# Ecosystem Approaches in Integrated Water Resources Management (IWRM)

## A Review of Transboundary River Basins

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# Executive Summary

Integrated Water Resources Management (IWRM) combines land and water management through broad-based stakeholder participation to realize multiple co-benefits in watersheds. The potential for IWRM in transboundary watersheds throughout the world is highly significant, since approximately 40% of the world's population lives in river and lake basins that comprise two or more countries (UN-Water 2008). Almost 50% of the Earth's land surface lies within such transboundary watersheds, which provide over 60% of global freshwater flow. These watersheds also represent large tracts of land with high biodiversity and forest cover. It has been estimated, however, that a third of the world's watersheds have lost more than 75% of their original forest cover and that 17 river basins have lost more than 95% (Revenga, et al. 1998). Competition with activities that lead to deforestation, mostly due to a need for increased food production, makes it imperative to sustainably manage such watersheds and the ecosystem services (ES) from them (including food and water).

IWRM recognizes the economic benefits of managing water and related resources in an integrated manner. Well-managed water and other natural resources provide high levels of ES. In essence, ES valuation and management is a practical way of achieving IWRM goals as well as other tangential socio-economic and environmental benefits. Additionally, the Intergovernmental Panel on Climate Change (IPCC) has identified IWRM as an important climate-adaptation strategy, which becomes a critical management priority for transboundary watersheds in light of climate change:

> *It can be expected that the paradigm of Integrated Water Resources Management will be increasingly followed around the world, which will move, as a resource and a habitat, into the centre of policy-making. This is likely to decrease the vulnerability of freshwater systems to climate change* (Kundzewicz 2007).

In principle, most river basin organizations (RBOs) recognize the need to adopt ecosystem-based approaches to basin management, acknowledging that rivers and wetlands provide important ecological services such as waste assimilation, floodwater storage, and erosion control. There is also an increasing acceptance of the role of ecosystem management in providing additional social and economic benefits, including local livelihoods and alleviating poverty within river basins.

While the rationale for such synergistic use of IWRM and ES paradigms is conceptually clear, most transboundary watershed managers focus on an IWRM framework that looks at traditional water resources such as water quantity, navigation, and hydropower. This is evident from this review of seven case studies of prominent transboundary basins in which IWRM commitments are being implemented.

The research aimed to provide a detailed review of selected transboundary basins to ascertain the application of ecosystem-based approaches and draw specific lessons for effective integrated water resources management in international contexts. Selected basins represent Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, North America, and West Asia, showcasing regional variables and a range of ecosystem service vulnerabilities. They focus on ES relevant to basin management, including climate regulation, water regulation, natural hazard regulation, energy, freshwater nutrient cycling, water purification and waste treatment, disease regulation, primary production, fisheries and recreation, and ecotourism. The analysis highlights whether or not management approaches recognize and incorporate bundled ES, such as uplands watershed

management through afforestation, which addresses the combined services of climate regulation, water regulation, and water quality.

The case-study analyses show a clear lack of focus on ecosystem services and a stronger focus on more conventional services. Examples include the Congo case, where there has been a focus on navigation, and in La Plata basin, where there is a clear emphasis on hydropower. These cases demonstrate a lack of transboundary-level attention to less conventional watershed services, such as carbon sequestration, food production, and wetland services such as water storage and flood prevention. The following are some broad conclusions from this study of seven transboundary basins:

1. **IWRM integration and implementation:** Although IWRM planning occurs in all case studies, none reveals well-established IWRM implementation.
2. **Use of ecosystem management instruments in IWRM:** Ecosystem approaches are in their early stages. The Okavango, which is in the most recent IWRM process, is building payments for ecosystem services (PES) systems, for example.
3. **Opportunities for incorporating ES methods into IWRM:** In all cases a stronger focus on ES would produce new benefit opportunities, such as biodiversity benefits and increased resilience to extreme climate events such as floods and droughts, which would complement more traditional benefits such as hydropower and navigation.

The case analyses reveal that successful IWRM implementation is limited in achieving its potential due to inadequate resourcing and fractured governance structures that continue to manage ES as distinct, department or sector-specific objectives (such as agriculture, natural resources, energy, etc.). Actively pursuing an ES agenda would help integrate these sectoral goals through watershed management, while economic instruments such as PES would help provide incentives and resources for such initiatives. Thus, both limitations could be potentially overcome by moving from a more traditional form of IWRM to one that incorporates ecosystem management principles, encourages incentives and markets for managing and providing healthy and sustainable ES, and addressing drivers of ecosystem change more systematically.

Using specific case-study examples, this research stresses that the evolution of the IWRM framework to encompass ecosystem services would enable the realization of a broader swath of benefits from well-managed water and related resources. These would include carbon sequestration, flood and drought mitigation, biodiversity and wildlife habitat conservation, food production, etc. The argument made here is one of enabling ES by incorporating IWRM methodologies at transboundary levels (thus pushing ES into international ecosystem policy discourse) as well as developing markets to pay for the management and provision of such ES at the transboundary level (thus providing a 'pull' for ES into international discourse and negotiations).

A number of existing methodologies have introduced the means to incorporate ES values and payments in transboundary contexts: the 'Transboundary Waters Opportunity (TWO) analysis' provides a conceptual framework that places particular emphasis on the potential for developing baskets of benefits at the regional level by identifying Positive-Sum Outcomes (PSOs) or 'win-win solutions' that would benefit all basin States.

Developing markets for such goods and services at the international level would provide an incentive to build transboundary-level ES markets. Given the prominence of the Global Environment Facility (GEF) financing for IWRM capacity building, the GEF might be the appropriate agency to design markets for ES-IWRM and to pilot their application. While IWRM at the transboundary watershed level can provide the 'push' for ES provision and management, these opportunities will not be

realized unless there is an equivalent 'pull' from the market. Given the momentum for the UN Reducing Emissions from Deforestation and Degradation (REDD) Programme and the high carbon, high biodiversity characteristics of transboundary basins, such an approach is wise.

In addition to developing the 'push and pull' incentive structures for ES mechanisms in IWRM, a clear rationale for building a benefit-sharing ES agenda in transboundary basins comes from the peacebuilding community. In cases such as the Congo River Basin and the Jordan River Basin, cooperation in managing natural resources will be particularly relevant to conflict prevention and to increased peaceful relations among all nations. Conflict over navigation rights, water supply, hydropower, and water quality figure prominently in most of the transboundary cases in this study and could benefit from an ecosystem-management approach and the new benefit sharing approach it employs.

# List of Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| ANBO | African Network of Basin Organisations |
| ASEAN | Association of South East Asian Nations |
| (AusAID) | Australian Agency for International Development |
| BDP | Basin Development Plan |
| CBFP | Congo Basin Forest Partnership |
| CBSP | Congo Basin Strategic Program (for Sustainable Forest Management) |
| CFMS | Comprehensive Flood Mitigation Strategy |
| CICOS | Commission Internationale du Bassin Congo-Oubangui-Sangha |
| COMIFAC | Central African Forest Commission |
| CSD | Commission for Sustainable Development |
| CRB | Congo River Basin |
| DABLAS | Danube-Black Sea |
| DEF | Danube Environmental Forum |
| DRBMP | Danube River Basin Management Plan |
| DRC | Democratic Republic of the Congo |
| DRPC | Danube River Protection Convention |
| ES | Ecosystem Services |
| ESCAP | Economic and Social Commission for Asia and the Pacific |
| FoEME | Friends of the Earth Middle East |
| FORAF | African Forest Observatory |
| GEF | Global Environment Facility |
| GLOWA | Global Change and the Hydrological Cycle |
| GMS | Greater Mekong Subregion |
| ICPDR | International Commission for the Protection of the Danube River |
| IISD | International Institute for Sustainable Development |

