Task Groups (TGs), composed of national experts and stakeholders, participated in the development of The Strategy, commenting on drafts and eventually endorsing The Strategy. To assist in creating the Strategy, the ICPDR created a new Climate Change (CC) Team, comprised of experts from eight Contracting Parties and four Observers. Countries nominated their experts to the Climate Change Team to provide additional input from the countries who provide the ICPDR guidance. According to the ICPDR, engagement with this broad set of ICPDR Expert and Task Groups is a strength of the approach in that it makes “best use of the knowledge and experience already existing in ICPDR Expert and Task Groups, thereby ensuring that the high complexity of the topic will be properly dealt with” (ICPDR 2013).

The Strategy also recognizes climate change adaptation as a cross-cutting issue with relevance for different sectors, and as an integral part of integrated water resource management (IWRM). Yet, while the focus is the basin-level, The Strategy also addresses the different levels of river basin management, including the sub-basin, national and/or sub-unit level, as requested by the WFD. According to The Strategy, national experts in the international working groups of the ICPDR will facilitate planning on smaller scales in the
In The Strategy, the ICPDR promises “further targeted exchange on climate change adaptation with specific experts and interest groups outside existing ICPDR structures will be undertaken (e.g. through participation in respective meetings or the organisation of specific workshops on adaptation)” (ICPDR 2013).

In terms of its content, The Strategy contains sections on the knowledge base (climate change scenarios, impacts on water resources, vulnerability and an overview of possible adaptation measures) and guiding principles, integration, and next steps (UNECE and INBO 2015). The Strategy is intended to be pragmatic. The absence of measures, timelines or budgets in The Strategy creates flexibility, allowing countries to develop their own adaptation measures (ICPDR 2012b).

Update of the ICPDR Strategy on Adaptation to Climate Change

Similar to the process followed to craft and approve The Strategy, the River Basin Management Expert Group and ICPDR TGs and EGs participated in developing the Revised Strategy. The Climate Change Team again served as an additional guidance. In March 2018, the ICPDR convened a workshop to share the Revised Study and engage stakeholders from all over the Danube basin by addressing experiences with weather extremes and impacts to different water-related sectors. At the end of these discussions, the workshop produced recommendations and suggestions for updating The Study (ICPDR 2018d). The final draft of the Revised Strategy was presented in late 2018.
The European Union Water Framework Directive

At the basin scale two primary tools are used to implement the regional directives of the EU WFD— the Danube River Basin Management Plan (DRBM) and the Danube Flood Risk Management Plan (DFRM). These management plans demonstrate a planning approach for the basin that outlines the water management priorities for the Danube Basin until 2021. The primary objective of The Strategy is to guide the way to fully integrate climate adaptation into the 2nd Danube River Basin Management Plan (DRBM) and the 1st Danube Flood Risk Management Plan (DFRM). The Strategy served as a direct input into these two plans, which then serve as an implementation tool for The Strategy. Because the DRBM and DFRM Plans are regularly updated based on a six-year planning cycle, this allows for an adaptive management of the basin and the consideration of progress in climate change-related research.

The ICPDR has adopted a “roof framework”, coordinating the two management plans which then guide national governments. Countries have come to trust the ICPDR as a natural vehicle for EU countries to develop river basin management plans with non-member countries (pers. comm. 26 June 2018). Thus far the EU Commission has reviewed all national and transboundary plans in the ICPDR and provided feedback to the ICPDR on transboundary plans in September 2018. The ICPDR is now working to address the approximate 150 negative comments raised.
Summary

The ICPDR involvement in developing a climate change adaptation strategy represents one of the first large-scale basin efforts to understand and address climate change impacts on water-related sectors. The ICPDR’s role was largely defined by DRPC, 2010 Danube Declaration and EU WFD requirements, while stakeholder engagement helped to inform how such mandated requirements could be translated into science production and the final strategy. The following analysis section explores the ways in which the ICPDR referenced its mandated responsibility to coordinate science production to conduct the The Study and the role member countries and stakeholders played in producing and identifying priority areas for The Study and its update.
**Works Cited**


ICPDR, 2018b. Revision and Update of the Danube Study. Vienna; ICPDR.


ICPDR. 2018d. ICPDR convenes Climate Change Workshop designed to collaborate and tackle climate change issues in a transboundary context. At http://www.icpdr.org/main/icpdr-climate-change-workshop-2018

Personal communication with ICPDR Representative. 26 June 2018.

UNECE and INBO. 2015. Water and Climate Change Adaptation in Transboundary Basins: Lessons Learned and Good Practices. NY: UN. At
CHAPTER 7
SUSTAINABLE HYDROPOWER DEVELOPMENT IN THE MEKONG RIVER BASIN

Sustainable Hydropower Development Case Study Background

Overview

The lower Mekong River Basin has a long history of cooperative management. In 1995, Cambodia, Thailand, Lao PDR, and Viet Nam signed the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin (also called the Mekong Agreement), which formed Mekong River Commission (MRC). The MRC was charged with overseeing and implementing the Mekong Agreement and, for the last two decades, has been supporting cooperative management across multiple sectors in the Mekong Basin, including agriculture, fisheries conservation, and renewable energy production. One of the more challenging tasks given to the MRC is the cooperative development of hydropower projects on the mainstream and tributaries of the lower Mekong Basin. This case study examines the role of the MRC in supporting sustainable hydropower development in the lower Mekong Basin by exploring the role of the MRC in drafting a set of guidelines for hydropower development in the basin. The initial guidelines, known as Preliminary Design Guidance (PDG), was completed in 2009 and was intended to help potential hydropower developers navigate the process through which the MRC and member countries review and share information about projects that affect the basin. A revision to the guidelines is currently underway.
Geographic Setting

The Mekong River originates in Qinghai Tibetan Plateau and flows approximately 4,900 km through China, Myanmar, Lao PDR, Thailand, Cambodia, and VietNam (MRC, 2018a, Kuenzer et al., 2012). The Mekong River is divided into two sub-basins called the Upper and Lower Mekong Basin (Figure 5). The mean annual streamflow of the Mekong River is largely influenced by monsoon rains, resulting in dry and wet seasons (Li et al., 2017). About 16% of the annual total flow in the Mekong River comes from China. In the LMB, tributaries in Lao PDR contribute 55% of total annual flow (MRC, 2018a). The LMB contains many important ecological sites, including Lake Tonle Sap (located in Cambodia) and the Mekong Delta (located in Viet Nam), which is where the Mekong River empties into the South China Sea (Li et al., 2017). Approximately seventy million people live in the Lower Mekong River Basin, with a majority living in Thailand and Viet Nam (MRC 2018a, Kuenzer et al., 2012). With the largest inland fishery in the world, many of the people living in the LMB depend on economies supported by fisheries for their livelihood (MRC 2018a).
Concern: Hydropower Development on the Mainstream

The planned development of hydroelectric dams on the mainstream of the Mekong River prompted the creation of the 2009 Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin (PDG). Only 10% of the Lower Mekong’s estimated hydroelectric potential is under use; as a result there is a growing interest in developing this renewable energy source (MRC, n.d.a). The potential for hydroelectric development in the Lower Mekong was evaluated as early as the 1970s when the Mekong
Committee (MC)—a predecessor of the MRC—recommended a potential 180 hydroelectric projects in their Basin Indicative Plan (MRC 2018a). When the Preliminary Guidance was published, eleven large-scale hydropower dams on the Mekong mainstream were planned (MRC 2009). As of 2018, there were 164 existing and planned hydropower schemes in the Lower Mekong Basin. Concern over unregulated hydropower development in the LMB led the MRC to formally agree on a standard process for evaluating new hydropower proposals. This process, called Notification, Prior Consultation, and Agreement (PNPCA), encouraged developers and member countries to meet certain criteria to assure riparian countries in the LMB that new hydropower projects would not have major negative impacts on the environmental or economic well-being of riparian countries (MRC 2018a).

The PNPCA did not offer guidance the criteria that would be used during the review process, which raised the concern that, without a set of technical standards and benchmarks, hydropower developers and the sponsoring member country would not have the information necessary to navigate the PNPCA process. In response to this concern, MRC developed the PDG to provide developers guidance on the technical standards and design principles the MRC would evaluate during PNPCA. Since the release of the PDG, it has been used during the PNPCA evaluation of three hydropower projects on the mainstream of the LMB. Application of PDG to these three projects highlighted that the lack of solid baseline data related to water flows, sediment transport, and fish ecology and the fact that the PDG did not sufficiently provide guidance on how to cumulative environmental and transboundary impacts could be addressed in the design of hydropower projects. Thus, the need for an update to the PDG became clear.
Chronology of MRC Efforts

The 1995 Mekong Agreement

In 1995, Cambodia, Thailand, Lao PDR, and Viet Nam signed the Mekong Agreement, which provides a series of objectives and a broad framework for cooperation, based on specific substantive and procedural rules on the use and the development of the basin. Included in these principles are: the cooperative, sustainable development of water resources in the Mekong River Basin (Articles 1 and 2), the protection the ecological health of the river basin and minimization of harmful effects (Articles 3, 6, 7, and 8), and the equal rights and abilities of member countries to use the resources of the Mekong River Basin for navigation, recreation, and economic development (Articles 4, 5, and 9) (MRC 1995).

Articles 5 and 6 of the Mekong Agreement are most relevant to the creation of the Preliminary Design Guidance.

Article 5 develops a framework under which member countries agreed to notify and consult one another about potential developments that would impact the basin. In 2003, member countries approved the Procedures for Notification, Prior Consultation, and Agreement (PNPCA), which translates the legal obligations outlined in Article 5 into specific rules and procedures and provides a template for member countries to use when submitting a proposal for review. Through notification, a country provides information on the details of the proposed project to other member countries. During Consultation, member countries conduct a technical assessment of the potential transboundary impact of the project on
ecosystems and livelihoods and recommend to the proposing country measures that could address those issues.

The MRC further clarified the implementation of PNPCA in 2005 when they released Guidelines on Implementation of the Procedures for Notification, Prior Consultation and Agreement. According to these guidelines, the procedure for Notification is as follows: The member country proposing the dam development submits a feasibility study report, implementation plan, and schedule to the MRC Secretariat. The Secretariat then checks the application for completeness and submits the completed Notification, along with Technical Review Report, to the MRC Joint Committee, which reviews comments made by member countries, provides consultations with stakeholders, and sets up a PNPCA Working Group for joint fact-finding (MRC 2003).

The PNPCA Working Group is made up of representatives from each of the member countries (MRC, 2014c). In addition to PNPCA Working Groups, Expert Groups within specific fields relevant to the PNPCA, such as fisheries, hydrology, geomorphology, and sediment, act as consultants. The PNPCA process concludes when the MRC Joint Committee decides on the completeness of the Prior Consultation proposal within six months of from the date when the proposal was received. The process for Specific Agreement is decided on a case-by-case basis, but generally follows the procedures for Notification and Prior Consultation (MRC 2003).

Article 6 of the 1995 Mekong Agreement charges the MRC with the cooperative maintenance of flows on the mainstem of the Mekong River including with specific, seasonal
provisions. Importantly, Article 6 applies to any diversions and storage releases on the mainstem, thus forecasting the necessity of developers to design hydropower projects in compliance with the Mekong Agreement (MRC 1995).

Similar to the PNPCA, the legal obligation outlined in Article 6 was formally translated into a set of rules and procedures in 2006. The Procedures for the Maintenance of Flows on the Mainstream (PMFM) is largely focused on setting up institutional processes and clarifying roles for monitoring flows and sharing data between member countries (MRC 2006). Neither the PNPCA nor the PMFM offer specific guidance on how to design hydropower projects in compliance with the 1995 Mekong Agreement, creating the need, as described below for additional guidance for hydropower developers, member countries, and the MRC Joint Committee.

**The MRC Initiative for Sustainable Hydropower**

The MRC established the Initiative for Sustainable Hydropower (ISH) in 2008 with the goal of advancing regional cooperation for the sustainable management of hydropower within a basin-wide perspective (MRC n.d.b). A primary objective of the ISH is to provide regional planning support, via the development and sharing of information, experiences, and practices.

Through the ISH, the MRC works with member countries, policy makers, and developers to embed sustainable hydropower design practices in the regulatory and planning frameworks of the riparian countries (MRC 2018a). The ISH coordinated the preparation of the PDG. After member countries provided input into defining the role of the PDG, the
ICPDR established the guidance as a reference for developers and member countries when they design hydropower projects and, subsequently, as they prepare PNPCA documents. The PDG is also used by the MRC Secretariat’s PNPCA Joint Task Force during the review PNPCA documents (MRC 2009).

