Transboundary Water Resources Management and the Potential for Integrated Water Resources Management (IWRM): Rhine River, Mekong River, and Zambezi River Case Studies

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Transboundary Water Resources Management and the Potential for Integrated Water Resources Management (IWRM): Rhine River, Mekong River, and Zambezi River Case Studies

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Abstract

Integrated Water Resources Management (IWRM) is an evolving concept used to address the difficult issues associated with making efficient and effective use of the world's limited freshwater resources. IWRM differs by country due to geography, culture, and stage of development, but generally involves the management of all water resources taking into account other natural resource management, as well as social, economic, environmental and technical issues. A significant issue in water management is the need for cooperation among nations sharing transboundary waters that may have different usage requirements. We look at the history, progress, and challenges in implementing IWRM in the management of transboundary water resources in three case studies: the Rhine River (Europe), the Mekong River (Southeast Asia), and the Zambezi River (Southern Africa).

Learning Objectives

1. Understand Integrated Water Resource Management (IWRM) and its potential to facilitate the planning and management of transboundary water resources
2. Describe the current history and progress of implementing IWRM in three contrasting case studies
3. Identify the principal challenges related to IWRM, and strategies for mitigating those challenges, across the case studies

"The Provision of adequate fresh-water resources for people and ecosystems will be one of **the most critical and potentially contentious issues facing society and governments at all levels during the 21st century**" (AMS 2008).

INTRODUCING INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

Integrated Water Resources Management (IWRM) is evolving as a means to address the complex and critical issues associated with making the most effective and efficient use of water resources throughout the world. The concept of IWRM contrasts the traditional, fragmented approach to water resource management, where the water resources of an area are developed and implemented without full consideration of water demand as well as water supply. Full consideration of water as a resource requires integration between and among both the natural supply system as well the human user system (Adeyemo 2003). The concept of IWRM came from the Dublin Principles articulated in 1991, in anticipation of the 1992 United Nations Environment and Sustainability Conference in Rio, Brazil. The Dublin Principles are as follows:

1. Fresh water is a finite and valuable resource essential to sustain life, development, and the environment.
2. Water development and management should be based upon a participatory approach involving users, planners, and policy-makers at all levels.
3. Women play a central part in the provision, management, and safeguarding of water.
4. Water has an economic value in all of its competing uses and should be recognized as an economic good.

In 1992, the United Nations Rio Conference introduced IWRM as an agenda item. Subsequently, IWRM has evolved in different ways in different countries as a function of geography, culture, and stage of development (UN-Water 2008). As a consequence

of this evolution, there are several working definitions that have been developed to communicate the essence of IWRM and its concepts. Representative examples of definitions include the following (Davis 2007):

1. The World Bank*: A perspective that ensures that social, economic, environmental, and technical dimensions are taken into account in the management and development of water resources.*
2. The World Conservation Union (IUCN)*: [Several definitions exist] The integrated management of all water resources (i.e. surface water, ground water, marine waters, etc.) The integration of water with the management of other natural resources such as soil and native vegetation, including related management issues such as alien invasive species.*
3. Global Water Partnership (GWP)*: A process that promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*

These three examples of IWRM represent global IWRM definitions and approaches. In 2002, the Johannesburg Summit on Sustainable Development incorporated water as one of the Summit's ten focal areas. The Framework for Action produced by the Summit established the two most important goals: (1) halve the number of people with no access to safe drinking water and improved sanitation by 2015; and (2) develop integrated water resource management and efficiency plans by 2005 (Varis et al. 2008).

In the United States, IWRM is perhaps less well known. Two examples of IWRM or IWRM-like definitions are (Davis 2007):

1. U.S. Environmental Protection Agency (US EPA): *A flexible framework for managing water resource quality and quantity within specified drainage areas or watersheds and includes stakeholder involvement and management actions supported by sound science and appropriate technology.*
2. U.S. Army Corps of Engineers (USACE): *The coordination of activities in pursuit of a set of common goals for water resources development and maintenance.*

The working definitions of IWRM cited above reflect the theory and concepts of IWRM as practiced both globally and in the United States. As touched on above, there is more active utilization of the IWRM approaches and concepts outside of the United States. Several factors contribute to this situation. For instance, two large U.S. federal government units have had responsibility for one or more aspects of water resource development for many years. The civilian section of the U.S. Army Corps of Engineers has been responsible for navigation and flood control of the nation's rivers since the 19th century, while the U.S. Bureau of Reclamation in the Department of Interior has held responsibility for the provision of water in the western region of the country (i.e., west of the 100th meridian) since early in the 20th century.

A number of organizations have been established to promote adoption of IWRM practices and approaches. One example is the Global Water Partnership (GWP), founded in 1996 by the Swedish International Development Agency (SIDA), the World Bank, and the United Nations Development Program (UNDP) to promote IWRM and to address the critical issues of sustainable water management (GWP 2009). The GWP's mission is to support countries in the sustainable management and development of their water resources through the implementation of IWRM (GWP 2009). To help share knowledge, the GWP has also developed a number of tools and resources, including an IWRM Toolbox (www.gwptoolbox.org/), designed to provide valuable insights and helpful information to professionals working in the IWRM Framework.

Transboundary Waters

In developed countries, many of us take water for granted. When we need it for personal use in our homes or places of work, it is provided. We may not know where our water comes from or where it goes after our use, or its potential use by other individuals downstream from our location. However, it is of critical importance to recognize four basic aspects of all water resources

that represent challenges. The first is the importance of the resource: water is an essential sustaining resource for life. Second, water is scarce. Water as a resource is not distributed equally across the landmasses of our world; in certain large regions, available water is scarce in relation to the water demands of the region. It follows that thirdly, water is not distributed evenly. Fourth, water is shared. Where water crosses national political boundaries, the issues of effective and sustainable water resource management become even more complicated (Box 1) (Frey 1993).

Transboundary waters are those waters—either surface water or ground water—that are shared by two or more nations. For example, there are 268 transboundary river basins worldwide; 250 rivers are shared between and among two or more nations; and over 50 rivers are shared by three or more nations (Draper 2007). For the purposes of our case study, in Europe, nine countries share the river Rhine; in Southeast Asia, the Mekong River is shared by six countries; and in Southern Africa, the Zambezi River is shared amongst eight countries. Given that approximately 40% of the world's population depends on these shared river basins for water, the need for effective cooperation among riparian countries for the planning and management of these shared waters is essential in the face of the growing demand for water and the potential adverse impacts in the river systems as a consequence of upstream usage (Draper 2007).

A transboundary riparian nation can be subject to multiple and complicating foreign policy factors that may impact the sharing of international waters. These factors include image (the concern of a nation for its international image); international law (the concern to abide by established legal rules); linkage (the perceived connection between water and other issues); reciprocity (a desire for mutual commitment and obligation); and sovereignty (the stress placed upon autonomy) (LeMarquand 1990).

Box 1. IWRM and Sustainable Water Resources

Historically, water resource development has often emphasized economic growth and benefits over important social and environmental elements. In recognition of this connection, the American Society of Civil Engineers (ASCE) and the UN Educational, Scientific, and Cultural Organization (UNESCO) derived sustainability criteria and guidelines for water resource systems. The sustainability guidelines are presented as six separate topics:

1. **Physical infrastructure**: The design, management and operation of the physical infrastructure supporting the development and use of water, e.g., design and manage systems to be effective, efficient, and robust in all respects; balance changes in demands and supplies over time and space.
2. **Environment and ecosystems**: E.g., ensure that water quality is considered along with water quantity when designing and operating water resource systems.
3. **Economics and finance**: Efficiency, survivability, and sustainability, e.g., fully consider all direct and indirect environmental costs over the full life cycles of the systems' projects.
4. **Institutions and society**: Meeting societal needs in equitable ways, e.g., implement fully democratic and participatory water planning and decision making processes, involving all stakeholders in the planning, execution, and management of the systems as much as possible
5. **Health and human welfare**: The provision of clean water and sanitation, e.g., guarantee a minimum water supply to all humans to maintain human health.
6. **Planning and technology**: Recognize that planning is multi-disciplinary in nature, and includes evaluation of all relevant options, including non-structural solutions and consideration of long-term effects of options and incorporation of conservation objectives into design criteria.

The working definition for sustainable water resource systems that emerged from the above effort is as follows: "Sustainable water resource systems are defined as supporting social objectives into the indefinite future without undermining the water resource system's hydrologic and ecological integrity" (ASCE Task Committee and UNESCO Working Group 1998).

IWRM and Transboundary Water Resources: Image and Reality

IWRM provides a framework for countries sharing transboundary waters to begin the process of planning, implementing, and eventually managing their shared resources on a sustainable basis. It includes the principles that water use in shared basins should be equitable and reasonable, and fulfill the obligation not to cause appreciable harm by taking into account all relevant factors and circumstances. Clearly, the process of bringing together two or more countries sharing transboundary waters is extraordinarily complex and challenging to all parties. It is clear that the each transboundary river basin is unique and each country has its own set of political, institutional, and legal frameworks as well as its unique water demand and use patterns, water use efficiencies, institutional, economic, and management capabilities (Varis et al. 2008). Accordingly, while IWRM offers an initial framework, the IWRM process that emerges has to be tailored to the individual realities in the basin itself.

IWRM is a useful starting point for transboundary water planning and management in light of the pressures that will face us now or in the near future. These include not only increasing population but increasing per capita water use, the availability of water in sufficient quantities and of adequate quality, sufficient water for agricultural production, increased cooling water to meet growing energy requirements, and appropriate collection, transport, and treatment of waste to protect and enhance public health. In addition to these challenges, there is another set of complex issues associated with maintaining environmental flows into rivers to support aquatic species, fishery resources, and hydropower production. A major challenge facing the water profession worldwide in the 21st century is how to develop and manage transboundary water sources in a sustainable and efficient way with full agreement and cooperation between the appropriate basin countries such that the result is a win-win situation for all parties (Varis et al. 2008).

IWRM Conceptual Frameworks and Concepts

IWRM is a framework for examining the nature/degree of management integration within a river basin; Cardwell et al. (2006) describe IWRM as a unified process directed toward a unified goal. This approach recognizes drivers for action such as competition for water throughout the basin plus complexity from stressors like climate change. Cardwell et al. (2006) also emphasize collaboration: basin countries must collaborate in order to achieve sustainable water resources use and benefit within the basin system.