| | |
|---|---|
| IJC | International Joint Commission |
| INRM | Integrated Natural Resources Management |
| IRRB | International Red River Board |
| IRBM | Integrated River Basin Management |
| IWI | International Watersheds Initiative |
| IWRM | Integrated Water Resources Management |
| JRB | Jordan River Basin |
| LJR | Lower Jordan River |
| LPB | La Plata Basin |
| LTA | Lake Tanganyika Authority |
| MA | Millennium Ecosystem Assessment |
| MBDC | Mekong Basin Development Cooperation |
| MC | Mekong Committee |
| MOU | Memorandum of Understanding |
| MRC | Mekong River Commission |
| MWRAS | Mekong Water Resources Assistance Strategy |
| NGO | Non-governmental Organization |
| NRFP | Natural Resources Framework Plan |
| ODMP | Okavango Delta Management Plan |
| OEMN | One Europe, More Nature |
| OKACOM | Permanent Okavango River Basin Water Commission |
| ORB | Okavango River Basin |
| OSFAC | Observatoire Satellital des Forêts d'Afrique Centrale |
| PES | Payments for Ecosystem Services |
| PSO | Positive-Sum Outcomes |
| REDD | United Nations Reducing Emissions from Deforestation and Forest Degradation Programme |
| RRB | Red River Basin |

| | |
|---|---|
| RRBC | Red River Basin Commission |
| SAP | Strategic Action Plan |
| SPCP | Stakeholder Participation and Communication Plan |
| TDA | Transboundary Diagnostic Analysis |
| TWO | Transboundary Waters Opportunity |
| UNEP | United Nations Environment Programme |
| UNDP | United Nations Development Programme |
| UNECE | United Nations Economic Commission for Europe |
| WFD | Water Framework Directive |
| WWF | World Wildlife Fund |

Transboundary watersheds such as that of the Red River are valued for providing fishing, recreation, habitat and cultural services. © Dimple Roy

# Introduction

Approximately 40% of the world's population lives in the world's 263 transboundary watersheds, identified as those that comprise two or more countries. These transboundary basins cover nearly half of the Earth's land surface and account for an estimated 60% of global freshwater flow (UN-Water 2008). Transboundary basins link populations of different countries and provide an appropriate ecosystem unit for managing international issues for hundreds of millions of people, including land use, food provision, floods and drought management, and other watershed-based services. Unilateral action by any one country in an international basin is often ineffective (fish ladders only in an upstream country, for example), inefficient (hydropower development in a flat downstream country), or impossible (many developments on boundary stretches) (Mostert 2005). Cooperation in managing transboundary water resources is desirable but can be difficult, often due to unclear and contested property rights.

Integrated Water Resources Management (IWRM) can be described as the coordinated development and management of water, land, and related resources to maximize the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. The first United Nations Water Conference in Mar del Plata, Argentina in 1977 recommended that increased attention should be paid to the *integrated planning of water management* and that particular consideration should be given not only to the cost effectiveness of planned water schemes, but also to ensuring optimal social benefits of water resource uses, as well as to the protection of human health and the environment as a whole (Chéné 2009). The concept, popularized by the Dublin

principles adopted at an international conference in Dublin in 1992, promotes a participatory approach to integrated resource management on a watershed basis and promotes the recognition of the economic benefits of managing water and related resources.

IWRM is one form of the *ecosystem approach* as a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way (Millennium Ecosystem Assessment 2005). IWRM promotes the management of water and related resources (land, biodiversity, etc.) on a watershed basis. This allows IWRM to be a relevant framework for both small catchments and transboundary basins. Managing water within a basin context at the national level is challenging; it is thus even more complex to accomplish in the transboundary context, yet it is increasingly recognized that managing at this level is crucial, especially for conflict prevention and peacebuilding. Transboundary ecosystem management is a core element of UNEP's mandate, and priority is given to developing methodologies for assessing social and economic costs and benefits of transboundary management of natural resources, and supporting the development of policies and laws to achieve this. There is a specific focus on increasing the number of tools to address competing interests in transboundary contexts (UNEP 2008a). The importance of effective water-resources management is especially significant for public-health benefits, especially in light of the anticipated impacts of climate change on basins across the globe (Costello, et al. 2009). The Intergovernmental Panel on Climate Change (IPCC) has identified IWRM as an important adaptation strategy, which becomes a critical management priority for transboundary watersheds in light of climate change:

> *It can be expected that the paradigm of Integrated Water Resources Management will be increasingly followed around the world, which will move, as a resource and habitat, into the centre of policy-making. This is likely to decrease the vulnerability of freshwater systems to climate change* (Kundzewicz 2007).

A growing number of countries are experiencing rising and often permanent water stress, and climate change consequences will increase the numbers of countries experiencing high variability in water resources availability, including higher flood and drought frequencies or intensities. Competition over water can heighten tensions and even lead to open conflict among nations that share the resource. Averting political disputes over water resources is considered a strong political driver for initiating cooperation on transboundary waters, as riparian states recognize that they must safeguard that greater common interest (UN-Water 2008).

According to the United Nations University International Network on Water Environment and Health, the critical obstacles preventing better water management globally are financial and institutional. The water sector requires a much greater use of innovative financial and investment instruments that reinforce local and regional IWRM and restore natural capital. The water sector also urgently requires new institutional capacity that can merge the natural sciences, social sciences, and public health concerns with engineering innovation and public policy, and can overcome the jurisdictional fragmentation that characterizes water governance (Schuster-Wallace 2008) (Schuster-Wallace 2008, Schuster-Wallace 2008, Schuster-Wallace 2008, Schuster-Wallace 2008). These challenges lie within UNEP's mandate and UNEP is working actively with partners to address the key issues.

## Ecosystem Management and IWRM

Ecosystems are dynamic complexes of plant, animal, and microorganism communities and their non-living environment, interacting as a functional unit. Ecosystems vary enormously in size, and can range from microorganisms to large international ocean basins. Integrated water resources management allows watersheds to be used as the appropriate scale for ecosystem-based management approaches. According to the Convention on Biological Diversity, *the ecosystem*

*approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.* According to the United Nations Environment Programme (UNEP), *ecosystems management promotes a shared vision of a desired future that integrates social, environmental and economic perspectives for managing geographically defined natural ecological systems.* Recognizing that ecological units do not follow political boundaries, transboundary ecosystem management is an integral part of UNEP's Ecosystem Management Programme. Working in a regional and sub-regional context, UNEP collaborates with governments and stakeholders to maximize the delivery of ecosystem services (UNEP 2008b).

IWRM, as described by the Global Water Partnership, highlights the interdependence of natural and social systems and provides a practical framework for such integration on a watershed basis.

In 2005, the Millennium Ecosystem Assessment reaffirmed the value of integrated ecosystem management and integrated river basin management as appropriate frameworks for "intentionally and actively addressing ecosystem services and human well-being simultaneously" (Millennium Ecosystem Assessment 2005). In May 2008, the 16th session of the Commission for Sustainable Development (CSD-16) confirmed IWRM as an essential tool to effectively manage water resources and to improve water services delivery, despite implementation and monitoring difficulties.

Al-Jayyousi and Bergkamp (2008) explain that the ecosystem approach in watersheds is based on the notion that water, biodiversity, and environmental protection require establishing interdisciplinary, inter-sectoral and inter-institutional initiatives. They note that these initiatives define strategies for actions and investments based on the needs and priorities of watershed inhabitants. These initiatives focus on allocating investments to continue providing critical services for livelihoods and economies, as well as ecosystem services essential to water supply, groundwater recharge, erosion control, and water purification.

IWRM recognizes the economic benefits of managing water and related natural resources. Well-managed water and watershed-based resources provide high levels of ES. In essence, ES valuation and management are practical ways of achieving both IWRM goals and additional benefits.

The use of ecosystem-based benefit-sharing approaches or frameworks that demonstrate mutual benefits from the management of a transboundary river system, as opposed to the more traditional dynamics of upstream managers and downstream beneficiaries, would enable more effective IWRM in these basins. Numerous frameworks are being developed to achieve such a mutual benefits approach. The environmental flows movement talks about the maintenance of water flows to maintain healthy ecosystems and, according to the Global Environmental Flows Network, has been integrated into water management programmes in Australia, South Africa, and the UK (Global Environmental Flows Network September 2006).

A conceptual framework termed the 'Transboundary Waters Opportunity Analysis', or TWO analysis, places particular emphasis on the potential for developing baskets of benefits at the regional level by identifying Positive-Sum Outcomes (PSOs) or 'win-win solutions' that would benefit all basin States. The PSO process is based on ES optimization within the entire basin under the assumption of no political or institutional constraints. The TWO approach enables a clear look at the ways in which the services flow and can be managed. This is achieved through the use of a simple but robust analytical methodology that stakeholders can use in a wide range of different circumstances to aid their own decision making, by developing insights into different options that might not be apparent at first glance.