**Development of the Preliminary Design Guidance**

Shortly after it was formed, the ISH began the process of developing the PDG. A series of meetings and workshops were held with developers and regulatory agencies to facilitate use of PDG in the preparation of project feasibility studies and environmental impact assessments and other requirements part of the PNPCA process. Along with this, ISH engaged with stakeholders and member countries to help them navigate the PNPCA. The PDG was approved in 2009.

The PDG is organized into four categories: navigation, fish passage on mainstream dams, sediment transport and river morphology, water quality and aquatic ecology, and dam safety. Within each category, performance targets and design principles are given in the guidance. Within each category, general design principles are supported by specific requirements and performance targets (MRC 1995). Lastly, the PDG includes a short section with general philosophies and principles related to dam safety intended to give developers a broad overview of the kinds of safety issues they should address in the design and operation of hydropower dams (MRC 2018a, MRC 1995).
Application of the Preliminary Design Guidance

To date, three Prior Consultation assessments have been made on proposed hydropower dams on the mainstream of the Lower Mekong: the Xayaburi in 2010, the Don Sahong in 2014, and the Pak Beng in 2017. A fourth proposed dam, Pak Lay, was submitted for review during June 2018. The process of assessing these projects highlighted information gaps about the basin and the potential impacts of hydropower development, as well as the need for more clarity in the guidelines and the need to include projects located on tributaries that would have transboundary impacts (MRC 2017a).

The first submission occurred in 2010, when Lao PDR submitted their proposal for the Xayaburi dam to the Joint Committee. However, the Xayaburi Prior Consultation process was tabled in 2011 because of a disagreement: according to member countries Cambodia, Thailand, and Viet Nam, there were significant gaps in knowledge regarding the impacts of the Xayaburi project on the environment and livelihoods of people, and therefore, more specific scientific studies were needed (MRC 2011a, MRC 2011b). The MRC Secretariat’s Technical Review found significant gaps in knowledge pertaining to transboundary and cumulative impacts as well as the scale of impacts on fisheries and livelihoods that depend on them. Lao PDR maintained they had followed the PNPCA guidelines and should therefore be able to proceed with the process, while the other member countries claimed that the 6 month timeline outlined in the PNPCA was not enough time to fully understand the possible impacts of the project (MRC 2011a). To date, no formal decision has been made by the MRC on the Xayaburi project; however, Lao PDR has moved ahead with construction.
The next test of the PNPCA process came in September 2013 when Lao PDR submitted Notification for the Don Sahong project. Laos PDF submitted the project as Notification, arguing it was not on the mainstem because the project only occurred on one channel of the river. However, member countries claimed there would be significant impact on the mainstream and requested the Don Sahong go through the Prior Consultation process (MRC 2015f). After a preliminary review, it was decided that Lao PDR should submit the project through the Prior Consultation process, which they did in July 2014 (MRC 2014a). The Technical Review during the Prior Consultation found the Don Sahong project did not meet the design standards set by the PDG. Following the Technical Review, during national consultations member countries raised additional questions Cambodia, Thailand, and Viet Nam requested a more rigorous Prior Consultation process to assess the potential impacts fish migration and water flows (MRC 2014a). MRC Representatives and other stakeholder groups also voiced concern over the lack of scientific studies on transboundary impacts (MRC 2014a).

The third project to undergo PNPCA review under the PDG was the Pak Beng project, submitted by Lao PDR for Prior Consultation in December 2016. In January, the Joint Committee Working Group (JCGW) met with Lao PDR and made clear the main issues they wanted the Technical Review to address (MRC 2017c). The Technical Review process was hampered by the fact the Pak Beng project was submitted for PC at the feasibility stage of design and so much of the information needed to assess the project against the PDG was incomplete or lacking altogether. This problem was highlighted during the two rounds of stakeholder consultations held in the early part of 2017. Another issue
highlighted during the review process is the role of the PDG in the PNPCA process resulting in some stakeholders asking for a more rigorous application of the PDG (MRC 2017d). For example, in their formal reply to the JC, Cambodia calls on the full application of the PDG by the notifying country (in this case, Lao PDR) (CNMC 2017). Similarly, Thailand called for the design of the Pak Beng dam to be in compliance with the PDG standards (TNMC 2017). In their formal response, Viet Nam requests compliance with PDG related to sediment transport and fish passage design. Similar to the previous two projects, member countries called on Lao PDR to take full account of cumulative transboundary impacts (VNNMC 2017). The final Technical Report for Pak Beng echos the concerns raised by stakeholders and member countries and offers additional guidance related to hydrology, sediment transport and river morphology, water quality and aquatic ecology, fisheries, socio-economics, navigation, and dam safety. The Technical Review also clarifies the role of the PDG as a non-legally binding guidance and reiterates the role of the MRC as a platform for cooperation between member countries rather than a regulating agency (MRC 2017h).

Having learned from the experiences with Xayaburi and Don Sahong, the MRC credited the success of the Pak Beng review process with clearer expectations at the beginning of the Technical Review, a clarification of the role of the MRC as a negotiating platform, and greater stakeholder engagement (MRC 2017d). As part of the Pak Beng review process, MRC member countries signed a special statement in which they agreed to a set of concrete goals and a timeline for the PNPCA process. The MRC also began the process of
creating a Joint Action Plan (JAP), which will set up a process for ongoing feedback and review at the conclusion of Prior Consultation (MRC 2017c).

**Updating the Preliminary Design Guidance**

The Preliminary Design Guidance (PDG) was not written as the final guidance for sustainable hydropower project design. Along with new baseline data, the PNPCA process for Xayaburi, Don Sahong, and Pak Beng made clear the need for an updated version of the PDG that would include contemporary performance targets, more of a focus on design and operating principles to mitigate negative impacts of dams, including socio-economic impacts, and an inclusion of tributary projects and cumulative impacts. While recognizing the necessity of updating the PDG, the MRC wanted to maintain the overarching philosophy of the guidance as a non-prescriptive set of performance standards, design principles and mitigation strategies to help developers design sustainable hydropower projects. In addition to broadening the scope and applicability of the PDG, there was recognition of the need to have a specific section within the PDG dedicated to hydrology and water flows (MRC 2017a).

In 2015, the Initiative for Sustainable Hydropower (ISH) began a comprehensive study called Development of Guidelines for Hydropower Environmental Impact Mitigation in the Lower Mekong Mainstream and Tributaries (ISH0306). The purpose of this study was to examine some of the knowledge gaps and ambiguities in the PDG and to review hydropower impact avoidance, minimization, and mitigation. This study was written to support the update for the Design Guidance, however it is not the final design guidance.
Recommendations of ISH306 include that the revised Design Guidance adopt a more holistic approach that includes guidance throughout the life cycle of the project, integrate early avoidance measures in each of the themes, include guidance for tributary projects, and focus more on spatial and temporal contexts in mitigation strategies.

In July 2017, while the ISH306 study was still underway, the MRC began the process for reviewing and updating the PDG (MRC 2017b). This process follows a typical MRC project process, which involves multiple iterations of review and participation by the MRC Internal Secretariat, MRC Joint Committee and Council, National Mekong Committees, and other stakeholders, which included hydropower developers, researchers, and government officials, media groups, and non-governmental agencies (MRC 2017c).

Table 5: Key Mekong River science products

<table>
<thead>
<tr>
<th>Initiative for Sustainable Hydropower Studies to Inform ISH0306</th>
</tr>
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<tbody>
<tr>
<td>Numerous studies conducted as part of the MRC Initiative for Sustainable Hydropower informed the revised Design Guidance. ISH01: Identification of ecologically sensitive sub-basins for sustainable development of hydropower on tributaries, sought to identify ecologically sensitive areas in the Lower Mekong River Basin and to provide a framework by which potential new hydropower developments could be evaluated for their impacts on ecologically sensitive areas (MRC 2015e).</td>
</tr>
<tr>
<td>The second study, ISH02: Development of guidelines on the multi-purpose evaluation of hydropower projects, the MRC contracted a team of consultants to develop a portfolio planning process for the evaluation of hydropower and multipurpose dam project portfolios (MRC 2015a, 2015b, 2015c, 2015d).</td>
</tr>
<tr>
<td>The ISH11 study, Improved environmental &amp; socio-economic baseline information for hydropower planning, analyzed information in order to improve understandings of social-economic and environmental conditions and trends in the LMB to inform sustainable hydropower planning (MRC 2013).</td>
</tr>
<tr>
<td>For the ISH13: Benefit Sharing Options for Hydropower on Mekong Tributaries, MRC member</td>
</tr>
</tbody>
</table>

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country working groups conducted an analysis of how mechanisms could apply within the context of their national setting (MRC 2014b).

Finally, for the ISH0306: Development of Guidelines for Hydropower Environmental Impact Mitigation in the Lower Mekong Mainstream and Tributaries, the MRC contracted a team of consultants to develop a generic and practical process for hydropower risk and impact mitigation by for the purpose of enhancing the Preliminary Design Guidance for Mainstream Dams and for supporting Member countries in their assessment and implementation of mitigation options. (MRC 2018a).

Summary

This case study chronicles the ways in which the MRC was involved in overseeing data collection and analysis in order to update the PDG for the PNPCA process. Throughout the case study the MRC relied on the 1995 Mekong Agreement to understand its responsibility to coordinate notification of hydropower in the basin and science production to best inform guidance for the PNPCA. The following analysis section seeks to detail the ways in which the MRC mandate and stakeholders influenced the content and methods of science production and, ultimately, its use in an updated PDG.
Works Cited


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CHAPTER 8

MANDATE INFLUENCE ON SCIENCE PRODUCTION AND POLICY OUTCOMES

Case Study #1: Nutrient Loading in the Red River Basin

Throughout the International Joint Commission’s (IJC) efforts to address water quality issues in the Red River Basin (RRB), the IJC and its subsidiary boards drew on treaties and mandates to guide decisions regarding science production and its use in policy. The BWT provides general guidance for the IJC and, subsequently the IRRB, while the IRRB mandate specifies the activities, such as water quality monitoring, under the IRRB’s domain.

The 1909 Boundary Waters Treaty (BWT) served as the primary guidance for the IJC and International Red River Board (IRRB) to inform the IJC’s understanding of the IRBO role in addressing nutrient pollution in the RRB. The BWT provides an encompassing mandate, broadly prohibiting the pollution of waters flowing across the border; however, the BWT does not explicitly give the IJC implementation powers to enforce water quality standards. In 1964, to address water quality in the RRB, and in accordance with the IJC structure, the U.S. and Canada issued reference for IRRPB (now the IRRB) to monitor 5 parameters at the border; the 1964 reference was in response to human and industrial waste concerns and was integrated into IRRB mandate (IJC 1964, IRRB 2001). While the IRRB is mandated to monitor five water quality parameters, the mandate does not include Nitrogen or Phosphorus, the primary pollutants of concern. Additionally, the IRRB mandate gives the IRRB jurisdiction over the RRB, which does not included Lake Winnipeg (IRRB 2001).
Thus, the BWT and the IRRB mandate define the IRRB role in addressing nutrient pollution as one of a coordinating platform between levels of government, but without authority to implement nutrient management strategies or goals across the basin.

The IJC’s limited scope of power, as determined by the BWT, also curbed the IRRB’s interventions in nutrient pollution, making it such that the IRRB, rather than addressing nutrient pollution alone, used its authority in the RRB to create a forum for stakeholders to address nutrient pollution. Within the BWT, the IJC has authority over issues regarding the “boundary waters,” which excludes, “tributary waters which in their natural channels would flow into such lakes, rivers, and waterways, or waters flowing from such lakes, rivers, and waterways, or the waters of rivers flowing across the boundary” (IJC 1909). Though Lake Winnipeg is the primary area of concern for nutrient loading from the Red River, under this clause of the treaty, Lake Winnipeg would not fall under the IJC or IRRB jurisdiction. Furthermore, the IJC needs member country approval in order to implement nutrient targets in the RRB, making it so that the IJC’s authority is restricted in regard to both its geographic jurisdiction as well as the specific nutrients it is authorized to monitor (pers. comm. 26 June 2018). Therefore, not in what it specified, but what it left out, the BWT blurred the role of the IRRB in addressing Nitrogen and Phosphorus loading, which had led eutrophication in Lake Winnipeg.

Though the BWT and IRRB mandate imposed some restrictions on the IRRB scope of authority, the IRRB work efforts were supplemented by the work of the Red River Basin Commission (RRBC), allowing the IRRB to collaboratively extend its reach in the RRB. The RRBC compliments the IRRB by working at the state level and conducting outreach to local
entities and cities. Unlike the IRRB, the RRBC is not beholden to governments or other entities, allowing the RRBC greater flexibility in how it chooses to carry out science and construct policy measures (pers. comm. 26 June 2018). The narrow IRRB mandate nudged the IRRB to expand its scope of jurisdiction by cooperating with the RRBC, which is free to operate without the limitations imposed by a mandate.