IWRM is aligned with criteria for sustainable water resource systems and can take various forms (box 1). Davis (2007) articulates that IWRM is best practiced at the river basin or sub-basin scale. Water sharing is an important component, including sharing between multiple units of government and between two or more countries. A basic premise of IWRM is that sustainable water resources may be approached through integrative collaboration and multiple-objective, strategic and operational planning and implementation processes, rather than through single-sector focused planning and implementation with limited stakeholder participation. IWRM is also a stakeholder process, to promote coordinated activities in pursuit of common goals for multiple objectives, leading to the development of sustainable water resource systems. IWRM results in better water use in that it supports economic and social objectives while seeking to maintain environmental ecosystems. Drivers for IWRM include but are not limited to: water scarcity/conflicts; water quality/environmental degradation; financial crisis/matters; macro-economic reforms; political reforms; social issues; donor/lender pressures; internal/external agreements; and institutional synergy/pressures (Davis 2007).

The Global Environment Facility (GEF) aims to assist countries in developing a better understanding of their international water systems and how multiple sector activities have an impact on these ecosystems. GEF also assists groups of countries to build the capacity of existing or new institutions to utilize a more comprehensive approach for addressing transboundary water-related environmental concerns and implement measures that address priority transboundary environmental concerns (Gerlak 2007). It defines its role in international waters as a "catalyst to the implementation of a more comprehensive, ecosystem-

based approach to managing international waters and their drainage basins as a means to achieving global environmental benefits" (Gerlak 2007). Gerlak (2007) points out that the greatest challenge is the creation of shared solutions to current problems. Increasingly GEF-led international water projects are incorporating the concept of IWRM, as most scholars and practitioners recognize integrated management as the best approach to resources management because it incorporates environmental, economic, and social considerations based on the principle of sustainability and involves broad stakeholder participation and capacity building.

Summing Up: Transboundary Water Resources and IWRM

Achieving effective IWRM is proving to be more difficult than initially envisioned. The approach is meant to facilitate integrating water priorities and related environmental issues into national economic development activities (World Water Development Report 3 2009). However, IWRM remains the best approach currently available to address issues that reach beyond national boundaries, and the even more complex problems of transboundary water sharing. Inter-regional cooperation built around sharing transboundary waters has the potential to both promote peace and build trust between cooperating countries (World Water Development Report 3 2009). Lastly, IWRM offers a framework for countries to jointly manage the potential impacts of climate change on shared water resources. This is an important advantage because developing countries are especially vulnerable to climate change, due to heavy dependence upon water resources, low capacity to adapt, poverty, and the multiple demands placed upon limited and potentially diminishing water resources. IWRM explicitly calls for consideration of the uncertainties arising from climate change and its impacts upon transboundary water resources (World Water Development Report 3 2009).

The following sections include three case studies of transboundary river basins: the Rhine, the Mekong, and the Zambezi. Each case study includes details about the shared resource, basin countries, and cooperative management structure. IWRM is discussed in each case according to the level of implementation in each basin.

IWRM Introduction Discussion Questions

1. What are the advantages of employing IWRM?
   a. Does your answer differ if you consider the context within which IWRM is applied (e.g., transboundary waters or waters governed by a single nation, developing or developed country)?
2. What are the shortcomings and/or difficulties of employing IWRM?
   a. Does your answer differ if you consider the context within which IWRM is applied (e.g., transboundary waters or waters governed by a single nation, developing or developed country)?
3. Does the water you use in your household originate from a transboundary water source? If so, what are the boundaries that it crosses prior to reaching you?
4. How might IWRM be useful for planning considering the possible adverse impacts of climate change on water supplies?

RHINE RIVER CASE STUDY

Introduction

Originating in the Alps, the Rhine River watershed covers parts of nine countries—Switzerland, Austria, Italy, France, Germany, Belgium, the Netherlands, Liechtenstein, and Luxemburg—before it discharges to the North Sea. While it isn't the longest or largest river in the world, it is the most important commercial river in Europe (ICPR 2005). It has a drainage basin of 200,000 square kilometers and a length of 1,320 kilometers. The river flows at an annual average discharge of 2,200 cubic meters per second.

The basin is home to 58 million people, a third of whom rely on the river as a source of drinking water. Approximately 50% of the basin is used for agricultural production while 8% is used for settlements (Francesch 2002). Besides providing water for drinking and agricultural production, the Rhine also provides water for ecosystem services, navigation, power generation, industry, and recreation.

Point source pollution was a major source of pollution in the Rhine until the late 1980s. Attention has now turned to non-point source pollution reduction and to flood control as the primary issues of concern. The International Commission for the Protection of the Rhine (ICPR) is the organizational body established to facilitate cooperative, transboundary management of the Rhine River. To date, management efforts have been focused on singular issues rather than an integrative approach and IWRM as such is not well established in the basin. However, sustainability (one of the principles of IWRM) is encompassed in the sustainable development aims of the ICPR.

Rhine River Basin

The headwaters of the Rhine originate in the Swiss Alps (ICPR 2005; see Figure 1). Switzerland, France, Germany, and the Netherlands dominate the watershed, together contributing 92% of the Rhine River Basin area. The remaining five basin countries—Austria, Italy, Belgium, Liechtenstein, and Luxembourg—contribute the remaining 8% of the basin land area. The nine basin countries are prosperous and stable. The stability of the economic and political conditions in the Rhine basin countries creates a favorable situation for addressing environmental issues and for cooperation on management of the Rhine River. Table 1 summarizes the Rhine River Basin country profiles.

Basin stressors vary. Stressors in the headwaters and upper basin countries arise primarily from non-point source pollution while in the middle Rhine pollution from both point and non-point sources are problematic. Flooding is also an issue for the middle Rhine through the lower Rhine and delta. The Netherlands, situated at the Rhine delta and on the North Sea, is particularly prone to flooding given its location and that much of the land is below sea level. Table 2 provides a summary of the Rhine River Basin area and stressors.

The State of the Rhine in the Mid to Late 20th Century

The Rhine has long been used for navigation purposes because of its strong, steady flow (Figure 2). Because of this emphasis on navigation, Rhine River management was historically focused on improvements in the navigability of the river, including canalization and dredging. This historical focus also contributed to the Rhine's prominence in the region as a navigation throughway and, more recently, to enormous "hundred year floods" in 1983, 1988, 1993, and 1994 (Verweij 2000). The Rhine serves the world's third largest port by cargo tonnage at Rotterdam, the Netherlands, and the world's largest inland port at Duisburg, Germany (Verweij 2000).

Navigation and trade along the Rhine led to extensive industrial, urban, and agricultural development along the river, including chemical, mining, and pharmaceutical companies and steel manufacturing as well as large urban centers like Bonn, Cologne, Basel, Rotterdam, and many

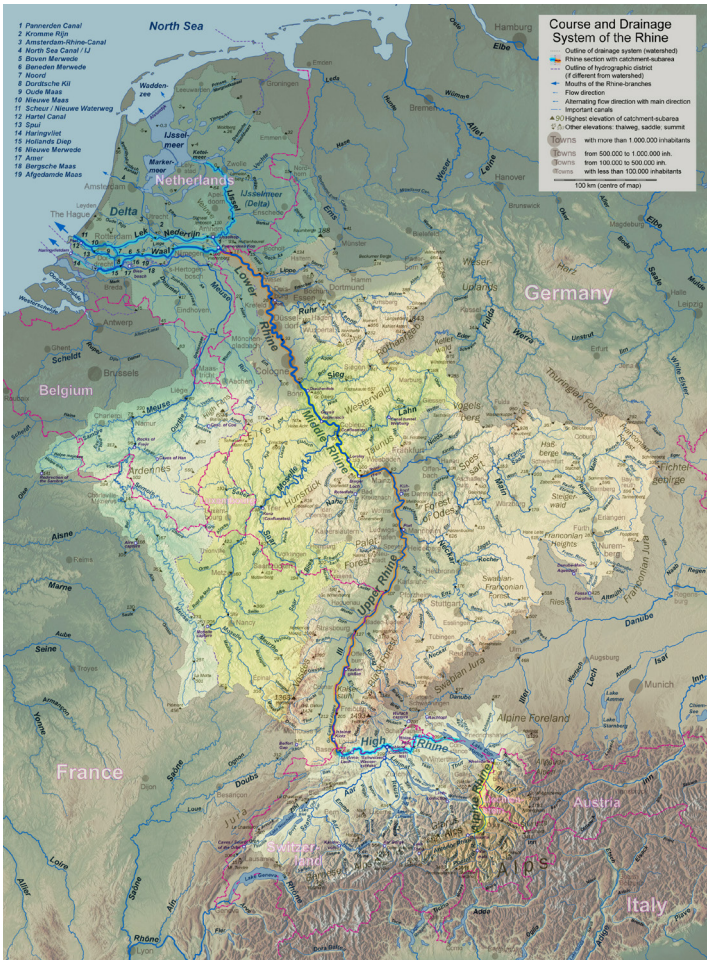

Figure 1. Rhine river basin
By WWasser (Own work) [CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

Table 1. Rhine River Basin Country Profiles - Source: CIA World Fact Book; Waterwiki.net; Frijters and Leentvaar 2003).