The conceptual framework of the TWO Analysis consists of a matrix with key development opportunities and main categories of water sources to realize those opportunities (see the Figure 8 matrix for a summary). The framework allows for context-specific analysis, which brings the

possibility to add other factors and categories for creative analysis and to realize change in particular transboundary basins (D. J. Phillips 2008).

**Table 1. TWO Analysis Conceptual Framework**

| **Categories: sources**<br>**Factors: development** | **A**<br>**New water** | **B**<br>**Efficient use of water** | **C**<br>**Other sources in basins that are not closed** |
|---|---|---|---|
| Hydropower and power trading | | | |
| Primary production | | | |
| Urban growth and industrial development | | | |
| Environment and ecosystem services | | | |
| Others (every basin is unique and other opportunities exist) | | | |

Source: (D. J. Phillips 2008)

Cowling et al. (2008) give another pragmatic model for the process of operationalizing ecosystem services and suggest a phased approach to mainstreaming ecosystem services. Based on this model, the following phased approached is suggested for adoption in transboundary basins:

**An Assessment Phase:** The assessment seeks to answer questions inspired by the beneficiaries and managers of ecosystem services. It must provide knowledge useful for mainstreaming ecosystem services into basin-level land-use planning. The authors then prescribe three types of assessments—social, biophysical, and valuation.

**A Planning Phase:** This second phase of the operational model is explicitly collaborative, involving all key stakeholders, including researchers**.** Collaborative planning is a discourse-based process that comprises the identification of a vision, a strategy to realize this vision, specific strategic objectives, and instruments, tools, and organizations for implementing actions to achieve the objectives.

**The Management Phase:** Management comprises the final phase of this operational model for achieving resilience in the socio-ecological systems associated with ecosystem services. The overall objective of this phase is to undertake and coordinate actions, including additional research, that protect biophysical features that provide ecosystem services and ensure the flow of services to beneficiaries. Actions may include implementing social marketing projects, restoring vegetation for carbon credits, protecting key watersheds for water delivery, or protecting view-sheds for nature-based tourism. The specific action depends on what has emerged from the assessment of implementation opportunities and constraints.

Supporting this sort of methodical inclusion of ES into mainstream IWRM processes, The Economics of Ecosystem and Biodiversity (TEEB, 2010) in its recent report for policy makers, identified the role of ecosystem services in different policy areas. The authors identify the many steps in the policy-making process and show how ecosystem and biodiversity values can be systematically used. This has been adapted in the following table:

**Table 2. Where are economic insights useful to the policy process? (Adapted from TEEB, 2010)**

| Stage | Type and role of economic information |
|---|---|
| Problem identification and agenda setting | • e.g. value of biodiversity losses<br>• e.g. carbon value of forests |
| Policy formulation and decision-making | • Costs and benefits of policy alternatives (e.g. comparing water treatment upgrades to source water protection)<br>• Developing indicators showing values associated with ES degradation |
| Implementation | • Evaluation of the costs of alternatives<br>• Identification of relevant stakeholders and their respective interests<br>• Justify compensation payments for losers |
| Evaluation | • e.g. local authorities' monitoring stations, statisticians' analysis, companies' monitoring demonstrate that economic values are lost<br>• ex-post valuation of benefits and costs |
| Inspections, compliance enforcement and non-compliance response | • cost-effectiveness of inspection<br>• implement the polluter pays principle<br>• applying economic instruments such as fines/ penalties, compensation payments or remediation in kind |

While the rationale for such synergistic use of IWRM and ES paradigms is conceptually clear, the use of IWRM as a management framework, especially in transboundary watersheds, was adopted before the popular advent of ES methodologies. As a result, most transboundary watershed managers focus on an IWRM framework that looks at traditional water resources such as water quantity, navigation, and hydropower. To explore the planning and implementation of the IWRM framework in the context of transboundary basins, as well as to investigate the extent to which ES valuation and management mechanisms have been used for IWRM goals, this research comprised seven case studies in selected transboundary watersheds of the world. This report documents the results of this research and analysis.

Sea of Galilee looking from Israel to Jordan. © Bryan Oborne

## Case Study Research

This research aimed to provide a detailed review of selected transboundary basins to ascertain the application of ecosystem-based approaches and draw specific lessons for effective integrated water resources management in international contexts. Basins were selected to represent Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, North America, and West Asia. The case studies represent regional variables while attempting to showcase a range of stresses and ecosystem service vulnerabilities. They focus on ecosystem services relevant to basin management, including climate regulation, water regulation, natural hazard regulation, energy, freshwater nutrient cycling, water purification and waste treatment, disease regulation, primary production, fisheries and recreation, and ecotourism. They include an analysis of whether ecosystem management principles are explicitly or implicitly applied in IWRM processes and whether the approaches recognize and are oriented towards managing bundles of ecosystem services, such as uplands watershed management through afforestation, which addresses the combined services of climate regulation, water regulation, and water quality.

The objective of the detailed review of selected transboundary cases is as follows:

- To obtain a deeper understanding of the application of ecosystem-based approaches within the context of IWRM in selected transboundary river basins and of the lessons learned for use in future awareness creation and capacity building interventions.

The case studies were selected on the basis of the following criteria:

- Presence of a large ecosystem management issue linking land and water management;
- Presence of a transboundary management entity with a defined management plan;
- Representation of different levels of basin-based stresses to demonstrate a variety of basin management tools; and
- Availability of case-study information for the study time-line.

An initial review of the literature resulted in a list of transboundary basins. An analysis based on the research areas of focus—the need for a transboundary management agency/plan and ecosystem-based management focus as stipulated in the criteria above—is shown in Table 3. The selected case studies demonstrate a wide range of climate and natural environment contexts, from temperate (Red River Basin, Danube Basin) to tropical (Mekong, Congo, Okavango, La Plata), as well as socio-economic contexts, from agricultural (Jordan Basin, Red River Basin) to fairly undisturbed (Okavango). Some of the selected basins are coastal (La Plata, Mekong, Jordan) while the Red River Basin and the Okavango are land-locked continental basins. This analysis of a wide variety of basins shows a range of management strengths, problems, and contextual and non-contextual issues related to basin management at the transboundary level.

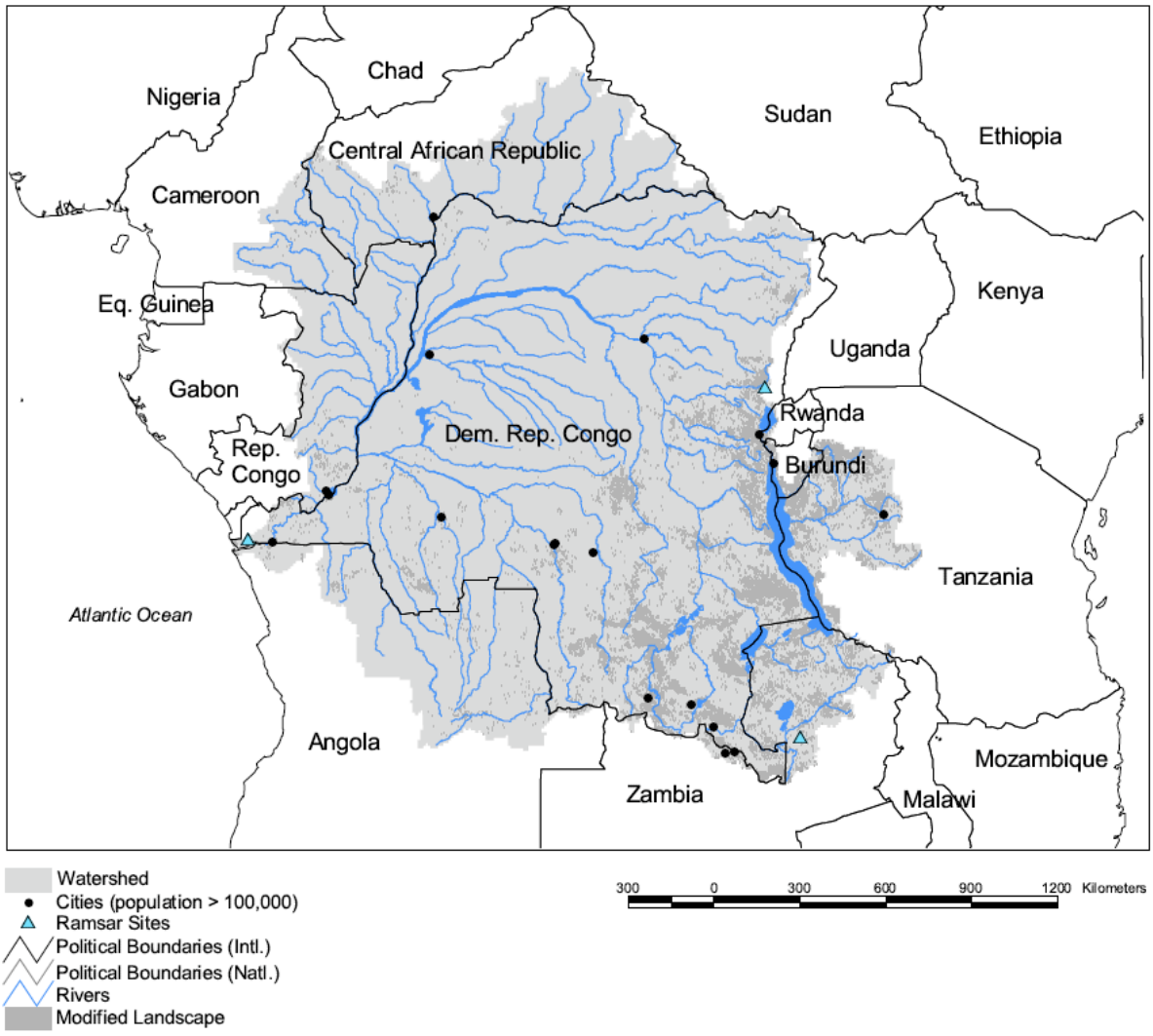
The following table lists the transboundary basins selected for the case studies with the key physical and institutional characteristics of each.