Overall, the IJC’s role in the RRB demonstrates how the broad BWT served as a framework for the IRRB to function within, by providing general parameters that outline the board’s responsibilities. This is evident in both the flexibility with which the IRRB can act (i.e. jurisdiction of water quality/quantity), coupled with the IRRB’s jurisdictional restrictions. The BWT was an important guidance for decision-makers in the RRB in that discussions regarding how to conduct science were centered around the BWT’s guiding principles. For example, the BWT outlines general provisions for the IRRB to follow, such as preventing pollution across the border; the BWT “no harm” principle was influential in guiding discussions regarding the need for science. Thus, when making decisions about how to address nutrient loading, the IRRB and stakeholders looked to the BWT to create a set of principles and policy goals. This is most evident when decision-makers first agreed upon nutrient targets, which then informed science production methods. Rather than conduct science and choose a policy accordingly, decision-makers chose policy goals and carried out science to match the policy. While the BWT was an important guidance for the IRRB, the BWT sets forth a limited scope of power for the IJC, which is applied to the IRRB as well. For example, because the IRRB is mandated to monitor five parameters and does not have jurisdiction of Lake Winnipeg, the IRRB collaborated with the RRBC and stakeholders in
order to increase their range of activity.

The overall influence of the BWT and IRRB mandate on the production of science and its uptake into policy is evident in the mandates broad guiding principles, which informed for goal-setting; however, the mandates also led the IRRB to rely on collaboration due to the restrictive nature of the mandates. The mandates, therefore, created a need for stakeholder participation in order to reach across RRB jurisdictions, providing stakeholders with the opportunity to participate in policy decisions (i.e. nutrient targets) as well as how to inform policy decisions with science (i.e. monitoring and modeling).

**Case Study #2: Fluctuating Water Levels in the Lake Ontario-St. Lawrence River Basin**

The International Joint Committee (IJC) structure, as outlined in the 1909 Boundary Waters Treaty (BWT), directed the ways in which study boards conducted science and involved interest groups in the science production process. The 1909 BWT requires that if member countries have a question or matter of difference, the member countries issue a reference to the IJC, which permits the IJC to investigate the matter (IJC 1909). The 1986 Reference, and ensuing directives, played a seminal role in the scientific process to address fluctuating water levels in the basin.

In 1986, the U.S. and Canada issued a reference, Docket 111, requesting that the IJC "examine and report on measures to alleviate the adverse consequences of fluctuating water levels" (IJC 1986). Following the 1986 Reference, the IJC issued a directive in 1990 to create the Levels Reference Board to fulfil the Docket 111 requests. Though the 1986 Reference
was broad, the IJC directive to the 1990 Levels Reference Board included specific requirements; the directive outlined principles, mandated a Plan of Study and included specific activities for the Levels Reference Study Board (IJC 1993a). The 1990 Directive also expanded upon the BWT by including a set of guiding principles that the Study Board identified as differing fundamentally from the 1909 BWT in some respects. While they did not recommend changing the 1909 BWT, the Study Board, “proposed that the guiding principles be used within the limits of the treaty” (IJC 1993b). The discussion of the BWT throughout the development of the Levels Reference Study demonstrated the role the BWT played in guiding the Study Board’s decisions.

Similarly, the BWT played a role in influencing the 1999 Directive to the Plan of Studies (POS) Team, which explicitly required the inclusion of study areas and activities, “in light of the 1909 Boundary Waters Treaty,” which prioritizes water allocation needs as: 1) domestic/sanitary use, 2) navigation, and 3) power and irrigation (IJC 1999). The 1999 Directive to the Lake Ontario - St. Lawrence (LOSLR) Study Board, as outlined in the POS, centered the LOSLR Board activities around the 1990 IJC Directive: “The Board’s main duty is to ensure that the study remains focused and aims to address the questions raised in the IJC’s Directive.” The 1999 Directive outlined in the POS was eventually the Directive for the LOSLR Study Board issued in 2000. In the LOSLR Board Directive, the IJC directs the LOSLR Study Board to use the 1909 BWT as guidance, “evaluate options… in a manner that conforms to the requirements of the Treaty, and the Board shall be guided by this mandate in pursuing its studies” (IJC 2000). Finally, the 2016 Order of Approval reflects the 1909 BWT priorities for water use (1. domestic/sanitary use, 2. navigation, and 3. power),
while accounting for additional interests, such as coastal property owners, recreational boaters and environmentalists in addition to other interest groups and the environment (IJC 2016).

In addition to serving as general guidance for conducting scientific research, the 1909 BWT requires that all interested parties have the opportunity to express their opinion in the decision and science-making processes; this requirements sets the standard for public involvement in scientific processes (IJC 1909). The 1909 BWT Article XII outlines a broad mandate for public involvement: “...all parties interested therein shall be given convenient opportunity to be heard...” (IJC 1909). The mandated public involvement was continually evidenced throughout the process of creating a new regulation plan. Starting with the 1990 Directives to the Levels Reference Study, the IJC mandated the Levels Reference Study Board include a Citizens Advisory Committee, which participated throughout the entire study process, provided input and created a set of recommendations (IJC 1993a). Building on the 1990 Directive, the 1999 Directive to the POS requires that the POS include public involvement in the study process by, “building upon the substantial public involvement already undertaken in developing the Scope of Work” (IJC 1999). The 2000 Directive continued to mandate stakeholder participation by directing the LOSLR Study Board to involve the public to the “fullest extent,” including public hearings, outreach. The 2000 Directive also required that the LOSLR Study Board to use the Public participation Guidance—a document that defines public, and public participation objectives and activities and directs the Study Board to work with the the Public Interest Advisory Group (PIAG) (IJC 2006). Finally, the 2016 Directive to the LOSLR Board requires that the 2016 LOSLR
Board create a communications committee which, “will ensure that the Board is proactive in acquiring knowledge about stakeholder needs and perspectives on an ongoing basis and in providing them with regular information about Board decisions and the issues before the Board” (IJC 2014). Throughout the entire process of creating a regulation plan, the IJC mandates and directives included requirements for public participation, demonstrating a pattern of stakeholder collaboration in both creating science and choosing a policy.

The decision-makers in the LOSLR basin used the BWT as guidance for setting priorities; the study boards used the BWT to determine study areas and include the public in the process of evaluating the final science and policy outcomes. The BWT served as a template for decision-making regarding what type of science to produce (i.e. what specific areas to focus on) as well as who to include in the process of translating the scientific findings into a regulation plan. The decision-making process incorporated stakeholders through the Shared Vision Model, which invited stakeholders to participate in reviewing regulation plans. Ultimately, while the BWT laid out priority issues, stakeholders introduced new topic areas through decision-making processes. Therefore, the BWT informed priority issues by establishing them in the treaty, but also by mandating public involvement, which led the study boards to develop new priority issues.

**Case Study #3: Development of the Joint Danube Surveys**

Throughout the International Commission for the Protection of the Danube River (ICPDR) efforts to understand the status of the Danube basin water quality and its priority issues, the ICPDR drew on its mandate and other policy frameworks to support decisions
regarding water quality standards in the basin. Such mandates and directives played a central role in determining the ICPDR’s responsibility in coordinating and leading efforts to understand and address water quality challenges in the basin.

Prior to the creation of the ICPDR, Danube Countries participated in international water quality coordination through the TransNational Monitoring Network (TNMN) under the Environmental Programme for the Danube River Basin (ICPDR 2007). The ICPDR was later established by the Danube River Protection Convention (DRPC), which reinforced the ICPDR responsibility to oversee joint monitoring efforts in the basin. In this way, the TNMN was built upon in the DRPC, which required that member countries cooperate on water quality monitoring efforts (ICPDR 1994, Article 9). Reinforcing this general framework for monitoring, when the European Union Water Framework Directive (EU WFD) came into force, it worked in tandem with the DRPC to create a policy platform from which the ICPDR drew its authority to address water quality challenge. Essentially, the TNMN provided a foundation for data collection, which the JDS built upon in order to meet EU WFD requirements for compliance (ICPDR 2007, 2008). Thus, through specific monitoring requirements, the convergence of the DRPC and EU WFD established the ICPDR’s responsibility to advance water quality objectives, building off of the existing TNMN procedures.

Following the introduction of the EU WFD in 2000, both EU and non-EU member countries in the Danube River basin drew on the EU WFD as a framework for expanding the work done for the TNMN while also building on EU WFD principles and requirements (European Commission 2012). Similar to the DRPC and the TNMN, the EU WFD outlined
requirements for monitoring programs, methods for monitoring and the ecological status
classification of water bodies (EU 2000). The overlap between the EU WFD and DRPC
made it such that the ICPDR became the platform for implementing the EU WFD
framework for water quality goals. The EU WFD influence is evident in the 1st JDS, which
states that the work done in the survey was focused on fulfilling EU water legislation
requirements, in particular the EU WFD (ICPDR 2002). Additionally, the Danube River
Basin Management Plan (DRBMP) 2015 Update follows the EU WFD requirements, citing
the EU WFD as the legal framework and impetus for the science used to inform the
DRBMP and explicitly naming the JDS3 as the underpinning for the 2015 update (ICPDR
2015). These examples demonstrate how the EU WFD requirements created specific
provisions, such as the DRBMP, which provided a narrow science production pathway for
the ICPDR by ensuring that the JDS would include data relevant to the EU WFD
requirements like the DRBMP. Thus, while the ICPDR had preexisting water quality goals,
they were altered and advanced by the EU WFD framework, which supported the ICPDR’s
work and accelerated its progress.

The ICPDR mandate, the DRPC, requires water quality monitoring and data
collection, which made the ICPDR an attractive platform for building on these requirements
to satisfy the EU WFD requirements. The JDS were a direct reaction to the need for more
data to inform the DRBMP, which was required under the EU WFD. Thus, requirements
included in the EU WFD combined with the agreements made in the DRPC complimented
each other, identifying a need for science production and creating a pathway for achieving
the subsequent use of science in policy in the DRBMP. Because the EU WFD required the
DRBMP, the ICPDR was able to focus on achieving this piece of science production, creating a narrow pathway for its uptake into management policies on both the basin and national scales.

**Case Study #4: Climate Change Adaptation in the Danube River Basin**

Included in its goal of overseeing the sustainable and equitable use of the waters within the Danube River Basin, the ICPDR is working to understand and address the impacts of climate change throughout the basin. The ICPDR derives its authority to coordinate climate change research and create policy directed at addressing climate change adaptation from its original mandate, the DRPC, as well as through other policy frameworks that include specific provisions regarding climate change. Accordingly, the ICPDR was given both a broad and encompassing mandate through the DRPC, which was focused through the 2010 Danube Declaration and EU WFD, which include specific instruction for the ICPDR to oversee climate change activities.

The ICPDR drew on three primary mandates and/or directives in order to rationalize efforts to collect data in order to develop a climate change adaptation strategy; these mandates and directives include the DRPC EU WFD and 2010 Danube Declaration. The first of these mandates, the DRPC, provided the ICPDR with an encompassing mandate, which allowed the ICPDR to cite the DRPC as a source of authority when seeking to address climate change issues. The DRPC provides a broad foundation to initiate scientific processes; however, the DRPC does not offer specifics on how to go about carry out scientific processes in order to achieve the objectives of the mandate (ICPDR 1994).
Building on the generality of the DRPC, the 2010 Danube Declaration hones in on the ICPDR responsibility to sustainable development by identifying and including provisions for climate change science. The 2010 Danube Declaration directs the ICPDR to “… encompass an overview of relevant research and data collection” and ensure that climate adaptation issues are included in the second Danube River Basin Management Plan (DRBMP) (ICPDR 2010). Reinforcing the 2010 Danube Declaration charge, in 2010 the EU provided the ICPDR with a grant to implement and follow-up the first DRBMP, a requirement under the EU WFD. The DRBMP required that the ICPDR incorporate climate change into river basin management, “by bringing together existing research results, making use of existing (EU) guidance, focusing on preparing proposals for adaptation actions and integrating these in the river basin management plan” (ICPDR n.d.). Together, the specific charges included in the 2010 Danube Declaration and EU WFD build upon the encompassing scope of the DRPC by supporting the DRPC general requirements for science production, but specifying that the ICPDR should facilitate a synthesis of existing science focused on climate change.

In addition to supporting the ICPDR’s involvement in climate adaptation research and management, ICPDR policy frameworks and institutional structure influenced the type of scientific methods employed to develop both The Study and The Strategy, as well as updates and revisions to both projects. For example, the 2010 Danube Declaration and EU directive each require the ICPDR to facilitate a synthesis of existing information regarding climate change. Rather than collect new data or carry out original research, the ICPDR drew on existing information to inform The Study. However, because Upper Danube countries had a greater number of climate-relevant studies, as well as a greater number of studies
available in English, the information collected for The Study was disproportionately skewed to Upper Danube countries (ICPDR 2012). Thus, as a result of the narrow directives to synthesize existing information, the type of science produced reflects an uneven understanding of climate change impacts throughout the basin.