COUNTRY	SWITZERLAND	AUSTRIA	ITALY	FRANCE	GERMANY	BELGIUM	NETHERLANDS	LIECHTENSTEIN	LUXEMBOURG
Type of Government	C	R	R	R	R	CM	CM	CM	CM
Total Population (millions)	7.4	8.2	58.1	60.9	82.4	10.4	16.6	0.03	0.49
Population Density (persons/km2)	181.4	99.2	197.6	114	230	344.3	395.8	221	186
Below Poverty Line (%)	n/a	5.9	n/a	6.2	11	15.2	10.5	n/a	n/a
Adult Literacy (%)	99	98	98.4	99	99	99	99	100	100
Women in Parliament (%)	25	34	11.5	12	32	35	37	12	17
Infant Mortality (#/1000)	4	4.5	5.6	3.4	4	4.5	4.8	4.5	4.6
GNP ($/capita)	41,000	38,400	30,400	33,200	34,200	27,570	38,500	25,000	80,500
Primary Economic Sector	B, I, S	B, I, S	I, S	I, S	I, S	B, I, S	I, S	I, S	I, S
Access to Clean Drinking Water (%)	100	100	100	100	100	100	100	100	100
Access to Sanitation (%)	100	100	100	100	100	100	100	100	100
Freshwater Resources (m3/ capita)	7,203	10,244	3,012	3,103	2,282	2,000	5,404	n/a	3,265
Emissions (metric tons/ capita)	7.3	11.3	9.9	9.3	12.3	14.4	13.3	7.6	24.9
Arable Land (%)	9.9	16.6	26.4	13.9	33.1	27.4	22	25	27.4

Symbols:
C = Confederation
R = Republic
CM = Constitutional Monarchy
B = Business
I = Industry
S = Services

Table 2. Rhine River Basin: Area, country position, basin and environmental stressors

COUNTRY	SWITZERLAND	FRANCE	GERMANY	NETHERLANDS
Basin Area Contribution (%)	18	13	55	6
Position in Basin	Headwaters	Upper	Middle	Delta
Basin stressors	Non-point source pollution	Non-point source pollution	Pollution control and flood protection	Flooding; upstream impacts
Country wide environmental stressors	AP, WP, AR, BL	AP, WP, AR	AP, WP, AR	AP, WP, AR

Symbols:
AP = air pollution
WP = water pollution
AR = acid rain
BL = biodiversity loss
Note: Austria, Italy, Belgium, Liechtenstein, and Luxembourg together comprise 8% of the basin area.

others (Saha 2008). This development, coupled with lax regulations, contributed to extensive degradation of the river, so much so that prior to the late 20th century, the Rhine River was known as the "open sewer of Europe" (Verweij 2000). In 1971, conditions worsened to an extreme, causing a 100 km stretch of the river to become devoid of oxygen (Verweij 2000), killing fish and other aquatic species and making visible the deplorable state of the river. Success at reducing river pollution over the last few decades has shifted attention to non-point source pollution reduction and flood management.

Early Efforts to Manage the Rhine

As previously mentioned, early efforts to manage the Rhine focused on navigation. The 1815 Peace Conference in Vienna, Austria established the Central Commission for the Navigation of the Rhine (CCNR), marking the first effort to cooperate on transboundary management of the river (Saha 2008). The CCNR is still active today, meeting twice a year to continue efforts to improve navigation and navigation safety protocols. The second transboundary management effort was the ineffective 1885 Salmon Treaty between Switzerland, Germany, the Netherlands, Luxembourg, and France (Verweij 2000; Cioc 2006). The Salmon Treaty was also notable for being the first attempt to protect the ecology of the Rhine.

The next serious effort to cooperate for protection of the Rhine was led by a Dutch delegation to the CCNR in 1946. The Dutch, motivated by their downstream location on the Rhine and the adverse impact of environmental degradation on the river delta, raised environmental concerns at the meeting (Ruchay 1995; Verweij 2000). Four years later, Switzerland, France, Germany, Luxembourg and the Netherlands formed the International Commission for the Protection of the Rhine (ICPR) (Saha 2008).

It took another 13 years for the ICPR to be recognized as an official body through the signing of the Bern Convention on the Protection of the Rhine in 1963 (Ruchay 1995; Oterdoom 2001). Thirteen more years would pass before the European Community would become a signatory to the Bern Convention (1976). The same year also marked the passage of the Chemical Convention and a year later (1977) the signing of the Chlorides Convention (Saha 2008). However, none of these early efforts resulted in significant improvements to the ecology of the Rhine (ICPR 2005).

In 1986, an accident at a facility owned by Sandoz AG in Basel, Switzerland dramatically changed the approach to managing the river (Verweij 2000). In the middle of the night on November 1, 1986, a fire erupted in a warehouse filled with chemicals. Firefighters battled the blaze with water that eventually washed into the river, turning the river red for 70 kilometers and killing fish and other organisms (Hull et al. 1986; Verweij 2000; EAWAG 2006). This accident made clear that current management efforts were ineffective and a new approach needed to be developed.

Accordingly, Switzerland, France, Germany, Luxembourg, the Netherlands, and representatives of the European Community signed a new Convention on the Protection of the Rhine in Bern in 1993. This new Convention for the protection of the Rhine entered into force in 2003 providing a revised framework for cooperation in the basin.

The International Commission for the Protection of the Rhine (ICPR) and the Rhine Action Program (RAP)

The ICPR is tasked with the following: (1) to monitor and report on the state of the Rhine; (2) to propose international policy solutions to ameliorate ecological problems in the river; and (3) to hold regular international consultations (about 80 per year) (Saha, 2008). Switzerland, France, Germany, Luxemburg, the Netherlands, and the European Community are members of the ICPR; Austria, Liechtenstein, and Belgium are "observers." Administrative offices of the ICPR are located in Koblenz, Germany (Saha 2008).

The ICPR is decentralized and operates by consensus. Decisions made by the ICPR are recommendations only and no sanctions are imposed on riparian countries in the event of non-compliance. These operating protocols were developed to promote trust and to ensure national sovereignty and individual responsibility at the lowest levels of government. Funding for the ICPR is through a regular budget cycle contributed by the riparian countries (Saha 2008).

Even though the ICPR was established in 1950, real progress on protection of the Rhine was stymied by legitimacy and credibility issues between riparian country scientists and civil servants, as well as a lack of trust that the ICPR could not overcome. However, the 1986 Sandoz accident changed the governance paradigm (Ruchay 1995; Verweij 2000). The accident raised awareness, called into question both the existing regulatory structures and the tepid efforts that had resulted in only modest improvements in river water quality, and provided an opportunity within the ICPR to build trust in responding to the crisis.

The Dutch minister and head of the Dutch ICPR delegation hired McKinsey, a private consulting firm, to develop an action program in consultation with the riparian countries, their scientists, and civil servants.

Figure 2. Rhine River at Boppard, Germany. Image by Isriya Paireepairit

This resulted in the drafting of the Rhine Action Plan (RAP) that called primarily for the return of salmon by 2000 and the reduction in point source pollution. In 1987, the ICPR member countries agreed to implement the Rhine Action Program (RAP) (Verweij 2000).

The ICPR assists the countries in implementing the RAP through facilitation of meetings, data acquisition and analysis, and the development of non-binding policy proposals. The non-binding agreements and decentralized approach have contributed to the ICPR's effectiveness as an international organization in the Rhine River Basin.

Transboundary Management: Organizations and Interactions

The European Union (EU), an economic and political union of 27 member states established by the Treaty of Maastricht in 1993, influences water management in the Rhine River Basin through its member states. Eight of the nine Rhine basin countries are members of the EU. The EU ensures that environmental legislation passed by the European Commission (the executive branch of the EU responsible for proposing legislation and implementing decisions) and agreed upon by the member states, is implemented.

The ICPR remains an important actor in the basin, working primarily in the area of pollution reduction and, more recently, flood control, while the CCNR continues to play a role in navigation. The ICPR has been instrumental in building trust among the riparian countries. However newly formed initiatives (such as the more recent efforts aimed at flood protection) still take time to mature, as differences in language, knowledge, and existing institutional structures must be overcome.

The location of countries along the river and the stressors associated with each location (Table 2) influence basin country priorities and their involvement in transboundary management. Historically, downstream countries have taken the initiative: for example, the Netherlands spearheaded the development of the RAP aimed at controlling pollution and returning salmon to the river. The Netherlands has also led recent efforts aimed at reducing flooding. Agricultural associations, drinking water associations, environmental groups and the public also provide input in various ways to the more formal transboundary management organizations. For example, a number of drinking water companies and environmental groups have been granted observer status in the ICPR.

Evaluating Transboundary Management Efforts: Successes

Since the passage of the RAP in 1987, point source discharges of toxic and other pollutants has decreased by 70% or more, with a subsequent increase in dissolved oxygen (Figure 3). Dioxins and DDT are no longer discharged and discharges of heavy metals and pesticides have been substantially reduced (Saha 2008). In addition, a new warning and monitoring system is in place to assist the riparian countries in detecting and responding to accidental releases of pollutants. As a result of the improvement in water quality, salmon returned to the river in the early 1990s.

New regulatory agreements have also been passed. In January 1998, the riparian ministers adopted the Convention for the Protection of the Rhine, which focuses on addressing next steps required to improve the ecological functioning of the Rhine. The 1998 Convention also targets reductions in non-point source pollution, removal of contaminated sediment, and an ecosystem approach for management of the watershed. Agreements such as the Rhine Action Program have stimulated the passage of water policies at the country level aimed at reducing pollution and more recently, the ecosystem-based approach for watershed management.

Since 1987, the ICPR has continued to provide a means for negotiating and establishing broad protection goals without prescribing the method for achieving these goals. This approach enables individual countries to govern more effectively. Additionally, in 1994, the ICPR was downsized to form a leaner, more agile management structure. Between 1950 and 1994, the ICPR had bourgeoned to 18 working groups, subgroups, and others, meeting along with the plenary sessions and meetings of the delegate heads. The downsizing reduced the number of permanent working groups to three, with two additional ad hoc groups. The revised

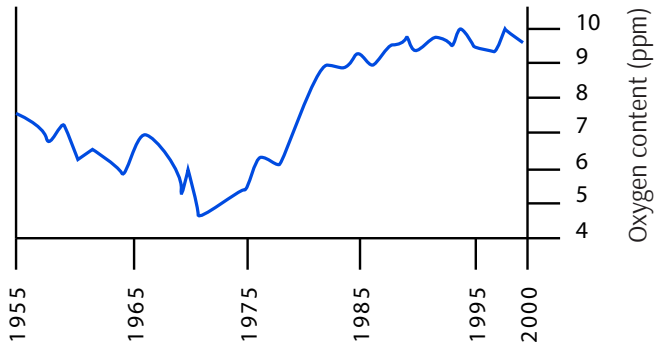

Figure 3. Improvement in dissolved oxygen level in the Rhine River (Adapted from ICPR 2005)

structure made for a more responsive, flexible and cost effective management regime (Ruchay 1995; Verweij 2000; Oterdoom 2001; ICPR 2005; Medema and Jeffrey 2008).

Evaluating Transboundary Management Efforts: Shortfalls

While point source pollution has decreased substantially, less success has been achieved in reducing non-point source pollution and its adverse impacts on the Rhine River. In addition to pollution from disperse sources, challenges remain regarding the treatment of contaminated sediment in the Rhine delta near the port of Rotterdam. Also, while salmon have returned to the river, the presence of large hydropower facilities impedes their progress upstream for spawning. Current management efforts are focused on non-point source pollution reduction.