**Table 3. Selected Case Studies**

| Name of basin | Basin size and riparian countries | Presence of transboundary management institution with defined management plan |
|---|---|---|
| **Africa** | | |
| Okavango River Basin | 721,000 $km^2$<br>Angola, Botswana, Namibia, Zimbabwe | Okavango River Basin-wide forum<br>Permanent Okavango River Basin Water Commission (OKACOM) |
| Congo Basin | 3,700,000 $km^2$<br>Angola, Burundi, Cameroon, Central African Republic, Democratic Republic of Congo, Gabon, Republic of Congo, Rwanda, Tanzania, and Zambia | CICOS—Commission Internationale du Bassin Congo-Oubangui-Sangha (CICOS) |
| **Asia-Pacific** | | |
| Mekong River Basin | 795,000 $km^2$ | Mekong River Commission (MRC) |
| **Europe** | | |
| Danube Basin (Black Sea basin) | 817,000 $km^2$<br>Austria, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Macedonia, Moldova, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, and Ukraine | International Commission for the Protection of the Danube River (ICPDR) |
| **Latin America and the Caribbean** | | |
| La Plata Basin (including Guarani Aquifer) | 3,100,000 $km^2$<br>(1,200,000 $km^2$ aquifer)<br>Argentina, Bolivia, Brazil, Paraguay, and Uruguay | Project for the Environmental protection and sustainable development of the Guarani Aquifer System (Part of the larger La Plata River Basin IWRM Program) |
| **North America** | | |
| Red River Basin | 116,550 $km^2$<br>Canada, United States | International Joint Commission (IJC)—International Red River Board (IRRB)<br>Red River Basin Commission (RRBC) |
| **West Asia** | | |
| Jordan River Basin/Dead Sea/Red Sea | 18,000 $km^2$<br>Israel, Jordan, Lebanon, Palestine, and Syria | |

# The Congo River Basin

**Figure 1: The Congo Transboundary Watershed**




Source: (Revenga, et al. 1998, 2-11)

## Ecosystem Services (ES) and Drivers of Change

The Congo River Basin (CRB) and its ES are increasingly threatened by the impacts of human activities, especially those that result in deforestation, such as logging, shifting agriculture, roads, and the oil and mining industries (AfDB 2009). Future hydroelectricity development would also have significant ecological impacts. The Democratic Republic of Congo's potential alone is 150,000 MW. There are plans to increase the amount of hydroelectricity produced at the Inga station to 44,000 MW by 2010, or twice as much as China's Three Gorges Dam (Maniatis 2008). Rapid population growth and development have already led to a rate of forest loss of 0.6% per year in 2009. Estimates of annual deforestation range from 934,000 ha (AfDB 2009) to 1.49 million ha (Maniatis 2008), while almost 3.8 million ha of forest are degraded every year (WWF 2009).

**Table 4. The Congo River Basin**

| | |
|---|---|
| **Location** | Central Africa |
| **Area** | 3,700,000 $km^2$ |
| **Length** | 4,667 km |
| **Riparian nations** | Angola, Burundi, Cameroon, Central African Republic, Democratic Republic of Congo, Gabon, Republic of Congo, Rwanda, Tanzania, and Zambia |
| **Population** | 126 million (2005) |
| **Characteristics** | • Spans the equator: 1/3 of basin in northern hemisphere and 2/3 in southern hemisphere<br>• Relatively constant flow throughout the year<br>• 1,600 km of total 20-25,000 km of waterways are transboundary<br>• Forests in the Congo River Basin sequester 24-36 GT of carbon (dioxide) annually<br>• Congo Basin's hydroelectricity potential represents about 1/$6^{th}$ of known global resources |
| **Major Ecosystems** | • Tropical rain forests: has a quarter of the world's total; after the Amazon, accounts for the planet's second-largest block of dense humid tropical forests<br>• Includes evergreen rainforest, semi-deciduous forest, evergreen montane, sub-montane forests, swamps, and inundated forests |
| **Climate** | Average annual precipitation: 1,600-2,000 mm |

Sources: (WHYCOS n.d.) (Ndala 2009) (CBFP 2006) (Maniatis 2008)

Forest and aquatic ecosystems in the CRB are intimately linked. Its forests provide essential ES, including those related to maintaining the watershed, such as regulating local, regional, and even global climates; storing and filtering water; controlling water flows; and anchoring soils and preventing erosion and silt from entering water courses (WCS n.d.) (WWF 2009). For example, the Congo Basin's forests are responsible for creating 75-95% of the region's rainfall through evaporation and evapotranspiration (Nkem, Idinoba and Sendashonga 2008); and evaporation from the CRB contributes about 17% of West Africa's rainfall (Maniatis 2008).

Forest loss and degradation reduces the enormous carbon regulating service provided by the Congo Basin's forests that helps to generate rainfall and regulate the climate. Forests in the Congo River Basin are a sink for 24-39 Gt of carbon, providing significant mitigation benefits for global climate change (Revenga, et al. 1998). Rainfall has declined by 15% in the region's undisturbed national parks, which is likely associated with deforestation in adjacent timber concessions (Maniatis 2008). The Central African rainforest is naturally drier than South America's and Southeast Asia's tropical rainforests and in recent decades, it has become drier (Nkem, Idinoba and Sendashonga 2008). Between 1960 and 1998, precipitation appears to have declined at a rate of 3-4% per decade in northern tropical Africa (Malhi and Wright 2004). Significant rainfall reduction could shift vegetation regimes to different zones, with more losses in biodiversity (Maniatis 2008). There has been a notable decline in river discharges in the CRB since the early 1970s, especially in northern tributaries. For example, there was a decrease of about 18% in the Oubangui River, causing an increase in the number of days navigation had to cease from four days a year in 1971 to more than 200 days a year since 2002 (CICOS 2008). The impacts of deforestation on water resources will be exacerbated by the likely impacts of climate change in Africa, which include increased drought and flooding; changes in rainfall; and potential decreases in run-off and water availability in its major rivers due to higher temperatures and the dramatic disappearance of forests and glaciers that act as water towers. These changes will affect many of the ecosystem services provided by the CRB, including agriculture,

navigation, and hydropower systems, among other services that support wildlife habitat and human well-being.