Finally, the specificity with which the the 2010 Danube Declaration and the EU WFD directed the ICPDR to conduct a synthesis with the explicit purpose of informing management decisions created a clear pathway for science production and its uptake into policy. The ICPDR identified the 2010 Danube Declaration as, “... the mandate for the elaboration of the ICPDR Strategy on Adaptation to Climate Change,” which was to be based upon The Study, that is, the “... main knowledge base for the elaboration of the adaptation strategy” (ICPDR 2013). Moreover, the ICPDR interpreted the EU WFD requirement for climate change measures in the DRBMP as directives for drawing on The Study to inform The Strategy goals (ICPDR 2013). Along with explicit direction to synthesize and use climate change studies to develop a policy framework, the 2010 Danube Declaration and EU WFD both emphasize the importance of updating and revising this information as a means of adapting to changes in the basin. This is manifest in the directives to periodically update The Study and revise The Strategy accordingly. In accordance with these mandates, the ICPDR set out to synthesize new climate change studies and revise The Strategy accordingly. Thus, throughout the creation and revision of The Study and The Strategy, both the 2010 Danube Declaration and EU WFD provided a narrow pathway for science production in The Study, and its integration into The Strategy and subsequent updates.
The broad overarching mandate of the DRPC gave the ICPDR flexibility, while the 2010 Danube Declaration gave the ICPDR specific direction. This led to particular science production, but with allowances for autonomy throughout the process of developing The Study. The 2010 Danube Declaration provides a narrow directive for the type of science to produce—a synthesis—and explicitly states that the findings should be included in the updated DRBMP. Thus, the combinations of such a clear directive within the general DRPC provisions informs both the type of science produced and how it should be integrated into a final policy decision.

**Case Study #5 Sustainable Hydropower Development in the Mekong River Basin**

The 1995 Mekong Agreement provision that the MRC oversee the cooperative maintenance of flows on the mainstream introduced the requirement for a process to guide notification of hydropower development (the PNPCA process) as well as guidance to navigate the process. In doing so, the 1995 Mekong Agreement established the MRC as a platform for cooperation, responsible for facilitating the PNPCA process as well as knowledge production, which the MRC did through development of the PDG. Though the member countries and developers initially struggled to fully understand the process, because the 1995 Mekong Agreement established the MRC’s role in overseeing the PNPCA process and producing guidance to inform the process, the science that MRC produced was more readily accepted by member countries.

While it is clear that the 1995 Agreement includes provisions for prior notification for development, the PNPCA process was vague. Following publication of the PNPCA,
member countries struggled to understand the process due to ambiguities in the PNPCA document, and, as a result of this obscurity, member countries, civil societies and donors requested that the MRC clarify the PNPCA process (TERRA 2008, Lee and Scurrah 2009, MRC 2011a). This stakeholder-led demand for policy clarification and science production reaffirmed the MRC’s role as a science provider, as established by the 1995 Mekong Agreement, and well-accepted by member countries and other stakeholders. Moreover, the MRC identifies its greatest strength as its knowledge base, which can provide a center for information collection and generation so as to inform decision-making at all levels of the basin (MRC 2008). For example, the perception of the MRC as a provider of knowledge was made clear in 2008 at the Regional Multi-Stakeholder Consultation on Hydropower, in which the MRC was continuously referenced as a source of information. A concluding statement outlined the MRC’s role as: “MRC has an important role in the region to collect, analyse and disseminate data and information for and on hydropower development” (MRC 2008).

Accordingly, both the requirements of the 1995 Mekong Agreement, positioned the MRC at the center of knowledge production, which contributed to the member country understanding of the MRC as a center of information, thereby prompting them to request the MRC to clarify the PNPCA process through the PDG and subsequent update.

The MRC’s mandated responsibility to assist member countries with the PNPCA process eventually led the MRC to facilitate science production to inform the process. The MRC responded to confusion regarding the PNPCA process with the Preliminary Design Guidance (PDG) for the PNPCA process, which served to clarified the process. However, the confusion regarding the PDG and PNPCA process persisted and the Development
Partners Group, a coalition of donors organizations and partner countries, reiterated a request for clarification at the MRC informal donor meeting in 2011. In addition to the Development Partners’ statement, Lao PDR, Australia and other member countries echoed a call for clarification on the PNPCA process, asking specifically for a workshop to discuss the roles of member countries in the PNPCA process. As a result of this direct request for clarification regarding the PNPCA, the MRC identified that their next step would include activities focused on filling knowledge gaps (MRC 2011a). In response to the identified need for information, the MRC Institute for Sustainable Hydropower (ISH) Strategic Environmental Assessment conducted the ISH0306- Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries (ISH306) (ICEM 2010, MRC2018).

The 1995 Mekong Agreement was decisive in defining the MRC’s role in the Mekong River basin. The 1995 Agreement ascribes specific requirements to the MRC, making the MRC a source of information generation. The PNPCA requirement made it necessary for the MRC to aid in developing guidelines, which, in turn, required science production - the PDG. The inclusive nature of the MRC structure allowed for participation from each member country in the process. The structure permitting member countries and stakeholders is seen when the member countries explicitly requested a workshop in order to discuss the roles of member countries in the PNPCA process. The PNPCA process was the driving factor for creating the PDG, which required collecting baseline data. Overall, the MRC mandate created a general need for policy, which subsequently created a need for scientific research to inform the policy.
Cross Comparison of Case Study Mandates

Overview

This set of case studies provides insight into how IRBO structure and mandate may influence science production and its uptake into policy. The following section compares across the five case studies to analyze how the founding treaties and subsequent IRBO directives delineate the role of IRBOs as well as their scope of authority in facilitating science and policy production. IRBO mandates, policy directives, may influence the involvement of basin actors, the timing and content of science and policy production and the IRBO impetus for conducting scientific research.

IRBO Treaty Authority in Science Production

For each International River Basin Organization (IRBO), the treaty, which serves as the IRBO’s founding document, provides the cornerstone from which the IRBO produces science by including text articulating the IRBOs role in science production. As such, the treaty serves as source of authority for the IRBO to engage in science production and for member countries and stakeholders to make claims on the IRBO for the production of science. Table 6 provides selected text from the IRBO treaties describing the IRBOs mandated role in science production. The 1909 Boundary Waters Treaty (BWT) gives the International Joint Commission (IJC) authority to examine and report on questions referred to the IJC by the member countries. The BWT determined a process by which the IJC was given authority to conduct and oversee science, but is prevented from acting until receipt of reference from the member countries. While the IJC is beholden to member country
references, upon receiving a reference the IJC may investigate matters and make relevant recommendations. In the International Convention for the Protection of the Danube River (ICPDR), the 1998 Convention on Cooperation for the Protection and Sustainable use of the Danube River (DRPC) charges the ICPDR with providing member countries with a framework for scientific research, in particular monitoring and assessment. Finally, the 1995 Mekong Agreement includes several clauses that direct the Mekong River Commission (MRC) to compile data and conduct scientific studies so as to protect and maintain the Mekong basin environment and its people.

The treaties vary in the level of specificity regarding what type of science the IRBO is charged with producing as well as what approvals the IRBOs need in order to produce science. In juxtaposition to the BWT, the DRPC and Mekong Agreement provide the IRBOs with greater autonomy to initiate and produce science by not requiring member approval prior to science initiation. Additionally, unlike the DRPC and Mekong Agreement, the BWT does not specify which scientific tasks the IJC should conduct, whereas the DRPC and Mekong Agreement both include provisions for activities such as data collection and monitoring. Each treaty establishes the IRBO as a source of scientific generation.

Table 6: Treaty excerpts delineating the IRBOs role in science production

<table>
<thead>
<tr>
<th>Treaty Determination of IRBO Role in Science Production</th>
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<tbody>
<tr>
<td><strong>IJC 1909 Boundary Waters Treaty</strong></td>
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<tr>
<td>“The International Joint Commission is authorized in each case so referred to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the treaty.”</td>
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<tr>
<td>Reference</td>
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<tr>
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</tr>
<tr>
<td>ICPDR 1994 Convention on Cooperation for the Protection and Sustainable use of the Danube River</td>
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<tr>
<td>MRC 1995 Mekong Agreement</td>
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</table>

**IRBO Treaty as Guidance for Subsequent Mandates**

While the IRBO treaties provide a foundation for establishing the general IRBO roles in science production, sub-mandates and directives narrow the IRBO role to address specific challenges in the basin. The comprehensiveness of IRBO treaties create a broad scope of IRBO authority, allowing the IRBOs to address a range of issues, including small-scale watershed processes. The breadth and flexibility make it such that many different activities can fall within the scope of the IRBO’s jurisdiction. Table 7 includes text from the IRBO treaties outlining their scope of authority.

The IJC BWT broadly prohibits the pollution of waters flowing across the border from one country into another. Accordingly, the flow of nutrients from the U.S. portion of the Red River into lake Winnipeg is clearly prohibited by the BWT and so is under the IJC
jurisdiction. In Case Study #1, the International Red River Board (IRRB) mandate narrows in on the prohibition of pollution by identifying five parameters the IRRB is responsible for monitoring at the border. The IRRB mandate adheres to the BWT and further defines the BWT application in the Red River by creating a basin-specific application for pollution in the Red River basin. Similarly, the BWT requires that if a construction project elevates the natural water levels with effects on the opposite side of the border, the member countries must provide specific provisions to account for such changes; this provision was especially relevant throughout Case Study #2. Under this general directive, and because the Moses-Saunders power dam affects water levels, the Lake Ontario-St. Lawrence River (LOSLR) study board directives, as well as the 2016 LOSLR Board mandate, identify specific regulations for outflow and subsequent water levels. Finally, the BWT provides general instruction for including the public in IJC processes to the greatest extent possible. Throughout the LOSLR studies, the study board observed this guidance and created formal and mandated mechanisms for public participation through Public Interest Advisory Group (PIAG), public comment periods and public hearings. In both IJC case studies, the BWT set the overarching framework for IRBO action while study directives and mandates allowed for the study teams to apply the BWT to address the issues through a basin-specific approach.

In Case Study #3, Article 9 of the DRPC explicitly makes the ICPDR responsible for facilitating joint water quality monitoring between the member countries. Article 9 provides specific directives for member countries to harmonize data collection and analysis methods and agree on parameters to monitor water quality. The DRPC requirements created the initial need for centralized water quality monitoring and assessment; by establishing the ICPDR in the same treaty, the DRPC situates the ICPDR as the appropriate organization for
coordinating joint monitoring efforts. Thus, the broad directives in the DRPC set up the ICPDR as a coordinating body such that with the introduction of the European Union Water Framework Directive (EU WFD), the ICPDR was able to expound up the DRPC requirements to satisfy the EU WFD requirements for the Danube River Basin Management Plan (DRBMP). Similarly, in the ICPDR climate change case study, Case Study #4, because the DRPC had helped to establish the ICPDR as a center for joint knowledge production, the ICPDR’s role was clear. The 2010 Danube Declaration draws on the ICPDR authority to facilitate the production of climate change science and policy. The DRPC emphasizes the ICPDR’s role in overseeing sustainable water use practices. Drawing on the DRPC general directive, the 2010 Danube Declaration narrows in on the ICPDR responsibility and authority to oversee climate change science.

Finally in Case Study #5, the MRC presents an exception to this trend because the 1995 Mekong Agreement includes the very specific directive for notification and prior consultation for development that will have transboundary effects. Through the Mekong Agreement, the MRC is responsible for coordinating the process of notification in addition to other responsibilities outlined in the Agreement, such as protecting the environment, cooperation, maintenance of flows on the mainstream prevention of harmful effects, freedom of navigation etc. The Mekong Agreement provides both a comprehensive and specific directive for the MRC.

Table 7: Treaty scope of authority

| Treaty Determination of IRBO Scope of Authority |

128
<table>
<thead>
<tr>
<th>Treaty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IJC 1909 Boundary Waters Treaty</td>
<td>“This International Joint Commission shall have jurisdiction over and shall pass upon all cases involving the use or obstruction or diversion of the [boundary] waters with respect to which under Article III or IV of this Treaty…” (IJC 1909).</td>
</tr>
<tr>
<td>ICPDR 1994 Convention on Cooperation for the Protection and Sustainable use of the Danube River</td>
<td>“The Contracting Parties shall cooperate in the framework of the International Commission. For implementing the obligations of the Contracting Parties pursuant to Articles 1 to 18 the International Commission elaborates proposals and recommendations addressed to the Contracting Parties” (ICPDR 1994).</td>
</tr>
<tr>
<td>MRC 1995 Mekong Agreement</td>
<td>“The institutional framework for cooperation in the Mekong River Basin under this Agreement shall be called the Mekong River Commission and shall, for the purpose of the exercise of its functions, enjoy the status of an international body, including entering into agreements and obligations with the donor or international community” (MRC1995).</td>
</tr>
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**IRBO Treaty Scope**

Drawing on the encompassing nature of their treaties, IRBOs may decide to take on science themselves, yet member countries often ask the IRBOs to take on specific science and policy tasks; these tasks either fall directly under the treaty scope or serve to expand that scope.