Managing the river for improved navigation coupled with extensive urban development in the basin has resulted in increased flooding (Verweij 2000; Saha 2008). In response to the floods of 1993 and 1995, the Netherlands and Germany signed the Joint Declaration for the Cooperation Concerning Sustainable Protection against Floods. In 1998, the Action Plan on Flood Defense was approved at the 12th Conference of the Rhine Ministers. This Plan had four goals: to decrease the risk of flood damage; to decrease high water levels; to increase awareness of flood risk; and to improve flood warning. Current management efforts to control and protect against floods include structural measures such as higher embankments and new flood control barriers and, more recently, non-structural controls, such as dedicated inundation areas, awareness, and flood warning systems.

While transboundary cooperation has been successful in the area of pollution control, less success has been achieved in working towards Integrated Water Resource Management (IWRM). Transboundary management and cooperation was triggered by a series of problems or crises from the Sandoz accident, which precipitated increased point source pollution control, to more recent flood events that led to the 1998 Action Plan on Flood Defense. These management efforts have been focused on addressing particular concerns rather than reforming the overall approach to river and water management. The process of transboundary water management in the Rhine River Basin incorporates the sovereignty of the nine basin states, and operates through consensus and recommendations considered feasible and appropriate by member states.

Rhine River Case Study Discussion Questions

1. Prepare a conceptual map of the organizations involved in managing the Rhine River. Include with your map a brief description of each organization. How did the organizations and/or context change after the Sandoz accident?
2. How does the Rhine River case study illustrate management characteristics of IWRM? In what ways does the Rhine River case fall short of IWRM?
3. Why might IWRM be a good approach for the Rhine River?
4. What strategies might you use to implement IWRM in the Rhine River Basin? How might the Rhine River context help you implement IWRM? How might the Rhine River context impede implementation of IWRM?

MEKONG RIVER CASE STUDY

Introduction

The Mekong River is the longest river in Southeast Asia. It has a drainage basin of 795,000 square kilometers and a

length of 4,800 kilometers, making it the twelfth longest river in the world (Jacobs 2002; ABD 2004; Mehtonen et al. 2008). The river flows at an annual average discharge of 15,000 cubic meters per second, ranking tenth among the world's largest rivers.

The Mekong River drains portions of six countries: China, Myanmar, Cambodia, Lao PDR, Vietnam, and Thailand. In Cambodia, the Mekong River splits into two rivers: the Tien and the smaller Bassac River (Mehtonen et al. 2008). As the river approaches the Vietnam delta region, the river further separates into many smaller rivers, where it is known as the River of Nine Dragons, before it discharges to the South China Sea (as shown in Figure 4).

The Mekong River Basin is divided into the Upper and Lower Mekong with China and Myanmar in the upper basin and Cambodia, Lao PDR, Thailand and Vietnam in the lower basin. The basin is home to 73 million people, a third of whom survive on a few dollars a day (Jacobs 2002; ABD 2004; Mehtonen et al. 2008). In addition, over 100 different ethnic groups live in the Lower Mekong River Basin, making it one of the most culturally diverse areas in the world.

The river provides many environmental, economic, and other benefits for the region, including fisheries, wetlands, transportation, trade, water supply, and tourism. The fisheries in the Mekong are among the most productive in the world, trailing only the Amazon (ABD 2004). The river also provides a source of energy through hydropower production. Lastly, the Mekong subregion is prized for its rich biodiversity.

There are a number of basin stressors including: flooding during the rainy season, land use change, watershed degradation, population growth, and the development of dams for hydropower (Jacobs 2002; ABD 2004).

There has been a long history of transboundary cooperative management of the Mekong River. The organization established to facilitate cooperative management of the Mekong is the Mekong River Commission (MRC). The agreement establishing the MRC includes principles of Integrated Water Resources Management (IWRM).

Mekong River Basin

Though the headwaters of the Mekong originate in China, China's Yunnan province, Lao PDR, Thailand, and Cambodia together dominate the watershed, accounting for 89% of the total basin area. The remaining two basin countries, Myanmar and Vietnam, contribute the remaining 11% of the basin land area. The six riparian countries have varying levels of wealth, population, literacy, and access to clean water and sanitation,

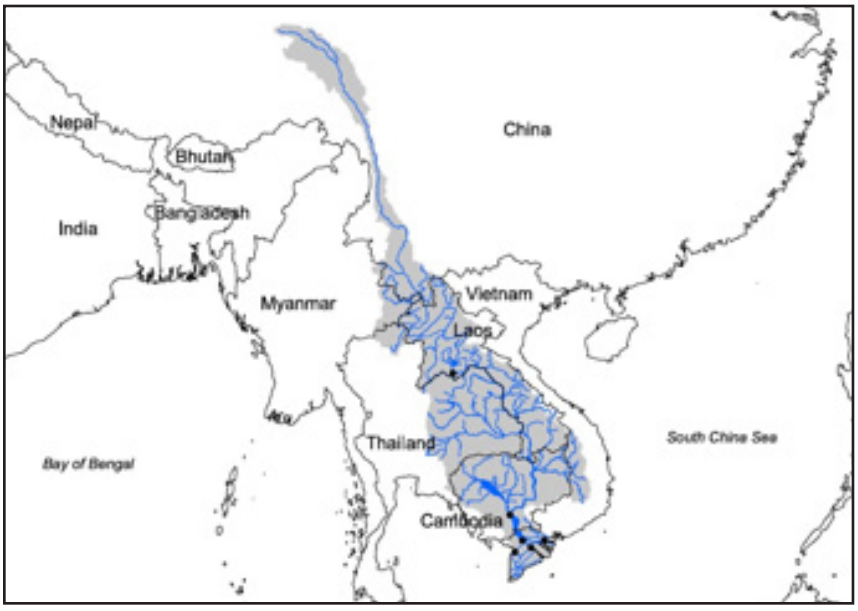

Figure 4. Mekong River Watershed
(Source EarthTrends: The Environmental Information Portal 2010)

Figure 5. The Mekong River Delta
(Source: NASA 1996)

however all six are classified as developing countries by the World Bank (World Bank 2009). At the time of writing, all six basin countries are stable politically. Table 3 summarizes the Mekong River Basin country profiles.

Basin stressors vary. In the upper basin, hydropower development and channelization along with concomitant aquatic ecosystem impacts and soil erosion are the dominant stressors. Downstream, potential impacts from hydropower development in the upper basin are of concern, and may already be altering river flows and aquatic systems (from the dams already constructed). Deforestation poses another significant problem in the lower basin. The fluctuations between flooding and drought are the primary stressors for Cambodia and Vietnam, respectively. Cambodia faces the greatest risk from flooding, given its location in the delta region of the Mekong along with Vietnam (Figure 5) and upstream flooding of Tonle Sap that occurs because of the rainy season flow reversal of the Tonle Sap River (Figure 6). Table 4 provides a summary of the Mekong River Basin area and stressors.

Because these are developing countries, the regional and national focus has been on economic development in the region, including developing transportation, electrical, and other infrastructure conducive to growing economies. This focus on development has concentrated attention on developing water resources to support economic growth and infrastructure development over and above possible social and environmental impacts and concerns. But, for example, if Lao PDR were to move aggressively towards energy development of tributaries to the Mekong, these new hydropower developments would have the potential to further impact river flows and aquatic ecosystems in the lower basin as well. However riparian countries, particularly in the Lower Mekong, have still developed a framework for transboundary cooperation in water resources management.

The State of the Mekong

The Mekong River provides water for drinking, sustaining important fisheries, hydropower energy production, navigation, agriculture, and ecosystem services, among other uses. A primary characteristic of the hydrologic dynamic of the Mekong is the strong natural seasonal variation in flow. The flood pulse, normally arriving in September through October, helps to maintain a functioning ecosystem, stimulate fisheries, and maintain salinity gradients (Sneddon and Fox 2006). But this seasonal variation also contributes to problems with flooding during high flows and with salinity issues in low flow periods. Wet season flows often exceed 20,000 cubic meters per second while in the dry season flows are on the order of 2,000 cubic meters per second (Jacobs 2002).

The fisheries in the Mekong and its tributaries supply ~60% of the protein intake of basin residents (Jacobs 2002). Fisheries in the delta region produce ~240,000-400,000 tons of fish each year (Sneddon and Fox 2006); the value of the fisheries alone is estimated to be about $1.2 billion (U.S.) per year (Jacobs 2002; Sneddon and Fox 2006). The fisheries and other natural resources support approximately 85% of the population living in the basin through subsistence and commercial fishing, rice production, and agriculture (Jacobs 2002).

Environmental degradation due to the impacts of pollution, logging and mining, population pressures, and agriculture are significant issues in the Mekong basin. Environmental degradation has led to decreased water quality in parts of the basin and also contributed to declining fisheries. These impacts are expected to increase as the population (which has doubled in the basin over the last 30 years) continues to increase (Jacobs 2002; UNITAR 2004; Hirsch 2006). Flooding (e.g., Cambodia) and water scarcity (e.g., Thailand) are also of concern. Floods in 2000, 2001, and 2003 caused an estimated $1 billion (US) in damage. As with environmental degradation, the threat from too much or too little water will be more problematic as populations and development increase. In addition, climate change has the potential to produce additional adverse impacts upon the region's water resources.

Lastly, regional economic development and the concomitant need for energy to drive development are spurring change in the basin (Jacobs 2002; Hirsch 2006). In the last decade, basin countries have proposed more than 100 new dams on the Mekong (Figure 7). The proposed dams will provide much needed energy for the region and help supply water for irrigation and

Table 3. Mekong River Basin country profiles

	CHINA, YUNNAN PROVINCE	MYANMAR	LAO PDR	VIET NAM	THAILAND	CAMBODIA
Type of Government	C	MJ	C	C	CM	CM/D
Total Population (millions)	42.4	51.1	5.4	78.9	62.9	13.3
Population Density (persons/km2)	109	70	25	253	126	192
Below Poverty Line (%)	4.6	14	39	37	13	36
Adult Literacy (%)	98	91	71	97	99	79
Women in Parliament (%)	22	n/a	21	27	6.6	5.5
Infant Mortality (#/1000)	32	47	90	30	25	95
GNP ($/capita)	565	n/a	260	390	2,000	260
Primary Economic Sector	A	A	A	I, S	I, S	A
Access to Clean Drinking Water (%)	75	70	58	56	80	30
Access to Sanitation (%)	38	70	46	73	96	18
Freshwater Resources (m3/capita)	>10,000	28,500	63,200	11,400	6,800	39,600
Emissions (metric tons/capita)	2.5	0.18	0.07	0.6	3.2	0.06

Symbols:
C = Communist
MJ = Military Junta
CM = Constitutional Monarchy
CM/D = Constitutional Monarchy/Democracy
A = Agricultural
I = Industry
S = Services

other uses. China is building a series of dams on the upper Mekong, and has completed six mega-dams. An additional fourteen dams are under construction or being planned (International Rivers 2013).Plans to build dams in Lao PDR, Thailand, and Cambodia are also under consideration. For example, Lao PDR has some 30 dams planned for installation to provide hydropower to serve the country's growing power needs as well as those of Thailand, Cambodia, and Vietnam. These dams are supported by basin countries that need power for development, as well as by basin countries with hydropower potential and limited national income, and by countries and companies that supply the money, parts, and labor for construction of hydropower facilities and associated infrastructure (Casey 2007; Imhof 2007; Lawrence and Middleton 2007; Salidjanova 2007).