The CRB's waters are also subject to inputs from development activities such as logging operations, industrial-scale mining, and increasingly, from untreated sewage from growing urban areas. These activities lead to pollution, erosion, and sedimentation in adjacent water bodies. Mining (for gold, diamonds, and coltan), is small-scale in small rivers and streams and can destroy these fragile ecosystems. Although direct impacts are usually localized, pollution and sedimentation can extend far from the original site, with impacts on both ecosystem and human health (CBFP 2006). Another threat to the CRB's water resources is the potential for diversion to other countries, which could lead to conflict unless there is effective transboundary water management. For example, the ecological and human impacts of a project to transfer water from the Oubangui River to Lake Chad need to be studied and negotiated (Ndala 2009).

## Basin Management

In November 1999, the Democratic Republic of the Congo (DRC), Cameroon, Republic of the Congo, and the Central African Republic signed an agreement to establish a framework to manage the river system. (Later, Angola became an observer). The accord set up the International Commission of the Congo-Oubangui-Sangha Basin, or CICOS (Ndala 2009). Its enduring goal is ensure the efficient and effective coordination of national institutions' activities directly related to issues of inland domestic navigation of international interest. Growing concerns about shared environmental problems led to the adoption of an addendum in early 2007 that extended the mandate to include IWRM across the Basin (CICOS 2008). Three of the four riparian nations have ratified the addendum, with the DRC's ratification pending.

Subsequently, CICOS developed a Strategic Action Plan (SAP) to sustainably manage the Congo River Basin, with assistance from its seven partners and international aid agencies. These partners support CICOS in planning and managing inland navigation, building its human and technical capacities, providing technical and other expertise, and by collaborating with CICOS personnel. Partners provide financial support for projects; funders include the Facilité Africaine de l'Eau and the German group Coopération Technique GTZ, which help CICOS implement the GETRACO transboundary management project. The partners provide institutional support for IWRM in the Congo Basin by creating national and regional partnerships among transboundary water sectors and helping to elaborate a protocol for exchanging data about the basin's water. They also give technical support by helping collect data and developing and implementing an information system and a documentation centre for water-related information (Tanania Kabobo 2010).

The SAP's long-term sectoral goals are to improve the Basin's physical environment, including water quality, water navigability, biodiversity, and wetland conservation; to improve knowledge about water resources and build capacity; and reduce poverty among the basin's populations by recognizing the value and importance of natural resources to them. The African Water Facility funded the SAP's initial development from August 2008 until December 2009, with an extension to December 2010. A funders' round table is planned for November 2010. Specific IWRM tools have yet to be created (CICOS 2008).

CICOS received funding to implement the Transboundary Water Management in the Congo Basin project, or GETRACO (CICOS 2008). Its goal is to establish and implement strategies for the Basin's riparian countries to jointly manage domestic shipping and water resources. To date, activities have centred on networking, developing a conceptual framework of the Congo Basin Water Information System (SIBCO), and training, and have been oriented toward fostering joint investments in shipping and maintaining water quality to promote trade and economic development along the river. CICOS is still developing its IWRM strategies through the elaboration of the SAP, so implementation is pending

and will commence once it is published at the end of 2010 (Tanania Kabobo 2010). The Global Environmental Facility (GEF) is supporting a data-management plan and regional cooperation to protect natural resources (GTZ n.d.).

Lake Tanganyika (and Lake Mweru), along with the highlands and mountains of the East African Rift, is a source of water to the Congo River. CICOS has made recent, albeit tentative, overtures to establish a cooperative relationship with the Lake Tanganyika Authority (LTA) (Tanania Kabobo 2010). The LTA is another transboundary organization within the Congo Basin. Established in 2008, it promotes regional cooperation among the governments of Burundi, Democratic Republic of Congo, Tanzania, and Zambia to sustainably manage the natural resources in the Lake Tanganyika basin, one of the sources of the Congo Basin's waters. The LTA coordinates the implementation of the Convention on the Sustainable Management of Lake Tanganyika, signed by the riparian nations in 2003. The Convention's goal is to protect biodiversity and ensure the region is managed sustainably. It has established a Strategic Action Plan (SAP) and oversees the Regional Integrated Management Programme, established to effectively implement the SAP. It is explicitly based on IWRM principles, including a strong emphasis on both national and regional stakeholder participation, and focuses on sustainable fisheries, catchment management, pollution control, climate change adaptation, and monitoring programs. The LTA Management Committee, which implements the Convention, consists of members from each country representing the fisheries, environment, water, and finance sectors (LTA n.d.). Cooperation during the first phase of the SAP has been positive, especially since the decrease in conflict situations has made it possible. The LTA, however, includes only three of the Congo Basin riparian countries (UNDP/GEF 2008).

The African Network of Basin Organisations (ANBO) is developing and will field-test governance and technical performance indicators to assess the design and implementation of IWRM in African transboundary water basins. CICOS was selected as a pilot project in the Congo Basin for the first phase (CICOS 2008). To date, technical indicators have not been developed due to a lack of data and resources, while the governance indicators show a lack of a legislative framework, high-level coordination, funding, and a platform for implementing IWRM (ANBO 2009).

In recent years, deforestation in the Congo has become an issue of international concern. Given the links between forests and water and their ecosystem services, international or transboundary initiatives to sustainably manage forests in the Congo Basin are important partners in IWRM. Among the forest organizations CICOS is establishing synergies with are UNDP/GEF's Strategic Program for Sustainable Forest Management in the Congo Basin (CBSP); the Congo Basin Forest Partnership (CBFP) (a UNEP initiative); the African Forest Observatory Project (FORAF); the Observatoire Satellital des Forêts d'Afrique Centrale (OSFAC); and the Central African Forest Commission or COMIFAC, with which CICOS has signed a protocol for collaboration (Tanania Kabobo 2010).

GEF's CBSP initiative aims to reverse deforestation and ecosystem degradation in the Congo Basin and to conserve biodiversity and the region's carbon capital, especially for the indigenous people who depend on forest resources for their livelihoods. The second of the three components of this four-year programme supports an integrated approach to "fostering of sustainable management and use of forest and water resources in the productive landscape of the Congo Basin" (GEF 2008).

The Congo Basin Forest Partnership (CBFP) is a voluntary multi-stakeholder initiative registered with the United Nations Commission on Sustainable Development (CSD). It is an umbrella for subregional organizations, bringing together the 10 COMIFAC member states, as well as donor agencies, international organizations, NGOs, scientific institutions, and the private sector. COMIFAC is the regional political and technical body in charge of sustainably managing forests in the region (CBFP n.d.). It has high-level political support and commitment and provides strategic guidance to national

governments, especially related to reducing emissions from deforestation and forest degradation (REDD) processes in the Congo Basin (GEF 2008).

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## Lessons Learned

The development and implementation of IWRM approaches in the Congo Basin are in the early stages, having been integrated by CICOS in 2007 and awaiting ratification by the DRC. Nevertheless, the SAP process has been initiated. CICOS is establishing synergies with other basin-level organizations and projects, including those that protect transboundary forest resources, and it has signed a Protocol with COMIFAC. It has also indicated an interest in collaborating with the LTA.

CICOS and GETRACO have not yet introduced IWRM approaches to address the impacts of navigation and dams on ecosystem services nor of deforestation on water losses that affect navigation. Links among ecosystem services (the forest's capacity to generate rainfall), the serious problem of deforestation in the Congo, and the significant decline in river discharges and consequent reduction in days of navigation are not yet evident in water management policies or plans; however, the SAP is still being prepared and will not be published until the end of 2010. IWRM strategies and the SAP being developed by CICOS will integrate plans on adapting to the impacts of climate change on the basin's water resources (Tanania Kabobo 2010).