In the IJC case studies, the IJC and sub-boards are beholden to member country references, which, when given, allows the IJC to investigate the matter of concern. In Case Study #1, the IRRB is tasked with monitoring a limited number of pollutants at the border, which did not include the nutrients of interest nor Lake Winnipeg. While these parameters do not fall underneath the scope of the treaty, the IRRB drew on the principles of the BWT...
to address nutrient loading in the basin and eutrophication in Lake Winnipeg. However, the IRRB is limited to establish nutrient targets under the IRRB mandate until the member countries give reference to do so. Similarly, in the LOSLR case study, Case Study #2, the IJC reference structure led to delays in creating a new regulation plan because the member countries had to first give a reference and then provide funding for the study.

In the ICPDR (JDS) Case Study #3, the ICPDR was given general provisions to monitor water quality under the DRPC. The obligations of some countries, and eventually all, to adhere to the EU WFD requirements prompted member countries to look to the ICPDR as a framework for implementing the EU WFD. In this case, joint water quality monitoring was under the DRPC scope, but member countries also created a demand for the science under the application of the EU WFD. Likewise in the ICPDR climate change case study, Case Study #4, at the 2007 workshop stakeholders requested a synthesis of climate change science to inform the study. The ICPDR oversees the sustainable use of the Danube River so this request falls under the general treaty, but the specific request to undertake a comprehensive climate change synthesis was requested by stakeholders.

Finally, in Case Study #5, the Mekong Agreement obligated the MRC to facilitate a process for prior notification— the Prior Notification and Prior Consultation Agreement (PNPCA) process. However, within the broader framework of prior notification, member countries nudged the MRC to produce guidance for the PNPCA process, which, in turn, led to studies to gather baseline information to inform the design guidance.
IRBO Treaties influence the IRBOs ability to respond to emerging issues

In some cases, the mandate or directive was in response to an emerging basin issue while other mandates provided for science initiation as a part of the IRBO’s ongoing responsibilities. In this way, the mandate or IRBO structure can influence if science production will be proactive (a continuing responsibility such as monitoring) or reactive (in response to a specific, acute issue). For example, in case Studies #1 and #2, the Red River and Lake Ontario - St. Lawrence case studies, the IJC could not address emerging issues (nutrient pollution and harmful water levels, respectively) without prior directives to do so from the U.S. and Canada. However, in Case Study #3 and #5, the ICPDR Joint Danube Surveys and MRC Design Guidance, the IRBOs had provisions in their original mandates that necessitated the production of science to achieve IRBO or basin goals. This may be, in part, due to the time at which the IRBO treaties were written. In the case of the BWT, the 1909 Agreement reflects a set of priorities relevant to the time, (domestic/sanitary use, navigation; power and irrigation) but makes no mention of more “modern” concerns, such as climate change. This is exemplified in the LOSLR case study, in which the 1999 Plan of Study (POS) Team consciously departed from adhering only to the BWT priorities in order to account for the shifting priorities of the basin over time. On the other hand, the MRC and ICPDR treaties were both written nearly a century after the BWT, ensuring that the IRBOs were able to address and respond to current basin challenges. For example, both treaties include provisions for adaptation and climate change, which was not explicitly included in the BWT. Thus, the IRBO treaties influence the IRBO’s ability to respond adaptively to emerging issues, in part due to the time in which the treaty entered into force.
IRBO Mandates may Lead to Jurisdictional Uncertainty

While a range of activities may fall under the IRBOs scope, there is sometimes uncertainty as to whether the science the IRBO wants to undertake, or is pressured to undertake by member countries or stakeholders, falls within the scope of the mandate; this can impede the science production process. This is primarily evident in Case Study #1 in which stakeholders such as the RRBC as well as state and provincial stakeholders sought to address nutrient loading through a collaborative effort. However, uncertainty regarding the IRRB scope jurisdiction for Lake Winnipeg led to confusion, but also coordination between the IRRB and other organizations in the region.

Discussion of Mandates’ Overall Influence on Science Production and Policy Uptake

IRBO mandates determine both the IRBO structure with implications for the scope of the IRBO’s authority in providing scientific knowledge and policy decisions. IRBO treaties and mandates primarily influence science production and its uptake into policy by creating parameters for the IRBO to operate within. The five case studies discussed in this thesis demonstrate the influence of mandates on science production and its integration into policy through establishing the IRBO structure and its role in science production; these mechanisms have implications for the IRBOs ability to produce CRELE knowledge, which supports the integration of scientific information into policy.

IRBO structure, as determined by the IRBO mandates, works to delineate the IRBO role in the basin. Each of the three IRBOs discussed in this thesis is classified as a “Commission,” which is regarded as, “A group of officials appointed by riparian
governments to undertake functions that include monitoring (e.g. data collection) and regulation (e.g. coordination, policy setting); commissions have full-time staff and a technical office” (Lautze et al. 2013). The function and mandate of commissions differentiates commissions from other IRBOs, such as committees or authorities, by establishing the commission’s role as that of coordinating and monitoring. Generally, commissions are given broad mandates, to act within the basin (Bakker 2006, Hooper 2006, Lautze et al. 2013). Such mandates serve both to establish IRBOs as a source of authority as well as define the parameters of that authority.

Previous research has identified best practices for IRBOs, including IRBO institution framework that is both robust and flexible, which includes modern legislation, and IRBO management that is grounded in knowledge generation. IRBO mandates should clearly identify the IRBO structure and function based on a decision-making process of authority and responsibility (Millington and Town 2000, Hooper 2003). Accordingly, strong mandates serve to provide the IRBO with the authority to conduct science while defining the IRBO’s role as a source of knowledge production within the basin. The clarity of an IRBO’s role in the basin has implications for the IRBO’s ability to produce knowledge that member countries conceive of as reliable and useful. If an IRBO’s position as a provider of knowledge is well-established and clearly accepted by member countries, the scientific output from the IRBO will bear more significance in influencing policy outcomes (Mukharov and Gerlak 2013, Schmeier 2014, Soomai 2017). Each of the three IRBOs in this thesis operate as sources of knowledge generation, with authority to carry out scientific processes. As such,
the IRBO’s authority in the basins is clear and accepted by member countries, allowing the IRBOs to facilitate production of usable information.

Finally, the flexibility of the mandate influences the IRBOs ability to act reflexively and pursue science projects relevant to the basin. Broad mandates allow organizations to tailor projects in response to basin activities, allowing for organizations to flexibility respond to and manage basin needs (Kistin and Ashton 2008). In contrast, narrowly-defined mandates have the potential to constrain an organization’s scope of power and limit their ability to monitor, predict and address emerging issues (Toope and Brunee 2005, Vignola et al. 2013). Each of the three IRBOs operates within a relatively broad mandate, but with varying degrees of specificity.

As discussed, the IRBOs treaty and mandates influence the IRBOs role and authority in generating scientific knowledge. The three IRBOs discussed in this thesis are each well-established as centers of scientific production with fairly broad mandates to carry out science; this combination of characteristics allows the IRBOs to flexibly determine the type of science and the methods employed to produce it. Accordingly, the IRBOs are equipped to adapt to basin needs in order by producing relevant information for emerging challenges. Additionally, the IRBOs authority in the basins provides credibility and legitimacy to the knowledge the IRBOs produce. Thus, the IRBO mandates and structure have implications for IRBO’s ability to create CRELE scientific knowledge, which is more readily integrated into policy decision.
Works Cited


MRC. (2018). ISH0306—Development of guidelines for hydropower environmental impact mitigation and risk management in the lower Mekong mainstream and


Personal communication with IRRB Member. 26 June 2018.


CHAPTER 9

STAKEHOLDER INFLUENCE ON SCIENCE PRODUCTION AND POLICY OUTCOMES

Case Study #1: Nutrient Loading in the Red River Basin

Collaboration between the IRRB and RRBC created an opportunity for the two boards to complement and supplement the others’ activities in addressing water quality concerns in the RRB. The RRBC board is comprised of representatives from each federal and state government, including Tribes, First Nations and local officials and agency representatives (RRBC 2005). Both the IRRB and RRBC seek to facilitate comprehensive and integrated watershed management (RRBC 2005, IRRB n.d.). The complimentary, and sometimes overlapping, composition and goals of the IRRB and RRBC expand the reach of each organization in producing and using science. The RRBC already had a strong history of convening stakeholders to conduct science and create policy—this strengthened relationships with stakeholders and the RRBC; a characteristic the RRBC was able to contribute to IRRB efforts. For example, prior to the creation of the IRRB, the RRBC assembled representatives from agencies and organizations within the basin to inventory major resource issues, including water quality to create a comprehensive and centralized source of information. This information set the foundation for the RRBC Natural Resources Framework Plan (NRFP), which sought to create common guidance for decision-makers in the basin (RRBC 2005). Similarly, during the initial phases of the RESPEC study, the RESPEC team required additional information on algae and waterchemistry; accordingly, an interagency group undertook a collaborative sampling process for the study (Miller et al. 2016). These collaborative efforts to participate in the RRB studies demonstrates the
strength of the RRBC is convening stakeholders to address water quality challenges in the basin.

While the RRBC has a history of science production and greater flexibility to conduct outreach and develop implementation plans, the IRRB has the authority to coordinate government activities to address nutrient pollution (pers. comm. 26 June 2018). The IRRB and RRBC collaboration is strengthened by overlap in membership between the two boards; two RRBC board members sit on the IRRB board. Furthermore, the RRBC and IRRB combined Water Quality Committees (WQC) to streamline efforts (pers. comm. 26 June 2018). Through multiple instances of overlap, the IRRB and RRBC work in tandem to reach across jurisdictions and out to a range of stakeholders, including stakeholders in developing the RESPEC stressor-response model and subsequent nutrient targets.

In the Red River basin, the IRRB and RRBC each played complementary roles in developing nutrient targets and carrying out or overseeing science production to inform nutrient targets and management. The RRBC, which is very active in the RRB, used its role as a source of knowledge and local collaboration to reach across state and provincial jurisdictions in order to include other stakeholders in science production and setting nutrient targets. RRBC-led collaboration created a foundation for stakeholder cooperation on addressing nutrient loading in the RRB. As a result, stakeholders participated in data collection and setting nutrient objectives, making them more willing to accept nutrient targets and management plans. Ultimately, the RRBC and other state and provincial stakeholders worked together to create a basin-scale body of information and drew on this information to create policies, such as nutrient targets and management plans.
Case Study #2: Fluctuating Water Levels in the Lake Ontario-St. Lawrence River Basin

The IJC provided multiple pathways for stakeholder participation and, on multiple occasions, stakeholders led the IJC to commission scientific studies or reviews. The 1993 Levels Reference Study included extensive public participation through the Citizen Advisory Committee. In a letter to the member countries, the IJC wrote that the Advisory Committee had a significant influence on the direction and outcome of the study. Further, the IJC Advisory Committee helped to bring individuals with diverse interests to common ground (IJC 1993a). Notably, the IJC recommended this structure of public participation for future studies: “The International Joint Commission recommends that the Federal Governments review the Commission’s public involvement experience under the Reference and use this experience as a model for future large-scale studies of natural resource matters” (IJC 1993b).

Throughout the study, the public was extensively involved through eight bilingual newsletters and 17 public workshops, progress review meetings and forums, as well as ongoing networking among the interest groups by Advisory Committee and Study Board members (IJC 1993b). Such stakeholder participation set a precedent for future IJC and LOSLR studies, demonstrating the extent to which stakeholders might be involved and the impacts they may have on science and policy production.