The potential ecological impacts of the proposed dams

Table 4. Mekong River Basin: Area, country position, basin and environmental stressors. (Adapted from MRC 2005)

COUNTRY	CHINA, YUNNAN PROVINCE	MYANMAR	LAO PDR	VIET NAM	THAILAND	CAMBODIA
Basin Area Contribution (%)	21	3	25	8	23	20
Position in Basin	Headwaters	Upper	Lower	Lower	Lower	Delta
Basin stressors	Hydropower development, soil erosion	Soil erosion	Hydropower development, deforestation	Deforestation, drought	Deforestation	Flooding, drought
Country wide environmental stressors	AP, WP, SE	D, UP, BL, SE	D, BL, UO	D, BL	D, BL, AP, WP, LS, SE, WS	AP, WP

Symbols:
AP = air pollution
WP = water pollution
SE = soil erosion
D = deforestation
UP = urban pollution
BL = biodiversity loss
UO = unexploded ordinance
LS = land subsidence
WS = water scarcity

are not well understood. A change in the Mekong hydrograph could negatively affect fisheries, endangered species habitat, and agricultural productivity. Existing dams are already blamed for decreasing yields in fisheries but the long-term impacts are unknown. The effect of additional dams that would further impede fish migration routes and inundate spawning is of serious concern to scientists studying dam impacts in the region (Pearce 2004; Imhof 2007; Lawrence and Middleton 2007; Salidjanova 2007). These concerns include the potential disruption of the flood pulse for Lake Tonle Sap in Cambodia and for the delta itself (Salidjanova 2007). The flood is critical because every monsoon season the river reverses flow and fills Tonle Sap. When the dry season returns, the flow again changes and water from the lake contributes as flow into the Mekong (as shown in Figure 6). This process is believed to provide the necessary nutrients and habitat for fisheries nurseries to survive and thrive—fisheries supporting millions.
The flood pulse is also critical for the delta. Seasonally inundated areas of the delta provide the necessary environment for reproduction utilized by 90% of all Mekong species (Sneddon and Fox 2006).

Dam proponents point to the possibility of reducing salinity issues in the delta with installation of dams along the main stem, which would ensure a greater dry season flow. Dam opponents counter with the negative impact of displacing tens of thousands of rural villagers from the affected areas. Existing dams are estimated to have already displaced tens of thousands of people. However, at present, environmental and social costs are less of a concern in the region than pressures for increased development. In addition to dams for hydropower, damming for large irrigation projects is also under consideration. One such project has been proposed by Thailand to divert water for irrigation.

In addition to dams, China is also working to remove rapids and canalize portions of the Mekong to improve

trade navigation. The canalization project would open a river trade route between China and neighboring Vietnam. At present, the environmental and ecological impacts upon the Mekong River from the canalization project are not well understood.

Managing the Mekong: A Brief History

Transboundary cooperation in the management of the lower basin began in 1957 with a United Nations-led effort to promote international river basin planning (Jacobs 2002; Hirsch 2006; Mehtonen et al. 2008). This effort resulted in the establishment of the Committee of Coordination and Investigation of the Lower Mekong River Basin, involving Cambodia, Laos, Thailand, and South Vietnam, called the Mekong Committee (MC). This committee initiated one of the first efforts to study the social, economic, and organizational aspects of a project prior to construction. This approach echoes the principles of IWRM as we understand them today. Cambodia's civil war and the subsequent regime of the Khmer Rouge reduced the effective activities of the MC. In 1978, a new arrangement between Lao PDR, Thailand, and Vietnam was formed, the Interim Mekong Committee, or IMC (MRC 2000; ABD 2004; Mehtonen et al. 2008).

The IMC remained active until April 1995, when the Agreement on the cooperation for the sustainable development of the Mekong River Basin was signed by all four lower basin countries: Cambodia, Lao PDR, Thailand, and Vietnam. This Agreement formed the new Mekong River Commission (MRC), the principal organization with responsibility for transboundary cooperative management of the Lower Mekong River (MRC 2000; Jacobs 2002; Mehtonen et al. 2008). The Mekong Agreement focuses on the sustainable and comprehensive management of the river including, in principle, environmental and social impacts. This approach echoes the tenets of Integrated Water Resource Management (Mehtonen et al. 2008).

In 1992, all six riparian countries entered into the Greater Mekong Subregional Economic Cooperation Program (GMS Program), ostensibly to strengthen environmental protections, institutions, and sustainable development mechanisms. This program was initiated by the United

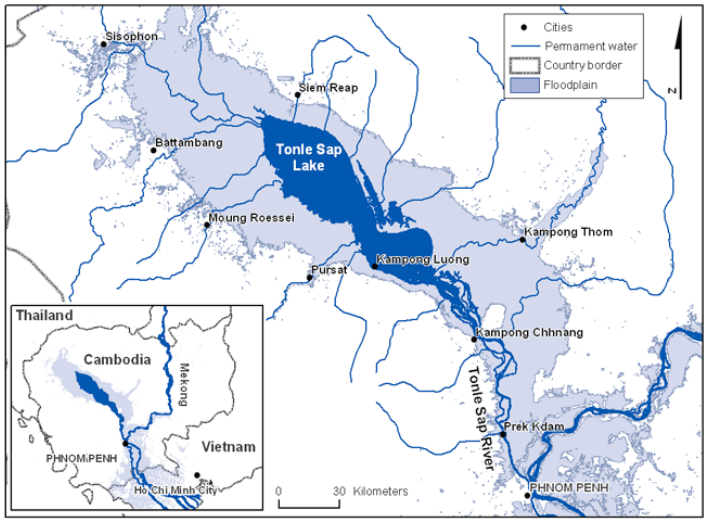

Figure 6. Tonle Sap flow reversal during monsoon season Mkummu [GFDL (www.gnu.org/copyleft/fdl.html), CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/) from Wikimedia Commons

Figure 7. Dam development on the Mekong (Image used with permission - © TERRA www.terraper.org - see Lawrence, S. and C. Middleton 2007)

Nations Economic and Social Commission for Asia and the Pacific. While environmental issues are listed in the GMS, activities have primarily focused on cooperation for economic and infrastructure development (Mehtonen et al. 2008). The Golden Triangle was established in 1993 between Thailand, Lao PDR, Myanmar, and China with a goal "to facilitate common use and development of the Mekong" (Jacobs 2002). Its focus has been on developing transportation and trade routes.

The Association of Southeast Asian Nations (ASEAN) was established in 1967 by Indonesia, Malaysia, the Philippines, Singapore, and Thailand to bridge the development gap and accelerate economic and trade integration. Today, all of the Mekong basin countries except China are members of ASEAN. In 1996, ASEAN began the Mekong Basin Development Cooperation initiative to enhance economic and sustainable development of the Mekong basin (Mehtonen et al. 2008). In 2002, ASEAN created a new Working Group on Water Resources Management focused on IWRM (Mehtonen et al. 2008) but it remains to be seen how much traction the environment and social issues will have as development projects proceed in the basin. Other development-focused management initiatives exist in the Mekong River Basin, but, as seen above, less emphasis is placed on environmental and social concerns.

The Mekong River Commission

In April 1995, the four lower basin riparian countries signed the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, in Thailand. By signing the Agreement, these countries agreed to develop, conserve, and use the river cooperatively in a sustainable manner (MRC 2000; Jacobs 2002). This Agreement created the Mekong River Commission (MRC) as the primary agent for cooperative river basin management (Figure 8). The MRC is a policy-making body and its policies are binding on the four member countries. However because China and Myanmar are not signatories of the Agreement, this framework is limited to the lower Mekong Basin.

The MRC consists of a Council, a Joint Committee (JC), and a Secretariat. One member at the ministerial and cabinet level from each member country sits on the Council while the JC consists of one member from each country at the department head level (MRC 2000). The Secretariat provides technical and administrative assistance to the Council and JC and is located in Phenom Penh, Cambodia. The MRC is funded by the member countries and donors (90%).