Since the introduction of IWRM approaches in the Congo Basin is very recent, many political, institutional, financial, and technical challenges still remain before they are implemented. The SAP has not yet developed any IWRM tools and implementation is hampered by a lack of a legislative framework, high-level coordination, funding, and an implementation platform. At the political level, however, there are presently no important issues of conflict that challenge IWRM in the Congo Basin and all the member nations have indicated their willingness to collaborate. Financially, however, the

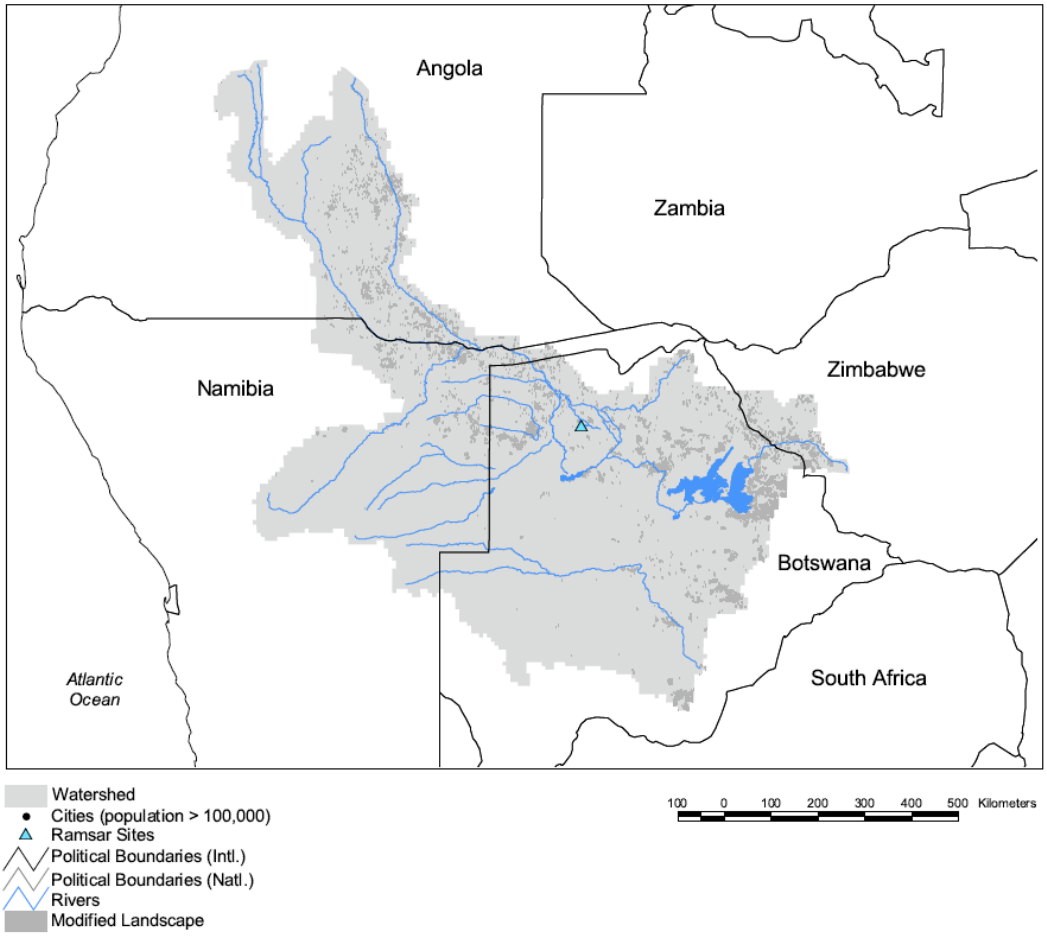
funds already mobilized are very limited compared to the actions needed to implement IWRM in the Congo basin; amounts will be determined during the SAP's development (Tanania Kabobo 2010).

Barriers related to technical capacities include a lack of data and the human and technical resources of member nations required to collect and disseminate them. At the institutional level, CICOS is working with numerous partners that provide important financial and other support, and it has established relationships with forest-related organizations. Closer collaboration with the LTA is important, since the lake is one of the Congo's water sources. It is also particularly important that CICOS strengthen its cooperation with forest organizations, since the Congo's water resources depend on the integrity of its forested 'Water Towers.' To date, CICOS has no plans to initiate any PES scheme related to water resources, although it is involved in COMIFAC discussions among central African countries related to establishing ES markets.

Although the Congo Basin presently has ample water resources (availability is 22,752 $m^3$/inhabitant/year—well above the 1,000 $m^3$/inhabitant/year that signifies water stress), the implementation of IWRM will help to ensure equitable water sharing. It will also help ensure the sharing of watershed-based ecosystem services among potentially conflicting uses and with water-scarce neighbouring basins, and it would be a precautionary measure to address the drivers of ecosystem change such as climate change and deforestation.

# The Okavango River Basin[1]

**Figure 2: The Okavango Transboundary Watershed**




Source: (Revenga, et al. 1998, 2-26)

## Ecosystem Services (ES) and Drivers of Change

Freshwater is the major environmental and socio-economic resource in the Okavango River Basin (ORB), directly supporting all human activity, vegetation, and wildlife habitats and their associated productivity. The productivity associated with freshwater use and its related aquatic ecosystems is estimated at approximately 25% of GDP in the basin as a whole, with considerable inter-country variability. Freshwater sources are also the natural resource component most at risk since there is no economic substitute for the basin's watercourses and associated aquifers, which are also the final repository of human waste. The status of the sources and characteristics of the freshwater balance in the basin are critical resources for development and are irreplaceable global environmental assets.

[1] The authors gratefully acknowledge the contributors of this case study: Ebenizario M. W. Chonguica, Geof M. Khwarae, and Dr. Nkobi M. Moleele of OKACOM

**Table 5. The Okavango River Basin**

| | |
|---|---|
| **Location** | Southwestern Africa |
| **Area** | 704,000 $km^2$ |
| **Length** | 1,600 km |
| **Riparian nations** | Angola, Botswana, Namibia and Zimbabwe |
| **Population** | 580,000 |
| **Geographical regions** | • The basin divide in Angola<br>• Caprivi Strip in Namibia<br>• Arid northwest of Botswana<br>• The Delta |
| **Characteristics** | • An endoreic system (does not terminate at the sea but rather flows into a low lying inland area)<br>• Negligible outflows at Delta due to evapotranspiration and evaporation (potential evaporation rates over the alluvial fan of about 2,000 mm/yr)<br>• A low-gradient hydrological 'sink' in an arid quarter of southern Africa<br>• The only water that flows on Namibian and Botswanan soil<br>• The fan is highly sensitive to climatic change<br>• The basin's hydrologically active area is much smaller than its topographic limits<br>• Angola generates 95% of runoff, while Botswana's ecosystems use most of the water |
| **Major Ecosystems** | • The Panhandle papyrus-dominated swamps<br>• Alluvial fan (Okavango Delta is a Ramsar site) and Kalahari Desert<br>• Moremi Protected Area |
| **Climate** | From sub-humid, through semi-arid, to arid zones<br>Mean annual rainfall: 58-800 mm, depending on region |

Source: (UNEP 2005)

The ORB is already subject to demands for water and land from agriculture, urban, tourism, and industrial development both within and outside the basin. Population growth and shifts in consumption patterns are driving increased pressure on the ORB's water resource base and associated environments. There are significant external linkages to the basin's water resources beyond the hydrological and topographic systems. The most significant include demands for water abstraction in the further reaches of Namibia; expected future demand from returning refugees in the Kwando Kubango taking advantage of the priority given to resettlement policies with the ongoing peace process in Angola; and the use of the Delta's wetland environment in Botswana. This delta provides a staging area for birds migrating to southern Africa during the boreal winter and is a storehouse of globally significant biodiversity, as well as a popular international tourism destination.

While the population within the ORB is currently estimated at approximately 580,000, demands from population centres outside the basin in Namibia and Botswana are now significant. The intra-basin population comprises predominantly low-income mixed agro-pastoral communities who are highly dependent on freshwater resources for their livelihoods. In contrast, the extra-basin population creating a demand for inter-basin water transfers is largely urban with associated industrial pressures as well as demands from international tourism. Botswana's mineral-led growth is also putting pressure on its vital freshwater resource base as urban centres on the fringe of the Delta expand. The ORB is the only perennial river system that lies within Namibia and is therefore the first candidate in Namibia's search for new water. Namibia is attempting to manage water requirements but faces

unprecedented levels of demand for municipal and industrial water, particularly in its central area, which lies outside the ORB's active system boundaries. In addition, with the ongoing peace process in Angola, it is anticipated that the previous decline in population, commerce, and trade will cease and current levels of water use in the basin will rise. Thus, the impacts of degraded water resources have ramifications far beyond the basin's physical boundaries and there is the potential for conflicting water demands between inter-basin and extra-basin users.