Following the 1993 Levels Reference Study, public participation was regularly incorporated into study plans and policy processes to create a new regulation plan. The Study Board continued public involvement upon the release of Plan 1998, which was subsequently open for public comment. Stakeholders gave input during six public meetings,
and, ultimately, the IJC heard a range of responses from “mild support to strong opposition” and decided that Plan 1998 was not a sufficient deviation from the existing regulation plan (Stakhiv et al. 2006, Clamen and Macfarlane 2018). Following the public influence in rejecting Plan 1998, the 1999 POS again emphasized the IJC’s focus on public involvement in the study process: “The continuous involvement of all interests throughout the criteria review process is critical to the success of the endeavor and will be included” (Feierstein et al. 1999). This provision of the POS was manifest in 2000, when PIAG served as a liaison between the LOSLR Study Board and the public with the principle objective of ensuring that the LOSLR Study integrated public interests and “natural knowledge” (Barletta et al. 2005). The impact of public input was demonstrated at a meeting towards the end of the LOSLR study in which a commissioner questioned the motivating reason for the LOSLR Study, to which a LOSLR Study Board member replied that there had been a call to do more for recreational boating and the environment. In this case, the stakeholders interested were seen as the impetus for initiating the LOSLR Study, when some had considered the ‘status quo’ regulation plan to be sufficient (IJC 2005). Throughout 2004-2005, PIAG hosted 14 public meetings to receive and integrate comments on regulation plans. PIAG gave over 140 presentations and gathered public feedback from roughly 6,000 citizens. Finally, the public contributed feedback through comments and surveys as well, which were used to tweak the plan options (Barletta et al. 2005). In 2008 the IJC opened Plan 2007 for public hearings and comment and heard widespread opposition and calls for a return to more natural flows. Again, the IJC cited lack of public support as reason to reject Plan 2007 (IJC 2014). Finally, after developing Plan 2014 the IJC sought public comment on the plan. “More than 5,500 comments were received, in total. This included 206 oral testimonies at the 12 hearings and
public teleconferences, over 3,500 signatures on four different petitions, more than 700 post cards and form letters, and nearly 1,000 written website, email and unique letter responses.” (IJC 2014). Though the IJC continued to hear opposition, Plan 2014 received much stronger support, helping to usher it in as the new regulation plan for the LOSLR basin (IJC 2014).

Throughout the 31 years it took to implement a new regulation plan, the IJC and its study boards integrated public input into the scientific process and policy development through meetings, hearings, surveys and online and mail-in comment periods. This is evidenced in the extensive public outreach efforts catalogued in this case study, which demonstrate a pattern of public participation at the beginning, (due to study directives) during the studies (while sitting on boards and participating in meetings), and in the final policy outcome (by reviewing and commenting on the final policy outcome — such as Plan 1998, 2007 and 2014).

Study directives required the inclusion of stakeholders through a variety of mediums and, as a result of stakeholder participation, the LOSLR study board co-produced science knowledge and included stakeholder input in the final policy decision. Stakeholders co-produced science in the application of the Shared Vision Model, which ensured that stakeholder interests were accounted for in the development and analysis of the regulation plans. Stakeholders also participated in policy formation through a number of meetings, comments and hearings, which allowed stakeholders to express their opinions; the IJC included these stakeholder interests in determining the appropriate regulation plan, thereby influencing how the science was used to inform the final policy.
Case Study #3: Development of the Joint Danube Surveys

The International Commission for the Protection of the Danube River (ICPDR) involved stakeholders, primarily member countries, throughout the process of collecting and reviewing data during the Joint Danube Surveys (JDS). By involving member countries during the process, member countries were able to identify relevant and useful information for the surveys, aiding in its final update into management plans.

Through review of science and in meetings, ICPDR member countries and observers identified and prioritized risks in the basin, which subsequently influenced the focus of how science was carried out to address water quality goals. The Danube River Protection Convention (DRPC) includes stakeholder groups as observers to the ICPDR, allowing organizations to participate in ICPDR meetings and sit on EGs (ICPDR, 2009; Sommerwerk et al. 2010). Additionally, each member country is responsible for nominating representatives to the Expert Groups (EGs). These EGs led the science production process, determining what type of science to produce under the ICPDR framework. For example, the Monitoring and Assessment Expert Group (MA EG) was completely responsible for planning and carrying out the Joint Danube Surveys (JDS), providing member countries with the opportunity to influence the methods and content of the JDS through meetings to discuss and review the JDS methods and findings. For each of the three surveys, the MA EG selected sampling location, parameters and analysis methods, as well as experts to participate in the process. Additionally, the Danube River Basin Management Plan (DRBMP) update included stakeholder input through written comments, a consultation workshop, online
surveys and social media so as to include stakeholders in the entire process, “from conceptualising policies, to implementing measures and evaluating impacts” (ICPDR 2015).

In addition to reviewing and verifying the JDS methods and results, National experts joined the sampling ship as it stopped in each country, allowing national representatives to board the ship and participate in data collection. This participation in data collection created the opportunity for stakeholders, in this case — national representatives, to work in conjunction with ICPDR scientists in order understand the science and ensure it addressed their priority needs. This type of co-production offers a valuable pathway for integrating scientific results into management and policy decisions, while also producing results stakeholders perceive to be reliable and relevant. Thus, through integrating national representatives into science production processes, the ICPDR provided an opportunity for stakeholder input to direct the methods and objectives of science production in the JDS.

In developing the JDS, member countries were given authority to determine what science was needed and the methods for producing it. Because of the role of TGs and EGs in data collection and science production, member countries were able to ensure that their interests were represented in the science produced and the ensuing management plans. The national teams that partook in the JDS contributed directly to data collection and analysis through their participation onboard sampling ships, allowing member countries to participate in science joint knowledge production with the ICPDR. Overall, by integrating stakeholders into science production, the ICPDR both ensured a consistent dataset across countries while also setting up a process for joint data collection in the future to be perceived as reliable and relevant by stakeholders.
Case Study #4: Climate Change Adaptation in the Danube River Basin

In the International Commission for the Protection of the Danube River’s (ICPDR) efforts to create and revise both The Study and The Strategy, the ICPDR incorporated stakeholders into the process through a variety of mediums. The ICPDR convened conferences in order to engage with national experts in Expert Groups (EGs), while soliciting priorities from the member countries regarding a comprehensive plan to understand and address climate change in the basin.

The impetus to carry out The Study came from the 2007 Adaptation of Water Management to Effects of Climate Change in the Danube River Basin Conference, in which member countries proposed a synthesis of existing climate change information in the basin (ICPDR 2018a). Through the member countries demand for the synthesis, which initiated The Study, the member countries maintained influence in deciding what type of information to collect. The ICPDR included stakeholders in science review and production by inviting national representatives to participate in workshops, allowing stakeholders to prioritize adaptation actions and create a vision for The Strategy. At these workshops, stakeholders and member country representatives highlighted the need for an interdisciplinary approach to The Study with coordination between different levels of governance (ICPDR, 2012). In addition to informing The Study priorities, each of the ICPDR EGs and Technical Groups (TGs), composed of national experts and stakeholders, participated in developing The Strategy by commenting on drafts and eventually endorsing The Strategy. In order to allow for each ICPDR member country to participate in developing The Study, member countries nominated experts to the Climate Change Team to provide additional input and guidance.
The influence of this stakeholder engagement is evident in the updates to The Study and The Strategy, which reflect stakeholder concerns, such as threats to groundwater. Specifically, the ICPDR shared the Revised Study at a workshop in March 2018 to engage stakeholders, which produced recommendations and suggestions for updating The Study, providing specific input regarding groundwater for the revision of the Danube Climate Adaptation Strategy (ICPDR 2018b). This stakeholder input was directly integrated into the Revised Strategy, thereby demonstrating the impact of stakeholder priorities in influencing the final policy outcome.

While stakeholders in this case study had limited participation in determining the use of science in policy, through workshops, meetings and TGs and EGs, member countries were able to identify the need for a synthesis of information to better understand the effects of climate change on the basin. Workshops and meetings between Climate Change team, along with the EGs and TGs, provided a means for national representation in the development of The Strategy. Overall, the ICPDR involved stakeholders in prioritizing issues included in The Study, while allowing for the stakeholders to review and inform The Strategy.

**Case Study #5: Sustainable Hydropower Development in the Mekong River Basin**

Stakeholders played an important role in identifying challenges and issues with the PNPCA process, which, subsequently informed the type of science necessary for updating the PDG. Additionally, the member countries and hydropower developers were involved in
developing baseline data for the PDG. Stakeholder participation in the PNPCA process and updates to the PDG, in conjunction with member country participation in data collection, ultimately influenced the content of the science produced for the purpose of updating the PDG.

Application of the PDG to the Xayaburi, Don Sahong and the Pak Beng projects unearthed challenges member countries faced with navigating the PNPCA process. In particular, the process of approving the three proposed hydropower projects highlighted the need for baseline data related to water flows, sediment transport, and fish ecology as well as the PDG’s insufficient guidance on how to measure and understand cumulative environmental and transboundary impacts. Such a need for information became apparent through the prior consultation and stakeholder forums, which provided opportunities for stakeholders to participate in the development process. For example, in a 2018 Op-Ed, the CEO of the MRC wrote that consultations with stakeholders had altered ongoing projects: “For example, during the prior consultation process for the Xayaburi hydropower project, stakeholders raised concerns on the scheme’s impact on fish migration, sediment, and more. As a result, Laos and the developer made a significant investment to revise the project, including by improving fish passages. The MRC has reviewed the Xayaburi design changes, concluding that while the effects of the redesign cannot yet be fully assessed, the prior consultation process was instrumental in identifying shortcomings of the original design and that the developer has with the redesign made commendable efforts to avoid, minimise, and mitigate harmful effects” (ICPDR 2018a). In the 2018 Op-Ed, the MRC CEO demonstrates the importance of stakeholder input in determining the type of science produced (MRC
The 2010 Xayaburi project was the first application of the PNPCA process. During the prior consultation process, member countries raised concerns regarding information gaps, especially concerning wetlands, fisheries and cumulative impacts (MRC 2011). These calls for more information led the MRC to create the Institute for Sustainable Hydropower (ISH) which was tasked with preparing the PDG, which involved studies to address stakeholder concern (MRC 2018b). This example highlights the influence of stakeholder participation, which led the MRC to conduct, or contract consultants to conduct, studies to inform the information gaps highlighted by member countries in the prior consultation process. Thus, stakeholders contributed to the production of the PDG and its implementation through the PNPCA process and forums in which member countries and developers were able to learn, ask questions and make revisions and suggestions.

In addition to stakeholder participation in identifying shortcomings of the PNPCA process, and thereby, necessary updates to the PDG, the member countries participated in review of the science produced in the ISH0306 study, including subsidiary studies, as well as the updates to the PDG. Such consultations served two primary purposes: to inform developers of hydropower projects and to seek feedback on the performance standards that should be added or revised by the expert teams in consultation with the member countries (MRC 2017). Through national consultation, which included private sector stakeholders and developers, relevant stakeholders were able to review and comment on the ISH studies, so as to ensure an understanding of the science and affirm its relevance to key stakeholders, such as hydropower developers. Through stakeholder inclusion in the review process, the MRC created pathways for communication and brought stakeholders into the science production
process. Such stakeholder participation in reviewing the science allows for the stakeholders to affirm the relevance and validity of the science produced by the MRC, thereby aiding in its update into the updates to the PDG.

Throughout the MRC involvement in overseeing sustainable hydropower development, the MRC included stakeholders in the process of identifying the need for particular types of science, while also providing stakeholders with the opportunity to review the completed science. Such involvement provided stakeholders with access the process at the initiation and end of the ISH studies, thereby allowing stakeholder needs to direct the type of science created while also allowing stakeholders venues for review and verification of the final product. Ultimately, the MRC’s inclusion of stakeholders encouraged stakeholders to perceive the science as relevant and reliable, thus expediting its incorporation into the updated PDG.

**Cross Comparison of Case Study Stakeholders**

**Overview**

Throughout the five case studies, stakeholders contributed to the type of science produced, the methods used to conduct the science and the acceptance of the science as relevant and useful. Throughout each case study, stakeholders’ interests were represented in the type of science produced. Stakeholders influenced the type of science in two primary ways: 1) stakeholders made a demand for the science or 2) IRBO processes required stakeholder input to inform the science production process. Because IRBOs are beholden to
member countries, IRBOs react to the interests and needs of stakeholders, whether the stakeholder is the member country or individuals and organizations within the country.

**Reasons for Stakeholder Participation**

The five case studies demonstrate a range of reasons for stakeholder participation. These include reducing conflict, stakeholders’ demand for the science, and International River Basin Organization (IRBO) requirements for stakeholder involvement.

Stakeholder participation was used in some cases to balance interests across the basin and minimize disputes and conflict throughout the production of science and policy. In Case Study #2, the Lake Ontario-St. Lawrence River (LOSLR), the Shared Vision Model (SVM) was explicitly developed in order to account for a diversity of stakeholder interests and balance between them to reduce conflict. Additionally, Public Interest Advisory Group (PIAG) included community representatives who acted as liaisons between the study team and the communities in order to create a sense of unity when carrying out the LOSLR studies and choosing the regulation plan. In the Mekong River Commission (MRC), Case Study #5, national and member country consultations were included in the science process so as to provide a forum for member countries to reach consensus regarding the science and the final design guidance. Additionally, MRC workshops included other stakeholders such as hydropower developers, experts non-governmental organizations and coalitions in order to promote agreement across the stakeholders and encourage their acceptance of the science.