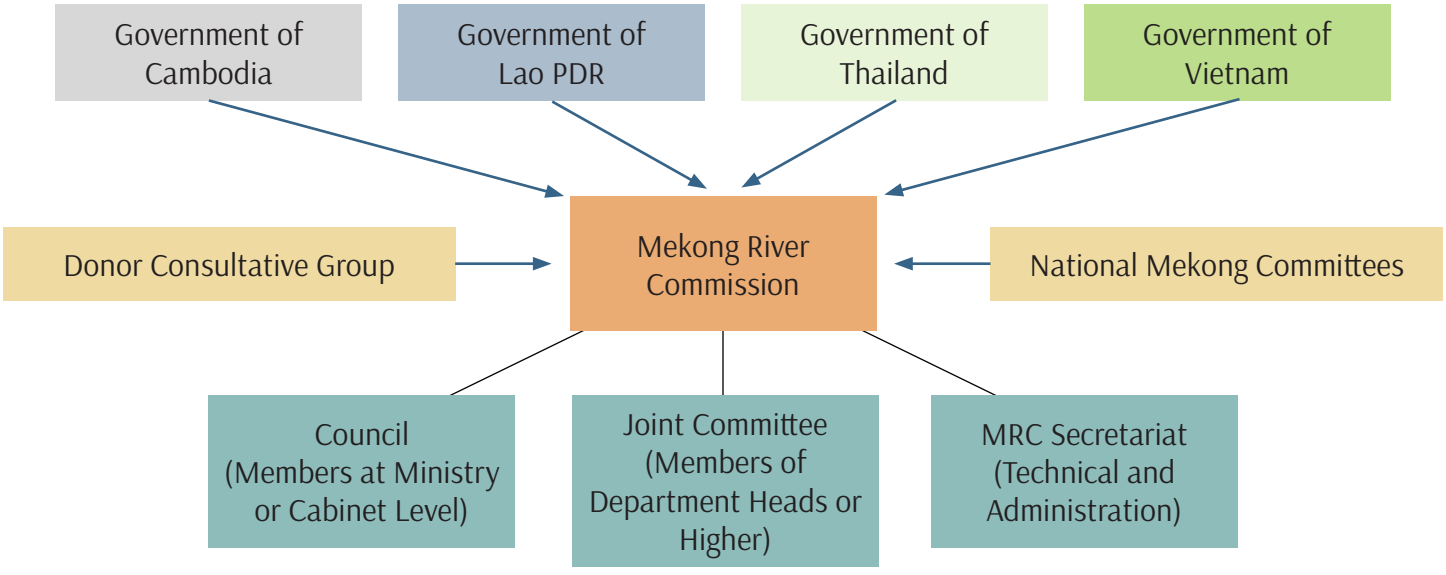

Figure 8. Mekong River Commission governance structure

Transboundary Management: Organizations and Interactions

The Mekong River Commission influences water management in the lower Mekong Basin countries through the prior consultation and notification provisions of the Agreement along with other binding decisions. The MRC has fostered regional cooperation for water resources development but has emphasized national and regional level interactions over local or community level interactions. Member states differ in terms of human, economic, and technical capacity for development. These differences can be a barrier to interaction and cooperation. MRC member countries and the other riparian countries are also involved in bilateral and multi-lateral cooperative efforts.

The Asian Development Bank, the World Bank, and other donors influence water management in the Basin by funding or not funding projects, and by requiring or not requiring environmental or social impact analysis and mitigation. The GMS Program, aimed at economic development, and the ASEAN Working Group on Water Resources Management also influence water management in the region. Like the MRC, these organizations promote dialogue at the regional or national level.

The location, varied interests, and characteristics of the individual riparian nations (Figure 4, Tables 3 and 4) influence each country's priorities and involvement in the transboundary management of the Mekong. Cambodia, the second most downstream country, emphasizes the maintenance of the seasonal high and low flows to protect Tonle Sap Lake and other flood plain ecosystems. Further downstream, Vietnam considers sufficient low flows as the most significant river issue. Upstream, projects that divert flow from the main stem and tributaries to support irrigated agriculture are priorities for Thailand. China and Lao PDR, on the other hand, are focused on hydropower development, and China is also focused on opening a trade route to Southeast Asia by making key portions of the Mekong navigable for shipping. These varied interests and motivations, as well as the sheer number of proposed projects, heightens the need to cooperatively plan and manage the Mekong River Basin in order to understand the potential impacts of development projects on river flows and ecosystems.

The role and involvement of NGOs in water resources management is increasingly important. For instance, the World Conservation Union (IUCN) and the Global Water Partnership (GWP) are active in the region. The IUCN has focused on increasing dialogue between local, national, and regional groups, while GWP has promoted IWRM through various water forums (Mehtonen et al. 2008).

Evaluating Management Efforts: Successes

The existence of a number of international agreements and management organizations in the Mekong River Basin is a testament to the recognition that cooperation is needed. Agreements and cooperative frameworks such as the MRC provide a forum for dialogue, albeit a dialogue that has historically focused on the regional and national level at the expense of the local and community levels. However, recent calls by NGOs and donor organizations for enhancing participation may increase communication at lower levels (Sneddon and Fox 2006). Cooperative efforts like the MRC have led to the development of data and improved understanding of the ecological and physical underpinnings of the Mekong River system. Cooperation has also led to the development of a flood forecasting and warning system (Jacobs 2002).

Instability in the region forestalled development of massive dams in the 1960s and 1970s. The delay meant that rapid dam building in the Lower Mekong River without consideration for subsequent environmental and social impacts (as happened in other parts of the world) did not take place in this region. This delay has also allowed new governance frameworks and approaches, like IWRM and those emphasizing sustainable development, to take hold. Dam projects now consider (at least to some extent) environmental and social impacts.

China and Myanmar have been dialogue members of the MRC since 1996. While the arrangement brings these upper basin countries into the discussion, it does not bind them to any decisions or agreements passed by the MRC (Mehtonen et al. 2008). The MRC is increasingly

reaching out to China particularly in the area of scientific cooperation. China is also taking a greater interest in regional development, which may translate to greater cooperation in management of the Mekong (Jacobs 2002).

Evaluating Management Efforts: Impediments

Ineffective water use planning, insufficient data and data sharing, poor intra-nation institutional coordination, incomplete understanding of the Mekong River system, lack of skilled personnel, poor communication, and weak policy, regulatory frameworks, and enforcement mechanisms, are the primary constraints limiting sustainable management of the Mekong River Basin.

The MRC as an institution also has significant issues, particularly with participation versus non-participation, members' differing priorities, and limitations to its authority. Additionally, China and Myanmar are not full participants; participation in the MRC is regarded by these two countries as a possible constraint to further development. Differential rates of regional development also create differential incentives and disincentives for participating or for refusing to participate in the MRC (UNITAR 2004; Hirsch 2006). For example, China, a non-participant, and Thailand, a participant, are developing more quickly than other countries in the region. While the MRC does have policy-making authority that binds participating countries, it does not currently have the ability to set a basin-wide agenda, nor do countries relinquish their sovereignty simply by participating in the MRC. Myanmar is a non-participant for other reasons, including internal political struggles and an abundant water supply. The MRC is further hampered by its small size and limited resources and by extreme poverty in the basin. Donor funding (which provides 90% of the MRC budget) impedes the sense of riparian country ownership in the MRC and its governance mechanisms. The MRC has also seen its authority undermined: for example, China established a separate cooperative network among the four upper basin countries to facilitate development of a navigation channel on the upper Mekong. This network completely bypasses the MRC and thus undercuts MRC's authority to govern the basin. Lastly, the MRC is not regarded as a forum for local or community concerns but rather only representing national concerns.

In addition to these issues, the pressure in the basin countries to increase development has suppressed efforts to promote environmental concerns to a certain degree. Critics argue that the overriding emphasis on river basin development by the MRC and other regional organizations has meant that development has proceeded in practice without a commitment to the environment and social issues (Sneddon and Fox 2006). Thailand is an exception, given the development of a strong environmental movement within the country that has elevated environmental issues onto the agenda. Cambodia is also beginning to develop an environmental movement.

The 1995 Mekong Agreement (which formed the MRC) lays out strict policies for maintaining minimum flows during the dry season but does not include provisions for maintaining high flows during the wet season (Sneddon and Fox 2006). This hamstrings the MRC regarding any control over main stem development projects that might alter the flood-pulse. Even a functioning basin organization does not guarantee comprehensive cooperation between riparian countries to enable implementation of IWRM principles (Mehtonen et al. 2008). While sustainable development is a foundational principle of the MRC Agreement and IWRM, neither sustainable development nor IWRM has gotten much traction in the basin.

Mekong River Case Study Discussion Questions

1. Prepare a conceptual map of the organizations involved in managing the Mekong River. Include with your map a brief description of each organization. What does your map indicate about how the Mekong is managed? How does this compare to the management of the Rhine?
2. Think back to the Rhine River Case Study. How are the ICPR and MRC similar? How are they different? How might these similarities and differences influence their success managing transboundary water resources in the basin?

3. How does the Mekong River Case Study illustrate management characteristics of IWRM? In what ways does the Mekong River case fall short of IWRM?
4. Why might IWRM be a good approach in the Mekong River?
5. What strategies might you use to implement IWRM in the Mekong River Basin? How might the Mekong River context help you implement IWRM? How might the Mekong River context impede implementation of IWRM?

ZAMBEZI RIVER CASE STUDY

Introduction

The Zambezi River Basin is home to about 40 million people in Southern Africa, who rely on the river for drinking water, fisheries, irrigation, hydropower production, mining and industry, ecosystem maintenance, and other uses. With a drainage area of 1.385 million square kilometers and a length of 3,000 kilometers (Chenje 2003; Wirkus and Boge 2006; Phiri 2007), the Zambezi River flows at an annual discharge of 3,600 cubic meters per second (Lamoree and Nilsson 2000; Wirkus and Boge 2006). The Basin supports a vast amount of terrestrial biodiversity and the richest and most diverse flora in Africa (Chenje 2003). The watershed covers portions of eight countries—Zambia, Angola, Namibia, Botswana, Zimbabwe, Malawi, Tanzania, and Mozambique—before it discharges to the Indian Ocean (Figures 9 and 10).

Once the recent Zambezi Watercourse Commission (ZAMCOM) Agreement (signed in 2004) is ratified by six of the eight basin states, the Commission will be officially established. Thus far, the Agreement has been signed by seven of the eight basin states but only four out of the seven signatories have ratified the Agreement through formal parliamentary adoption. The new organization will facilitate transboundary, cooperative management of the Zambezi River. Integrated Water Resource Management principles are embodied in the nascent ZAMCOM Agreement and in the IWRM strategy for the basin.

The Zambezi River Basin

The headwaters of the Zambezi originate in Zambia. Together, Zambia, Zimbabwe, Angola, Malawi and Mozambique dominate the watershed, contributing 95% of the Zambezi River Basin area. The remaining three basin countries—Botswana, Namibia, and Tanzania—contribute the remaining 5% of the basin land area.
The eight basin countries have varying levels of wealth,

Figure 9. The Zambezi River Basin (Used with permission from Dr. Amy Burnicki, 2008. University of Wisconsin, Department of Geography)

population, literacy, and access to clean water and sanitation, however all eight are classified as developing countries by the World Bank (World Bank 2009). A summary is included in Table 5.

Basin stressors vary, however many of the basin countries struggle with water scarcity, drought, rapid population growth (averaging 2.9% per year in the basin), poverty, water pollution, and lack of information about available water resources. Poverty is an environmental stressor due to overexploitation of the environment for survival, resulting in degraded and less productive land and water resources (Chenje 2003). Table 6 provides a summary of the Zambezi River Basin area and stressors.

With the exception of Zimbabwe, there is a stable political framework within each of the riparian basin countries. Because these are developing countries, the regional and national focus has been on economic development in the basin including developing the transportation, electrical, and other infrastructure conducive to support growing economies. This focus on development has concentrated attention on developing water resources to stimulate economic growth and infrastructure development over and above possible social and environmental impacts and concerns. However, despite this development focus, the riparian countries in the Zambezi Basin, have developed a framework for transboundary cooperation in the management of the water resources of the Zambezi River.