There are a number of situations that can lead to conflict over the Okavango's water resources, especially between Angola and Namibia in the upper part of the river, and Botswana downstream, where the river forms a fertile Delta. In the north, it is likely that the thousands of returning refugees will create the demand for more dams to divert water for agriculture and other development. Namibia is already planning a hydroelectric dam on the river. Such dams will change the river's flow and trap sediments, preventing them from contributing nutrients to the fertile Okavango delta downstream in Botswana (TVE n.d.). There is also an ongoing dispute between Namibia, which wants to draw irrigation water for the Caprivi Strip, and Botswana, which wants to maintain water levels in the Delta to sustain its lucrative tourism industry, which generates a significant demand for amenity uses (UNEP 2005).

Another source of resentment over water resources in the ORB is the Delta's status as a Ramsar site. International special interest groups with a vested interest in protecting the wetland can limit future development options in both Botswana and Namibia. With development by legitimate domestic governments subject to approval by foreign interests, there is an added international dimension to the complex political dynamics in the ORB (Green Cross International n.d.).

Angola Research Team/Hydrology at Capico during the e-flows studies. © Jackie King

These disparate levels of dependence upon the basin's natural resource base in each country create barriers to harmonized basin development. In addition there is concern in both Botswana and Namibia that current national development patterns are unsustainable. Demands are already resulting in modified water quantity, quality, and sediment flows. State of the Environment (SoE) reports, dealing specifically with water, have recently been commissioned by the ministries responsible for the environment in both countries.

The key environmental pressures on water resources are over-grazing, which is accelerating land and soil degradation in Namibia and Botswana; unplanned abstraction from watercourses and aquifers due to development in Angola along de-mined transport corridors in the Cubango and Cuito sub-basins as the peace process re-settlement occurs; pressure for new and increased water abstraction to service urban expansion and irrigated agriculture, such as in Bie Moxico and Kwando Kubango provinces, where the water demands are anticipated to increase as resettlement occurs and agricultural development projects follow; and the growth of effluent disposal and non-point pollution. It is anticipated that these factors will continue to accelerate. Already, Botswana and Namibia are water scarce and it is expected that future water scarcity could severely limit economic development and even raise water resources management to a national security issue (Turton and Ashton 2008).

Climate change will exacerbate the situation: scenarios project that drier conditions will accompany increased abstractions, with significant impacts on the Delta's southern reaches in particular. It could result in both reduced water use and less groundwater recharge, adversely affecting some 47,000 people living in Maun and along the downstream Boteti and Kunyere rivers (Ringrose 2008). All these issues could outpace policy and institutional response in riparian countries.

## Basin Management

Although there are competing demands for water among the riparian countries, they have made concerted efforts to manage water resources peacefully. In 1994, Angola, Botswana, and Namibia formed the Permanent Okavango River Basin Water Commission (OKACOM). Its objective is to act as the technical advisor to contracting parties on matters of common interest relating to the conservation, development, and utilization of water resources in the Okavango River Basin (OKACOM 1994). This entails promoting coordinated and sustainable water resources management while addressing the legitimate social and economic needs of the riparian states.

The Commission is guided by a shared vision to anticipate and reduce unintended, unacceptable, and often unnecessary impacts on the ORB system. Operational principles of equitable allocation, sustainable utilization, sound environmental management, and balancing water demand and supply support the vision. The Commission's mandate requires it to investigate the pre-requisites and set-up conditions to determine the long-term safe water yield available from the river; estimate reasonable water-demand scenarios from consumers; prepare criteria for conservation, equitable allocation, and sustainable water use; investigate water infrastructure; recommend pollution prevention measures; develop measures to alleviate short-term difficulties, such as temporary droughts and floods; and visibly alleviate poverty in riparian communities through resource-management options (OKACOM 1994).

OKACOM initiated a Transboundary Diagnostic Analysis (TDA) to critically identify emerging issues and trends in the ORB. The results will inform an IWRM-based Strategic Action Plan (SAP) that will constitute the backbone of OKACOM's programs. The TDA will objectively assess the basin status; identify causal chains among the issues; and be a diagnostic tool for measuring the SAP's effective implementation. The TDA process uses the Environmental Flows Assessment methodology to improve understanding of the implications that changes in flow regime may have on basin ecological

systems (broken down into various bio-physical systems components), socio-economic conditions (livelihood strategies), and the Okavango River Basin's overall macro-economic system. A specially developed decision-support system is being used in the integrated basin-flow assessment that will assess 'triple bottom line' impacts (ecological, socio-economic, and macro-economic) of possible development scenarios in the basin. A special component on PES will be built into OKACOM's SAP to reinforce the possible methodological options of a tri-country benefit-sharing approach. In addition, under Botswana's Okavango Delta Management Plan, a study was conducted on the economic value of the Okavango Delta's ES as a first step in providing management with some decision support tools.

A climate change scenario is also being considered in the scenario analysis process. Ultimately, this analytical/thinking tool can be used to guide OKACOM in how best to define 'acceptable development space' in the basin that can sustain fundamental development needs without undermining the river's stability and functionality. The final TDA report and SAP are still being completed and are expected to be released in 2010.

One drawback to OKACOM's capacity to manage transboundary water resources in the ORB is its role as strictly an advisory body. As such, it can promote liaisons among the countries, foster information sharing, and provide information to the three nations on water-resource management issues in the Okavango basin; actual water-resources management, however, remains the responsibility of respective governments. "OKACOM represents a transitional stage on the trajectory of institutional development between informal technical cooperation and a fully-fledged River Basin Organization (RBO) that actively undertakes management actions on behalf of the respective governments" (UNEP 2005, 38). On the other hand, in its present form, OKACOM is an important channel for cooperation, communication, partnerships, and trust-building (UNEP 2005).

Botswana Research Team in the Panhandle during the e-flows studies. © Cate Brown

A ‘Water for Peace’ project initiated in 2003 in the ORB had the goal of exploring the potential for benefit sharing among the three countries to catalyse peaceful water resources development by ensuring the equitable and sustainable use of the Okavango River, following OKACOM guidelines. It resulted in a publication that outlines the threats to the region from development and the potential for conflicts due to ‘hydropolitical’ drivers (Turton and Ashton 2008). It concludes that “[c]onflict prevention measures are essential if serious disputes are to be avoided when the next drought hits the region” (Green Cross International n.d.).

In addition to OKACOM, the Okavango Delta Management Plan (ODMP) has been developed for the Okavango Delta in Botswana. Its goal is to integrate resource use and conservation of the Okavango Delta wetlands resources and the surrounding environs. The ODMP is based on the principles of ownership and accountability. Stakeholder participation among all affected parties was a key component of the plan and it is regarded as a model for meaningful stakeholder engagement. The ecosystem approach and IWRM are major planning tools in Botswana’s ODMP.

## Lessons Learned

OKACOM has successfully brought the riparian countries together under the organizing principle of ‘Three Nations One River’. The cooperation among states and between nations and civil society to manage transboundary water resources is a significant shift away from the top-down approach to water rights that has been historically prevalent. It is a promising step towards a new model of benefit-sharing across the basin (Earle and Méndez 2004) and bodes well for a future of consensual management to solve problems related to shared water resources (Turton and Ashton 2008).

OKACOM’s framework analysis under the TDA/SAP views the ORB as a whole and it adopts the IWRM and ES approaches, especially in the application of the Environmental Flows Assessment, which treats the systems in an integrated fashion that cuts across national political boundaries. It also recognizes and addresses the pressures from outside the hydrologically active basin. Through its goal to secure poverty eradication without undermining the integrity of ecological systems, OKACOM acknowledges how changes to ES will affect the economy and livelihoods. Thus, OKACOM consolidates the political basis for transboundary IWRM and continues to provide the unifying structure for cooperation.

If the ORB is to continue to furnish its flow of environmental benefits and maintain a critical stock of freshwater services, minimum requirements need to be met, but the national institutional and policy responses to date have been oriented to supply management. In financial, economic, and environmental terms, this approach is not sustainable. Politically, the major impediment to IWRM is OKACOM’s role as an advisory body, while some expect it to actively manage water resources although that role is not within its mandate. There are significant political challenges to avoiding conflict over water resources and important conflicting demands between inter- and extra- basin uses and between upstream and downstream needs. As well, present pressures may compromise future water demands due to needed development, and there is the controversial matter of international public pressure against large-scale water projects that could have negative impacts on the Okavango Delta’s ecology (UNEP 2005).