The involvement of stakeholders from the onset of an emerging basin challenge orients stakeholders to be the driving force to create the science, ensuring their participation
throughout the process. In Case Study #1, the case of the Red River; however, stakeholders were the impetus for science initiation and, accordingly, were intrinsically part of the science process. Prior to 2001, the Red River Basin Commission (RRBC) had been working to convene stakeholders from around the basin to address water quality and quantity challenges. Through cooperation at the local and regional levels, stakeholders began to collaborate on scientific studies to better understand nutrient loading in the Red River. This cooperation helped to promote continued stakeholder engagement throughout the International Red River Board (IRRB) processes to study and address nutrient loading.

In some cases, IRBO procedures required stakeholder involvement in science production. Throughout Case Study #2, in the LOSLR basin stakeholder involvement was explicitly required in each Study Directive. Though the member countries first made a request for the science, through Docket 111, every ensuing Study Directive and mandate included a required provision for stakeholder and public involvement. Case Study #2 was influential in setting precedent for future studies, which now have formalized stakeholder involvement, such as PIAG. This suggests that the International Joint Commission (IJC) considers the stakeholder involvement in this case study to be important and a success. Both of the IJC case studies were, to some degree, required to involve stakeholders because of the 1909 BWT. However, explicit LOSLR directives made this a much “firmer” requirement than the general provision in the 1909 BWT. In Case Study #3, the International Commission for the Protection of the Danube River (ICPDR) Joint Danube Surveys (JDS), the ICPDR structure requires stakeholder participation. Through Technical Groups (TGs) and Expert Groups (EGs), member countries contribute representatives to science production by acting as leads in the process and determining the methods for science
production. In both ICPDR case studies, the ICPDR relies heavily on the structure (EGs and TGs) to involve stakeholders in the process. For example, outreach for the JDS4 seems to be a recent development ‘Watch Your Danube!’ and the 2018 Strategy Update highlights the need for ongoing public outreach. These two recent actions highlight a shift to involving a wider public, as opposed to just formal input from member countries and developers etc.

The Case Study #5, the MRC Case Study, exemplifies both how mandate stakeholder participation influenced science production and how stakeholders created a demand for science. The Prior Notification and Prior Consultation Agreement (PNPCA) process requires member country involvement, while the need for the Preliminary Design Guidance (PDG) was primarily brought up by developers and member countries, who all were required to participate in the PNPCA process regardless. Similar the the ICPDR, the MRC has a formalized method of including stakeholders in science production at the IRBO level (whereas the IJC has no structure like this across all the basins). The PNPCA process, and the role observers play in the process, in some ways mirror the member country participation in the ICPDR through EGs and TGs.

**Forms of Stakeholder Participation**

Stakeholder involvement took many different forms, each with varying implications for the final science and policy product. These forms of stakeholder involvement include participation on study boards, participation in science production, public comment and review, and co-production of science and policy.
Stakeholders participated on scientific study boards, helping to determine methods employed in scientific studies, thereby helping to create the science. Such participation on study boards facilitated science co-production processes, enabling stakeholders to work together with experts to inform scientific processes with local expertise and knowledge. In Case Study #1, the Red River case study, the IRRB board is comprised of stakeholders throughout the basin, including overlap with RRBC board members and federal and state agencies in the region. This cross-pollination of stakeholders was integral for creating a unified approach to addressing nutrient loading across jurisdictions. Additionally, stakeholders actively participated in collecting water quality samples for the RESPEC report, thus co-producing the IRRB-funded science report. In the LOSLR case study, Case Study #2, the study board and technical working groups were similarly comprised of stakeholders and experts, allowing stakeholders access to creating and developing the science carried out in the LOSLR studies. Because stakeholders were part of technical committees, the stakeholders actively participated in collecting data and contributing to the SVM decision-making process. Finally, in the ICPDR JDS, Case Study #3, stakeholders participated in data collection through expert groups, which are comprised of member country representatives. Member country representatives were selected to work with the study team to collect and analyze data. This co-production approach allowed for stakeholders to contribute local knowledge and ensure their interests were represented in the science that was undertaken.

While some case studies exemplify stakeholder participation in study development, data collection and analysis, other case studies demonstrate a range of stakeholder input throughout the science process, including science review and verification. In the IJC LOSLR Case Study #2, the PIAG study board represented was conducted in conjunction with the
2006 LOSLR Study. PIAG’s role was to review and disseminate the science the study board conducted to the public as well as participate on the technical working groups. In addition to PIAG’s involvement, the National Research Council conducted a peer review study of the 2006 LOSLR Study. This peer review consisted of a review of the methods and overall study and was intended to evaluate the scientific processes. Finally, in the MRC Regional and National Reviews and workshops provided hydropower developers and member countries with the opportunity to learn about the studies, ask questions and contribute recommendations.

Institutional pathways for public comment created formal and transparent mechanisms for stakeholder participation in both the science and policy development processes. In the LOSLR Case Study #2, the LOSLR study boards were required, often through mandate, to provide a period of time for public comments to be heard and integrated into the studies. In the LOSLR case study, this was done both in the science production process as well as the policy production process. Throughout the 2006 LOSLR study, the LOSLR study board held hearing to disseminate information and solicit responses from stakeholders in the region. Following the publication of Plans 2007 and 2014, the LOSLR Study board received an overwhelming response from the public regarding the plans. In the case of Plan 2007, public comment led the IJC to reject Plan 2007. Additionally, the PIAG presented a formal group specifically tasked with soliciting public comments and integrating them into the scientific studies. PIAG, which is itself made up of local stakeholders, created a clear pathway for public participation through accepting public comments at meetings and hearings.
Following science production, policy co-production allowed for stakeholders to contributed to the ways in which science was understood and applied to create a final policy outcome. In the ICPDR climate change case study, Case Study #4 the ICPDR hosted workshops to involve stakeholders in the policy production process. Through these workshops, member countries and stakeholders were able to communicate their priorities from the scientific findings to advocate for their inclusion in the final climate change strategy document. In the ICPDR climate change case, member countries were the drivers for initiating science (through the 2007 conference) and recommending that the science product be a synthesis of existing information. Workshop participants also created a list of priorities for The Study and shared recommendations which were incorporated into The Strategy.

Table 8: Stakeholder participation in science and policy production

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Stakeholders participation in Science and/or Policy Production</th>
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<tbody>
<tr>
<td>IJC Red River</td>
<td>In the Red River basin, stakeholders were the drivingforce in collaboratively working to identify and address nutrient pollution. In this role, stakeholders created and collected scientific information to inform management plans. Stakeholders worked together to create a basin-scale body of information and drew on this information to create policies, such as nutrient targets and management plans.</td>
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<tr>
<td>- Red River Basin Commission</td>
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<td>- Provincial and State-level governmental agencies</td>
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<tr>
<td>- Local governments</td>
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<tr>
<td>IJC Lake Ontario - St. Lawrence</td>
<td>Stakeholders in this case study were highly influential in determining study objectives and the final use of the science in developing a regulation plan. IJC studies mirrored concerns voiced by stakeholders and the IJC relied on local experts to inform regulation plans and the final determination</td>
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<tr>
<td>- Local governmental agencies</td>
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<tr>
<td>Stakeholders</td>
<td>Role</td>
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<td>Non-governmental Organizations</td>
<td>to use Plan 2014.</td>
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<td>Private Property Owners</td>
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<td>Recreational Boaters</td>
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<td>Environmental Groups</td>
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</table>

**ICPDR Joint Danube Surveys**
- Member Countries
  - Technical Groups (TG)
  - Expert Groups (EG)
  - Universities

In developing the JDS, member countries were given nearly full control to determine what science was needed and the methods for producing it. Because of the role of TGs and EGs, member countries were able to ensure that their interests were represented in the science produced and the ensuring management plans.

**ICPDR Climate Change Adaptation**
- Member Countries
  - Technical Groups (TG)
  - Expert Groups (EG)

While stakeholders in this case study had limited participation in determining the use of science in policy, through workshops, meetings as well as TGs and EGs, member countries were able to communicate their priorities regarding how the science should be integrated into The Strategy.

**MRC Design Guidance**
- Member countries
- Hydropower developers
- Experts
- INGOs

The member countries and hydropower developers explicitly requested design guidance for the PNPCA process, which highlighted the need for baseline data in the basin. In this way, stakeholders initiated and participated in producing relevant information used to inform the guidance that member countries and developers had originally requested. Additionally, stakeholders reviewed the science and policy during workshops to ask questions and contribute recommendations.
**Discussion of Stakeholders’ Overall Influence on Science Production and Policy**

**Uptake**

These five case studies demonstrate that the type of stakeholders involved in science and/or policy production, the timing of stakeholder involvement, as well as the methods of involvement, influence the IRBO process of producing CRELE scientific information.

The modes by which stakeholders are involved in science and knowledge production determine the extent of their influence in the process of creating knowledge to inform decision-making. Participatory approaches that engage citizens and stakeholders in the basin can lead to varied output of actual stakeholder impact on the final product, and, subsequently, the output of CRELE information. The EU WFD describes three sequential types of public participation: information supply, consultation and active involvement (EU 2000). Information supply refers to activities that provide information to participants, while consultation includes soliciting stakeholder written or verbal input. Lastly, active involvement includes processes that include stakeholders directly in watermanagement (Carr 2015). These three types of public participation, which represent different degrees of participation, may also inform the weight of stakeholders’ influence in the final policy or science product. The five case studies described in this thesis represent a range of such participation methods. For example, the IJC case studies, Case Studies #1 and #2, include stakeholder participation through workshops and study boards, which are considered consultation and active involvement methods. Similarly, the ICPDR member countries
participated in were actively involved in conducting the JDS studies in Case Study #3. In contrast, the MRC stakeholders in Case Study #5 primarily participated through review, which falls within the first tier of information supply. In order to effectively integrate science and policy, joint research should include stakeholders in research framing and planning through study and steering boards (Sommerwerk et al. 2010). This integration of stakeholders in active participation allows for decision-makers to assess stakeholder needs, compile relevant information to create usable knowledge (Roll 2004). Ultimately, such co-production processes helps to develop mutual understanding between stakeholders, experts and decision-makers of what is considered salient, credible, and legitimate (Weichselgartnet and Kasperon 2010).

When a variety of stakeholders are engaged in science co-production the impacts of the science on policy are considered to be more effective (Bukowski 2017). In addition to member countries, a variety of actors, such as local stakeholders, non-governmental organizations, research institutions, private sector participants and donors should be involved in the science production and decision-making processes (UN 2008). Often, participatory approaches in river basin management are promoted for normative reasons, namely so that stakeholders may enhance the efficacy of resource management and decision-making by contributing to environmental management (Carr 2015). In order to promote efficient river basin management, organizations must include a diversity of understandings and interest in the basin, which produces more just and equitable management strategies (Fung 2006, Carr 2015). The type of stakeholders involved in basin management has implications for creating legitimate decisions or policy actions defined as, “... legitimate when citizens
have good reasons to support or obey it” (Fung 2006). By bringing together a variety of stakeholders, or, “knowledge holders,” information of the socio-ecological basin can be integrated across scales to create a more informed understanding of the basin (Carr 2015). Thus, co-production processes which involve a diversity of stakeholders produce more equitable and legitimate science and policy, enhancing the uptake of science into final policy outcomes. Each of the five case studies successfully integrates a range of stakeholders, including the public, NGOs, interest groups and coalitions as well as governmental agencies. In doing so, the IRBOs were able to integrate a diversity of interests in research planning and execution, thereby enhancing their ability to create relevant and usable information.

The timing of stakeholder engagement influences the type of science produced and its acceptance as relevant. In one study, stakeholder participation was deemed important for setting priorities and understanding how stakeholders were using water resources among sectors (Grizzetti et al 2010). The researchers concluded that the inclusions of stakeholders in science production significantly contributed to prioritization of stakeholder problems and increasing stakeholders’ acceptance of measures and policy implementation (Grizzetti et al 2010). While the timing of stakeholder involvement should be context-specific, stakeholder participation in early stages helps to improve transparency and inform decisions with relevant and local knowledge (EU 2000). By including stakeholders early, and throughout the process, IRBOs have the opportunity to enhance the production of CRELE science. In the Red River case study, stakeholders were the impetus for science production and, accordingly, involved from the outset of the project. Similarly, in the LOSLR case study, stakeholders were involved in the study processes. Both of the IJC case studies demonstrate how an ‘early
and often’ approach to stakeholder engagement contributed to the creation of relevant and legitimate knowledge, which was readily integrated into policy decisions. In the case of the ICPDR JDS and Climate Change study, Case Studies #3 and #4, stakeholders were involved in developing the science and collecting data, allowing them access to decisions regarding priority setting. Again, this approach to stakeholder integration helped to ensure that the science produced was considered valid by the stakeholders. Finally, in the MRC Case Study #5, stakeholders participated through review processes throughout the study. While this form of stakeholder participation is considered less active, the involvement of stakeholders during the process contributed to the MRC understanding stakeholder needs and collecting relevant information to address those needs.
Works Cited


ICPDR. (2012). Danube Study – Climate Change Adaptation. Vienna: ICPDR. 