The State of the Zambezi

Of the approximately 40 million people living in the Zambezi River Basin, the majority live in Malawi, Zimbabwe, and Zambia (Wirkus and Boge 2006). This population living in the Basin represents about 20% of the total population in the Southern African Development Community (SADC), making the Zambezi an important river in the region (Chenje 2003). Basin residents rely on the river for drinking water, fisheries, irrigation, hydropower production, mining and industry, ecosystem maintenance, to name a few uses. The Zambezi River also attracts tourists from around the globe, who visit Victoria Falls and the wildlife that the river supports along its banks. Tourism supports local economies along the river and brings much needed foreign currency into the basin countries. Though the river is an important natural resource, protecting and managing the sustainable use and development of the Zambezi is an ongoing challenge.

Figure 10. The Zambezi river and its floodplain, seen from the international space station. (Source: NASA)

Table 5. Zambezi River Basin Country Profiles (Source: Population Reference Bureau (2009); CIA Fact Book)

	ANGOLA	BOTSWANA	MALAWI	MOZAMBIQUE	NAMIBIA	TANZANIA	ZAMBIA	ZIMBABWE
Type of Government	R	PR	D	R	R	R	R	PD
Total Population (millions)	16.3	1.8	13.1	20.4	2.1	38.7	11.5	13.3
Population Density (persons/ km2)	13	3	110	25	3	41	15	34
Below Poverty Line (%)	70	30.3	53	70	34.9	36	86	68
Adult Literacy (%)	73	89	76	63	93	92	89	98
Women in Parliament (%)	16	7	15	30	26	21	12	10
Infant Mortality (#/1000)	141	56	96	108	55	78	100	60
GNP ($/capita)	5,600	16,400	800	800	5,200	1,300	1,300	200
Primary Economic Sector	I, S, A	I, S, A	I, S, A	I, S, A	I, S, A	I, S, A	I, S, A	I, S, A
Emissions (metric tons/capita)	0.5	2.3	0.1	0.1	1.2	0.1	0.2	0.9
Arable Land (%)	2.65	0.65	20.7	5.43	0.99	4.23	6.99	8.24

Symbols:

R = Republic
PR = Parliamentary Republic
D = Democracy
PD = Parliamentary Democracy
I = Industry
S = Services
A = Agricultural

Eight basin countries share the Zambezi Basin watershed; however, their national interests in the river differ. For example, Zambia and Zimbabwe have the lion's share of the watershed within their borders and participate in bilateral management of the river through the Zambezi River Authority, sharing the Kariba Dam and Victoria Falls. Zambia has sufficient water resources but Zimbabwe suffers from water scarcity. For this reason, Zimbabwe plans to divert water from the Zambezi to Bulawayo (its second largest city) to provide municipal and irrigation water to a region chronically short of water. The pipeline would extend for about 225 miles (450 kilometers) and require major energy inputs to overcome both distance and an increase in elevation of about 3,000 feet (1000 meters) to reach the Bulawayo municipality (Wirkus and Boge 2006). Namibia also has pressing needs for water for new irrigation projects (Wirkus and Boge 2006). One proposed solution is to build infrastructure necessary to transfer Zambezi River water to the Okavango River (Turton 2008). In addition, Botswana sees the Zambezi as a source of water for its capital city, Gaborone.

Table 6. Zambezi River Basin: Area, country position, basin, and environmental stressors

COUNTRY	ANGOLA	BOTSWANA	MALAWI	MOZAMBIQUE	NAMIBIA	TANZANIA	ZAMBIA	ZIMBABWE
Basin Area Contribution (%)	14	1.5	12	12	1.5	2	41	16
Position in Basin	Upper	Upper	Lower	Delta	Upper	Lower	Headwaters; upper	Middle
Basin stressors	Poverty	Water scarcity	Poverty	Drought; floods; poverty	Drought; floods; poverty	Drought	Pollution; poverty	Pollution; poverty
Country wide environmental stressors	SE, DS, DF, BL, WS, P	DS, WS	DF, WP, P	DS, WP, D, F, P	WS, DS, D	DF, DS, D, F	AP, AR, WP, DF, SE, DS, P	DF, SE, AP, WP, D, P

Symbols:

SE = soil erosion
DS = desertification
DF = deforestation
BL = biodiversity loss
WS = water scarcity
P = poverty
WP = water pollution
D = drought
F = flooding
AP = air pollution
AR = acid rain

The increasing demand for water is a crucial concern as a consequence of population growth, increasing irrigation to increase food production, and the reality of climate change. The population in the Zambezi River Basin is increasing at the rate of 2.9% per year. More than 40% of the current population is under 14 years of age. It is anticipated that the population will continue to expand until at least the year 2015. Rainfall is the primary source of freshwater renewal in the Basin. Global warming and climate change are already apparent in much of Southern Africa including the Zambezi River Basin. Air temperatures are increasing; rainfall is decreasing; and the frequency of drought conditions are increasing. Water rich countries like Angola, Mozambique, and Zambia are less reliant on surface water for irrigation but Namibia and Botswana receive scant rainfall and are reliant on groundwater, an unsustainable practice as groundwater resources in the area are essentially non-renewable (Chenje 2003; Scholes and Biggs 2004). Table 7 summarizes the water resources available for each of the eight basin countries.

Seasonal rainfall variation is also an issue as it can lead to flooding, particularly in downstream countries like Mozambique. These floods were once cyclical but damming of the river has made the floods unpredictable and difficult to manage, and the flooding issue remains contentious. In water scarce countries, drought is always a concern, exacerbated by the risks and uncertainties associated with climate change. As indicated by Table 7, two countries, Malawi and Zimbabwe, are already under water stress. Climate change is expected to cause increased water stress in these areas and others, as rainfall continues to decrease and evaporation rates increase with rising temperatures. Continued population growth will also lead to increasing water stress (Chenje 2003).

Even in areas with plentiful water resources, access to clean drinking water and sanitation remains a persistent and significant challenge in Southern Africa, particularly in rural and impoverished urban areas. Lack of access to clean water contributes to illness and death particularly among children and those with compromised immune

Table 7. Water resources in the Zambezi Basin (Source: Scholes and Biggs 2004)

BASIN COUNTRIES	RENEWABLE WATER RESOURCES			
	TOTAL (KM^3/AC)	WITHDRAWALS (KM^3/AC)	WITHDRAWALS % OF TOTAL	WATER 2001 (M^3/ PERSON)
Angola	184.0	0.4	0.19%	13,620
Botswana	14.4	0.1	0.97%	8,471
Malawi	17.3	0.6	3.65%	1,641[a]
Mozambique	216.1	0.6	0.29%	11,960
Namibia	17.9	0.3	1.51%	10,022
Tanzania	91.0	2.0	2.20%	2,642
Zambia	105.2	1.7	1.65%	10,233
Zimbabwe	20.0	2.6	13.05%	1,560[a]

[a] Indicates water stress (1,700 m^3/person)

Table 8. Clean water and sanitation in the Zambezi River Basin (Source: Scholes and Biggs 2004)

BASIN COUNTRIES	DRINKING WATER ACCESS		SANITATION	
	% URBAN	% RURAL	% URBAN	% RURAL
Angola	34	40	70	30
Botswana	100	90	88	43
Malawi	95	44	96	70
Mozambique	81	41	68	26
Namibia	100	67	96	17
Tanzania	90	57	99	86
Zambia	88	48	99	64
Zimbabwe	100	73	71	57

systems (Scholes and Biggs 2004). Table 8 summarizes the percentage of access to clean drinking water and sanitation for rural and urban populations in the eight Basin countries. Reduction of the number of people without access to water and sanitation is of critical importance, and is an example of one of the many issues competing for time, attention, and money in the region.

Several large dams have already been constructed on the Zambezi to generate much needed electrical power for basin states. The two largest dams are the Kariba Dam, located between Zimbabwe and Zambia, and the Cahora Bassa Dam in Mozambique (Wirkus and Boge 2006). A number of other new dams are under discussion. One proposed dam to be located at Batoka Gorge would generate 1600 megawatts, while another new dam at Devil's Gorge would generate 1240 megawatts. The need for electricity and the availability of external funding means that hydropower projects are likely to be built along the Zambezi in the coming years. Eight additional dam sites along the Zambezi's main stem have been identified. However, resistance to building additional large dams is growing because of environmental costs and, more recently, concerns regarding loss of water from reservoirs through evaporation. In-country diversions of water from the Zambezi River are limited by the costs involved and out-of-basin diversions are the least likely, because of the very large financial costs involved as well as the significant political complexities.

Pollution in the surface water and groundwater of the Zambezi Basin is a result of mining, industrial,

agricultural activities as well as the discharge of human wastes without adequate treatment. The deterioration of lakes, streams, and rivers has been a consequence of these pollutant loadings, resulting in major negative water quality impacts on the surface waters. The in-stream manifestations of these negative impacts include eutrophication (excessive nutrients causing algal blooms), increased dissolved and suspended solids, increased nitrates, and toxic contaminants from mining operations. Non-native invasive species introductions have also impacted the Zambezi River: for example, the introduction of the water hyacinth, a floating plant that covers the water surface and disrupts the normal functions of aquatic ecosystems, has had negative impacts. Conversely, the introduction of the Lake Tanganika sardine, known locally as the Kapenta, has had positive consequences: it has become a major source of protein for the population within the Zambezi Basin. However, the survival of the Kapenta is threatened by overfishing of this important food source. Another threat facing the region has arisen from the fact that nearly 74% of the energy needs within the Zambezi Basin are provided by burning of biomass or fuel wood. This use of fuel wood for cooking and lighting has resulted in deforestation and the subsequent erosion of soil that is carried to the basin's surface waters by rainfall and subsequent runoff.

Managing the Zambezi River Basin

Most of the basin countries have adopted environmental standards and regulations. However, persistent problems include lack of enforcement of existing regulations, weak institutional and legal structures, and inadequate economic, human, and technical capacity (Chenje 2003). Fully effective transboundary water management of shared water resources remains a continuing challenge for Southern Africa, particularly in the Zambezi River Basin. The lack of adequate institutional structures both within each country and at the basin level has long impeded progress on transboundary water management of the Zambezi River, though the tide may be turning. The earliest effort in transboundary management resides with the Zambezi River Authority (ZRA), a bilateral organization involving Zambia and Zimbabwe. The ZRA is focused on the joint operation of the Kariba Dam and has responsibility for water allocations to both countries and their respective electricity companies (Wirkus and Boge 2006). Other responsibilities include: data collection, monitoring, and planning for new dams.

The United Nations Environment Program (UNEP) has played a role in energizing cooperative transboundary management of the Zambezi River. In 1987, the governments of Botswana, Mozambique, Tanzania, Zambia, and Zimbabwe adopted the Agreement on the Action Plan for the Environmentally Sound Management of the Common Zambezi River System (ZACPLAN) (Lamoree and Nilsson, 2000; Wirkus and Boge, 2006); Angola, Malawi, and Namibia joined in the early 1990s. ZACPLAN details some 19 Zambezi Action Projects (ZACPROs), including plans for water resource assessments, water project planning, a monitoring system, a database, and an integrated water resources development plan. The implementing agency for ZACPLAN is the Zambezi Watercourse Commission (ZAMCOM). The agreement for establishing ZAMCOM was signed in 2004 by seven of the eight basin states (Turton 2008); Zambia announced its readiness to join the Commission in May 2013, but have not yet signed the Agreement (ZAMCOM 2013). The principle sticking point is that Zambia contains the bulk of the watershed drainage area for the basin. As such Zambia does not wish to give control to other basin countries over waters it feels belongs to Zambians. Though seven of the eight basin states have signed the Agreement, in order for the Agreement to take effect six of the eight basin states must ratify the Agreement. This occurred in 2011, seven years after the initial signing of the Agreement (ZAMCOM 2012).

In moving to establish ZAMCOM, seven of the eight basin countries have demonstrated their commitment to adhere to the principles of equitable, reasonable, and sustainable use and efficient management of the water resources of the Zambezi River, inter-generational equity, prevention of harm, and cooperation (Wirkus and Boge 2006). These principles are key to the tenants of IWRM (Wirkus and Boge 2006). ZAMCOM's functions include: (1) data collection and dissemination; (2) support, coordination, and harmonizing management and development of the Zambezi; (3) advising member states; (4) fostering awareness; (5) cooperation with the Southern African Development Community (SADC) and

other organizations; and, (6) promoting and supporting the harmonization of national water policies and legislation (Wirkus and Boge 2006). The Agreement uses the Revised SADC Protocol of 2000 as the basis of the agreement. The Protocol provides a legal framework for governance of the shared watercourse (Turton 2008).

The SADC encompasses all of Southern Africa from the Democratic Republic of Congo to South Africa and Madagascar. This supra-regional organization was established for the purpose of integration, harmonization, and sustainable development for the region. But SADC's charge is not simply economic; rather SADC is also concerned with the sustainable use and management of natural resources including water. SADC's Water Division has been instrumental in facilitating the development of institutions for more sustainable water resource management of the 15 shared rivers in Southern Africa, including the Zambezi River (Tumbare 2005). SADC has also been instrumental in trying to harmonize national level water policies and in spearheading the development and adoption of several regional water protocols governing shared watercourses. Principal among these is the Revised Protocol on Shared Watercourses (Chenje 2003).

Transboundary Management: Organizations and Interactions

The Zambezi River Authority exercises authority over operation of the Kariba Dam. This powerful organization exerts influence on the Zambian and Zimbabwean governments through its knowledge and expertise of the hydrology of the river and potential future dam sites. The ZRA has also played a significant role in the ZACPRO6 project to create a basin-wide integrated water resource management plan. ZRA oversaw the effort and was instrumental in achieving progress on an otherwise slow-moving effort (Wirkus and Boge 2006). Oversight for ZACPRO6 will be in the hands of ZAMCOM.

Donors and NGOs also play a role in the basin. The Swedish International Development Cooperation Agency (SIDA) provides financial support for the ZRA's Environmental Monitoring Program; similarly, the French Global Environmental Facility (FGEF) provides money to the ZRA for the Pollution Monitoring and Management Program (Wirkus and Boge, 2006). Donors are also largely responsible for supporting ZACPLAN: the ZACPLAN meetings were 100% donor funded (Wirkus and Boge, 2006). Furthermore, SIDA, the Norwegian Agency for Development Cooperation (NORAD), and the Danish International Development Agency (DANIDA) are the principle funders for the ZACPRO6 effort concerned with developing an integrated water resource management plan for the Zambezi River basin. UNEP played a pivotal part in the establishment of ZACPLAN along with the World Bank and the United Nations Development Program (UNDP). Regional stakeholders have been participating in annual stakeholder dialogues.

Evaluating Transboundary Management Efforts: Successes

The ZRA is seen as a successful bilateral management effort between Zambia and Zimbabwe primarily because of the many shared interests, organizational strength, autonomy, and clear mandate (Wirkus and Boge 2006). At the basin-scale, the adoption of the SADC Water Protocol and Revised Protocol for Shared Watercourses are regarded as great achievements. The 2000 Revised Protocol marked SADC's first legally binding framework program. Adoption of that protocol set the stage for further cooperative effort and led to the commitment to establish ZAMCOM. The ZAMCOM Agreement took years of negotiation, implying basin states take the process very seriously (Turton 2008).

ZAMCOM requires notification and consultation of member states for any river main stem development project and includes provisions for dispute resolution. These provisions mean basin states have a framework for cooperatively managing the Zambezi. Another achievement was the creation of a database for the basin states containing information about water resources and existing and planned projects. The Zambezi River Basin Information System and Database was recently completed, no small feat given each individual state's resistance to supplying information. Eventually, these impediments were overcome and the database was finalized. Efforts are currently underway to implement the Integrated Water Resource Management Strategy for the basin developed under the auspices of ZACPRO 6.4.

Evaluating Transboundary Management Efforts: Shortfalls

Unfortunately, national sovereignty, competing water demands, human and financial resources, lack of knowledge, and political power differentials have made instituting sustainable water resource planning and management difficult on the Zambezi (Swatuk 2005). National interests and national sovereignty often stymie cooperation; but, eventually, progress is made. Evidence suggests that over the long-term, water scarcity in basin countries will create strong incentives to support cooperative management and investment in water resources (Turton 2008). Also, even with SADC in play, governance remains a key constraint to the achievement of sustainable water resource management in the Zambezi Basin (Scholes and Biggs 2004). Other impediments to sustainable water resource management include: poor data collection, management, and dissemination systems, inadequate training, and weak stakeholder participation (Phiri 2007). Heavy donor involvement and support of the ZACPLAN and ZAMCOM process has hampered national and regional collaboration due to coordination problems among the donors. Lastly, strong water sector involvement has had the effect of limiting input from other ministries, making integrated water resources management more difficult within and between basin countries.

Zambezi River Case Study Discussion Questions

1. Prepare a conceptual map of the organizations involved in managing the Zambezi River. Include with your map a brief description of each organization. Compare your map of the Zambezi River Basin management organizations to the maps you drew for the Rhine and the Mekong. What similarities and differences in the management structure do you notice across the three river basins?
2. Think back to the Rhine and Mekong River Case Studies. How does the proposed ZAMCOM differ from the ICPR and MRC? How is the proposed ZAMCOM similar to the ICPR and MRC?
3. How does the Zambezi River Case Study illustrate management characteristics of IWRM? In what ways does the Zambezi River Case fall short of IWRM?
4. What strategies might you use to facilitate successful implementation of IWRM in the Zambezi River Basin? In your answer consider strategies at the regional level (e.g., SADC), national level (e.g., Zambia, GWP, SIDA, etc.), and local level (e.g., NGO, water department, community organization, etc.)

DISCUSSION

Integrated Water Resources Management (IWRM) is a process that promotes the coordinated development, management, and sustainable use of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP 2009). The three cases presented above—the Rhine River, the Mekong River, and the Zambezi River—illustrate the challenges associated with implementing IWRM in three international transboundary contexts. IWRM process is weakest in the Rhine and strongest in the Zambezi. This uneven application of IWRM illustrates and underscores the challenges of applying this approach.

Gerlak (2007) provides a summary of the challenges faced when implementing IWRM and how to mitigate those challenges in a broader context. She summarizes important lessons learned in Global Environmental Facility (GEF) projects in transboundary waters as follows (Gerlak 2007):

1. Creating a shared vision;
2. Involving the public and the private sectors;
3. Coordinating program activities;
4. Building governance institutions and capacity;
5. Improving the ecosystem;
6. Difficult to transform data into information necessary to inform decision makers;
7. Participating agencies must commit to the priorities outlined in the Strategic Action Plan;
8. Need strong analysis that is technically sound, thorough, and comprehensive;
9. IWRM failures observed from inadequate

incorporation of stakeholders;
10. IWRM failures occur if the root causes of transboundary problems are not identified;
11. Broad public participation in the IWRM process can help build regulatory success and legitimacy;
12. Tools for effective public participation in IWRM processes are in the highest demand.

GEF and the Environmental Law Institute have developed a collection of training materials to deliver a series of regional workshops on public participation in international water management. These training materials describe how to conduct a Transboundary Diagnostic Analysis (TDA) and how to develop a Strategic Action Program (SAP). The purpose of the TDA is to: (a) analyze major threats within a river basin; (b) create and disseminate scientific knowledge; (c) examine the root causes of conflict and/or degradation; and, (d) reveal social issues. The TDA serves as the basis for creating the Strategic Action Plan (SAP). The SAP integrates actions to address the findings of the TDA and may include policy, institutional, and/or legal reforms at both the national and multinational levels. The implementation of the SAP integrates the regional priorities into national development plans. Lessons learned through application of the TDA and SAP approach are as follows:

1. Collaborating nations should create inter-ministerial technical teams whose task it is to assemble information on water-related environmental problems in their part of a particular basin or ecosystem;
2. Deficiencies observed in communication and coordination results in reduced effectiveness of GEF program;
3. Need for inter-ministerial coordination, particularly from the finance minister in GEF-led projects;
4. Early projects lack of effort in building capacity on a system-wide basis in terms of strengthening governmental organizational frameworks and processes;
5. Primary emphasis on creation of institutional mechanisms and diagnosis of the problem and less emphasis on activities to correct the problem(s); 20-30 year time period is needed to observe and document environmental improvements in large ecosystems.

While difficult to achieve, IWRM is still a worthwhile framework. As we face increasing pressures on water resources, we must change our management approaches. IWRM is one such approach and is necessary if we are to achieve sustainable water management.

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