ICPDR. (2018b). Revision and Update of the Danube Study. Vienna; ICPDR.


Personal communication with IRRB Member. 26 June 2018.


CHAPTER 10
DISCUSSION

Introduction

Scientific information can be essential for understanding the causes of water challenges while also identifying possible policy solutions. While science-informed policy is important for promoting sustainable management practices, the production of science is often separated from policy decisions, creating a gap between these two functions. This science-policy gap is especially challenging in the transboundary context, in which managers not only seek to reconcile this gap, but to do so over various levels of governance and across international borders. To address the issue of divergent levels of governance, International River Basin Organizations (IRBOs) seek to manage natural resources across political borders to reconcile the differences between political and ecological scales. Importantly, IRBOs may bridge the gap between science production and its uptake into policy through facilitating the production of Credible, Relevant and Legitimate (CRELE) science, which leads to the production of usable science, that is, information that may inform policy.

In order to demonstrate how IRBOs participate in the production of CRELE science, and subsequently the use of such information in policy, this research focused on two factors that influence science production: the IRBO mandate and structure, as well as stakeholder and member country participation. To explore these two facets of science production this research asked:

I. How do IRBO scope of authority and jurisdiction, as determined by its mandate, inform the production of science and its use in policy and,
II. What is the role of stakeholders in contributing to the process of producing and integrating science into policy in IRBOs?

The following sections seek to reflect on the findings regarding the role mandates and stakeholders played in science production so as to answer these two research questions. Table 9 presents anticipated and known science outputs and their corresponding use in policy and policy actions.

Table 9: Science outcomes and uptake into policy through policy action in the five case studies

<table>
<thead>
<tr>
<th>Science Outcome</th>
<th>Nutrient Management in the Red River Basin (IJC)</th>
<th>Water Levels in the Lake Ontario- St. Lawrence River (IJC)</th>
<th>Design Guidance for Sustainable Hydropower (MRC)</th>
<th>Joint Danube Survey (ICPDR)</th>
<th>Climate Change Adaptation Strategy (ICPDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Outcome</td>
<td>Harmonized datasets, basin modelling tool</td>
<td>Shared vision model and detailed understanding of impacts of flow on sectors</td>
<td>Baseline data for hydropower developers, developments in how to conduct assessments</td>
<td>List of priority substances, new knowledge of substances, homogeneous database</td>
<td>New understanding of climate change impacts, baseline data and new methodologie s</td>
</tr>
<tr>
<td>Science Integration into Policy</td>
<td>Possible water quality standards</td>
<td>Levels plan and adaptive management strategy implemented</td>
<td>Draft design guidance, dam design improvements and assessment process</td>
<td>Changes in national monitoring programs, results inform management</td>
<td>Informing national adaptation work, crated adaptation strategy example</td>
</tr>
</tbody>
</table>

Reflection on the Role of Mandates in Science Production
Overall, mandates and institutional structure served to determine the IRBOs scope of authority, helping to define the scientific production responsibilities within the IRBOs jurisdiction. As a result, the mandate and institutional structure had implications for the content of the science produced and those involved in producing it. Where mandates and structure allowed for flexibility, IRBOs were able to adapt and respond to emerging issues and stakeholder priorities. However, while the case studies demonstrated how IRBO mandates supported adaptability within the basin, some cases also depicted scenarios in which the IRBO was constrained by its mandate and, as a result, was impeded in its ability to address an emerging issue.

As discussed previously, relevant information increases the usability of science knowledge and, subsequently the likelihood that it may be drawn on to inform a policy decisions. IRBO mandates influenced the production of relevant science in two ways: 1) by delineating the scope of authority which provided flexibility for and encouraging IRBOs to engage in the production of science to aid in addressing emerging issues and 2) by requiring participation in producing the science through the IRBO structure (which sometimes included member countries inherently) and/or through specific directives that the IRBO include the public and other basin stakeholders.

While the fact that the IRBOs producing science in response to and in alignment with their mandates helped to increase the relevancy of that science for IRBO policy-making, science produced be can IRBOs has the potential to also inform or be integrated into policy by other at the national, regional and local levels. Information considered relevant to IRBO decision-making may or may not take the same form as information relevant to national and sub-national decision makers. Inclusion of stakeholders from those
governments in the science and in the IRBO policy production processes helped to ensure that the information produced would be useful to actors at varying scales throughout the basin. For example, when IRBOs provided forums for participation that included local, regional and national-level stakeholders, the IRBOs were able to produce science that addressed the concerns of stakeholders at different governance levels throughout the basin.

Finally, while the IRBO mandate and institutional design may contribute to the production of relevant science, the mandate represents one in a range of aspects that may provide relevance in the science production process. Simply because an IRBO has a mandate that allows for adaptation or provides for the inclusion of member countries and stakeholders, this does not necessarily ensure that the IRBO will produce relevant information. IRBOs face various challenges to the creation of usable science knowledge, some of which may be overcome without the need for a broad mandate and through alternative governance mechanisms. Future research and case study examinations may seek to identify such mechanisms in the IRBO context so as to provide a more complete understanding of the varied ways in which IRBOs may define and produce relevant and usable science.

**Reflection on the Role of Stakeholders in Science Production**

The case studies present various examples of the type of stakeholders involved in science production, the timing of stakeholder involvement, as well as the methods of involvement. Stakeholder participation served to legitimize the science by allowing member countries and stakeholders to determine scientific methods, review findings and dictate the issues the science addressed. Stakeholders and member countries were able to provide a local
understanding of the ecological and social challenges in the basin, thereby promoting science focused on relevant basin issues. Stakeholders and member countries participation in the science production also served to ensure that the scientific processes were accurate and transparent.

In each case examined, stakeholders participated to different extent and through different mediums, which allowed for member countries and stakeholders to contribute to science production to various degrees. The role of stakeholders differed between case studies, but ultimately, stakeholders helped to identify the need for science, contribute to collecting and analyzing data and reviewing the final science product for accuracy and saliency.

While these findings demonstrate how stakeholders influence the production of legitimate and relevant science, participation by stakeholders and member countries in the science-production process may not always directly contribute to usable science. For example, stakeholders may participate in science production and review without directly providing legitimacy to the process. This may happen when IRBOs or governance structures seeks to involve stakeholders solely in order to provide accountability and not to participate in active scientific development (Videira et al. 2006). Further, while participation in science production is not the only way to produce relevant and legitimate science, For example, the IRBOs used peer-review and/or built upon existing studies and information, to produce science that is understood as legitimate and relevant by the users in the basin.

Additionally, in producing science, the IRBOs in each of the case studies used a range of methods of stakeholder participation and multiple methods concurrently. These findings raise the questions regarding how different forms of participation may influence the
final science product. Future research should examine what types of participation are necessary and create a typology of such participation that indicates the relationships between the mechanisms and extent of participation and the final science product or policy outcome. Similarly, future studies may seek to understand if IRBOs benefit from facilitating many types of stakeholder participation simultaneously and what the effect of repeated stakeholder inaction is on science production, as opposed to one-time or occasional participation. Such an exploration into these research questions may provide insights into which forums are most or least productive for stakeholder engagement and how stakeholder participation may be measured so as to contribute to a broader understanding of the influence of member countries and stakeholders on the production of usable science.

**Reflection on the Overall Importance of Mandates and Stakeholders**

**in Producing CRELE Science**

Mandates and stakeholders do not influence science production in isolation. Instead, these two facets of science production interact with one another, as well as countless other factors, in order to influence the production of science. Mandates delineate the IRBOs scope of authority, thereby determining the issues the science addresses and who it includes. Further, mandates often included provisions member country or stakeholder participation in scientific processes. In these case studies, when member countries and stakeholders were included due to an IRBO mandate or institutional design mechanism, stakeholder participation was more often sustained throughout the science production process.

Conversely, stakeholder interests also informed study directives in some case studies. Some mandates and directives included specific charges to focus on an area of study as the
result of stakeholder or member country request. In this way, member countries and stakeholders were also able, through IRBO mandates, to determine which issues the science addressed. While both the IRBO mandates and stakeholder participation were influential in producing relevant and legitimate knowledge, these two aspects of IRBO science production do not fully bridge the divide between science production and its uptake into policy.

Each of the cases studies presented in this thesis represents a narrow selection or science produced within a subset of well-established IRBOs. Future research projects may seek to broaden the understanding of the role mandates and stakeholders play in different types of IRBOs, for example IRBOs that are identified not as “commissions,” but perhaps as “authorities” or “committees,” which are shown to have different objectives and mandates (Lautze et al 2013). Understanding these processes in a diversity of IRBOs may supplement the understandings of how mandates and stakeholders influence the production of usable science and its uptake into policy across various types of IRBOs.

Additionally, each of the five case studies unfolds over different periods of time and, subsequently, with different iterations of stakeholder engagement. While this facet of science production is not analyzed in the above text, continuing to explore how timeframe and repeated stakeholder engagement influences trust- and relationship-building between the IRBO and stakeholders could provide understandings of how such relationships influence the production of credible, relevant and legitimate science.

Lastly, while these findings about the role of mandates and stakeholders serve to help bridge the gap between science production and policy by producing relevant and legitimate information, these two facets of science production are not alone sufficient for producing CRELE information and are not the only IRBO aspects which influence the
production of usable, CRELE science. Future research should explore aspects outside of mandates and stakeholders that influence IRBO production and use of science in policy. For example, the problem context, both political and ecological could have significant impacts on how IRBOs decide to produce science. Policy problems, especially those which are ill-defined, may act as an impediments to the production and uptake of science in policy. While a body of literature exists on policy problems (Turnhout et al. 2007, Michaels 2009), future research may consider how policy problems influence the production of science. Additionally, future research may explore how policy problems and the specific ecological problem context interact so as to inform science production and it use in policy. Finally, future studies could consider the role that IRBO funding mechanisms play in funding the methods and content of science projects, thereby perhaps influencing the overall usability of the science.

**Recommendations**

While this research does not present a comprehensive examination of factors that maybe influence an IRBO’s ability to produce CRELE information, the findings presented in this thesis may help to inform management decisions in the future such as:

- The IRBO’s flexibility to engage with basin actors, while continuing to advance the IRBO overall goals creates parameters for the IRBO to work within while providing the opportunity to adapt to basin circumstances.
  - Recommendation: Clearly identify and delineate the IRBOs role in management plans and study directives.
○ Recommendation: Create specific functions for subsidiary boards while providing for flexibility through encompassing terminology that works to fulfil the board’s purpose.

- The IRBOs sustained inclusions of member countries and stakeholders helps to minimize conflict and stakeholders are more likely to accept the science as legitimate and therefore accept the policy outcome.

○ Recommendation: define which entities are considered basin stakeholders.

○ Recommendation: Use mandates and directives to outline the role stakeholders may or may not play in science production processes.

Specifically:

■ In what ways will stakeholder participation be solicited?

■ In what ways will stakeholders be invited to participate in science production?

■ During which stages stakeholders will be included in the research?

■ Which stakeholders will be included in science production?

The research presented here on stakeholder engagement may be of particular use, as IRBOs seek to reinforce the credibility and promote acceptance of their science and policy through co-production and management. Along with stakeholder engagement, the analysis on the effect of IRBO mandates on science-policy pathways provides IRBOs with an understanding of how mandate interpretation and implementation may inform science and policy decisions. Therefore, these analyses and results serve to enhance the scientific literature surrounding science production and its use in policy in IRBOs, while providing
specific examples of how managers and decision-makers may employ mechanisms to aid in the production of science integrated into policy.
Works Cited


https://doi.org/10.1016/j.envsci.2017.07.005


178


ICPDR, 2018b. Revision and Update of the Danube Study. Vienna; ICPDR.


ICPDR. (2018b). Revision and Update of the Danube Study. Vienna; ICPDR.


ICPDR. 2018d. ICPDR convenes Climate Change Workshop designed to collaborate and tackle climate change issues in a transboundary context. At http://www.icpdr.org/main/icpdr-climate-change-workshop-2018


184


Personal communication with ICPDR Representative. 12 June 2018.

Personal communication with ICPDR Representative. 26 June 2018.

Personal communication with ICPDR Representatives. 26 June 2018.

Personal communication with IJC Representative 20 April 2018.

Personal communication with IJC Representative. 14 June 2018.

Personal communication with IRRB Member. 26 June 2018.


https://doi.org/10.1016/j.envsci.2015.04.019