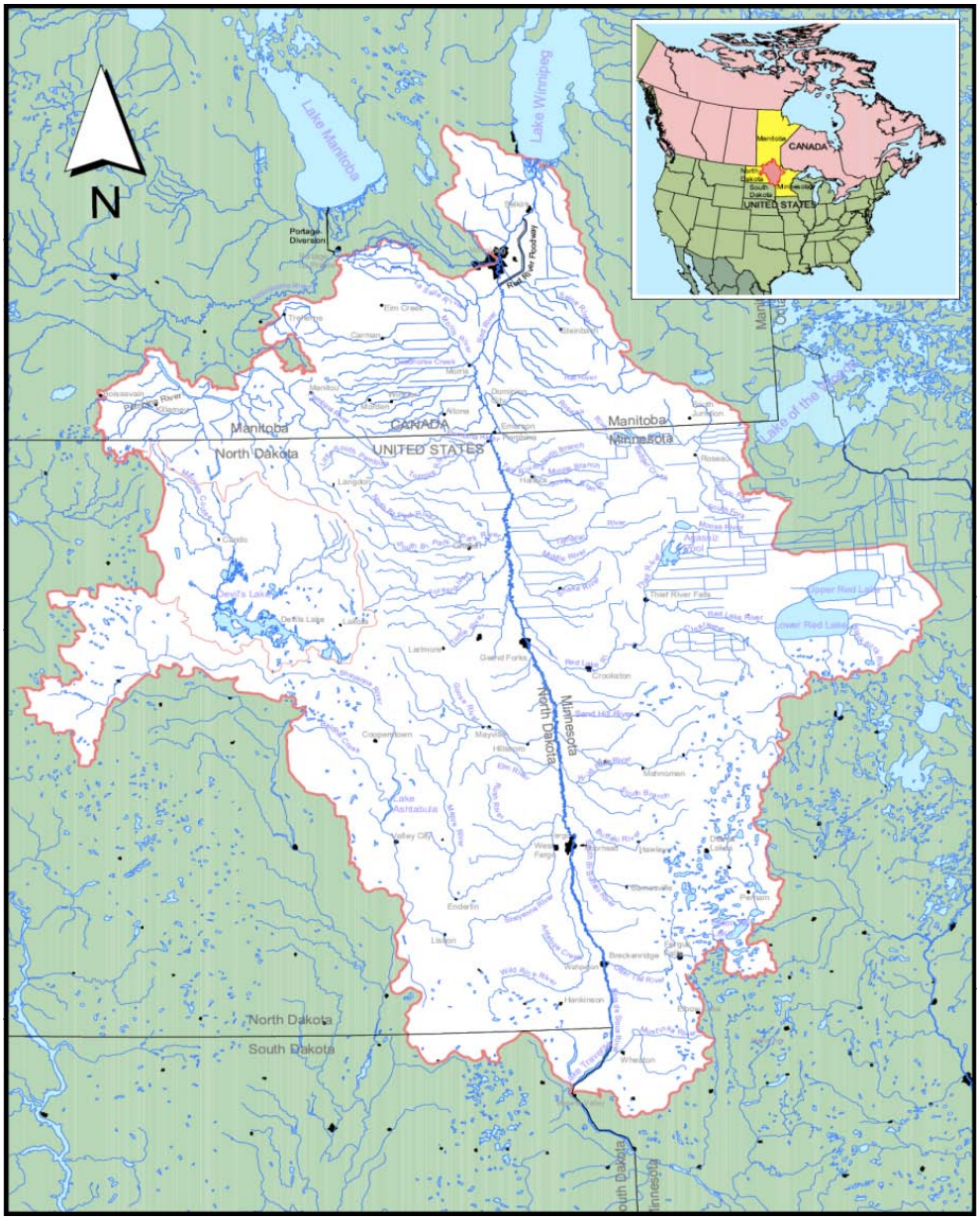
Technical challenges include the vast distances and lack of transportation in the region. For example, OKACOM is only able to meet once a year and it takes some members three days to arrive. There is also a lack of uncontested and shared basin-wide data that would inform water management approaches. Financially, the first challenge is to estimate the cost of managing the transboundary river basin (Green Cross International n.d.).

Regional demands for water resources need coordination, with an integrated joint management plan and a comprehensive approach to demand management to avoid conflict (Mbaiwa 2004). OKACOM

has begun this process, but its role and responsibilities need to be formally expanded to foster the equitable sharing of the basin's waters among riparian nations and to allow them to jointly decide on the types of development they wish to encourage (UNEP 2005). OKACOM has shown foresight in including a special component on PES in its SAP, which promises to strengthen benefit sharing in the basin. If the threats to the basin's ES are not addressed through IWRM, however, there will be irreversible changes in the basin's water balance and hydro-chemical and hydro-geomorphological responses. Such changes will affect the productivity and environmental integrity of the basin as a whole.

# The Red River Basin

**Figure 3: The Red River Transboundary Watershed**




Source: (Schindelka 1999)

## Ecosystem Services (ES) and Drivers of Change

Human land uses, especially agriculture and settlements, have substantially altered the Red River Basin's (RRB) natural landscapes; most of the area is now devoted to agriculture and only 9% is covered by forest and rangeland (RRBC 2005). Flooding is the foremost challenge to transboundary water management, with water quality also growing as a concern.

**Table 6. The Red River Basin**

| | |
|---|---|
| **Location** | North America |
| **Area** | 116, 550 $km^2$ |
| **Length** | 880 km |
| **Riparian nations** | Canada, United States |
| **Population** | 1.3 million |
| **Geographical regions** | • Main tributaries: Wild Rice, Sheyenne, Pembina, and Assiniboine Rivers<br>• Occupies twice as much area in the United States than in Canada |
| **Characteristics** | • Naturally flood-prone<br>• Low northward gradient<br>• Subject to ice jams during snowmelt<br>• Fertile soils |
| **Major Ecosystems** | • Rare Northern Tall Grasslands<br>• Eastern part of Prairie Pothole ecosystem<br>• Delta Marsh<br>• Lake Winnipeg |
| **Climate** | • Annual mean temperature: 4.4°C<br>• Annual mean summer temperature: 35-39°C summer<br>• Winter temperatures as low as -37°C |

Sources: (Hearne 2007) (NRCan 2007) (RRBC 2005) (River Keepers 2005) (WWF n.d.) (Environment Canada 2004)

The impacts of floods have been exacerbated since human settlement in the region and now have severe social, economic, and environmental consequences. Drought is also a concern, and there have been a number of severe droughts that have affected the region's agricultural production and potable water supplies (Hearne 2007). Before extensive land-use change, meandering channels draining slow-moving water over the plain were integral parts of the ecosystem, as were wetlands that store and regulate water flows, filter nutrients and pesticides, trap sediments, stabilize shorelines, provide wildlife habitat, and store carbon. Over the years, artificial drainage systems have been needed to prevent flood damage to growing settlements and agricultural land (RRBC 2005). Both countries constructed water diversion and control schemes, including dykes, reservoirs, and comprehensive flood-control systems, including an extensive floodway around Winnipeg, built from 1962 to 1972, and the English Coulee Diversion around the sister cities of Grand Forks, North Dakota and East Grand Forks, Minnesota, built between 2000 and 2006 (Beduhn 2005). Control measures such as straight-line drains that replaced the natural features, however, tended to accelerate runoff from fields and exacerbated downstream flooding (Venema, Oborne and Neudoerffer 2010).

The RRB has a history of major floods that have damaged infrastructure, farms and cropland, businesses, industries, homes, and water quality, and caused loss of life and affected human health (RRBC 2005). The disastrous flood of 1997, for example, disrupted the lives of over 100,000 people in Manitoba, Minnesota, and North Dakota, and caused damages estimated at US $5.8 billion in 2004 dollars (RRBC 2005)(IJC 2000). A more recent flood in 2009 resulted in millions of dollars in damage and a renewed interest in flood protection in the basin.

As a result, both countries have put increasing emphasis on the need for a long-term approach to flood management in recognition that structural protection has fostered a sense of security and encouraged development in the floodplain. They are complementing diversions with non-structural flood damage reduction measures such as land-use regulation and mapping, forecasting and warning, and flood proofing, among others (Simonovic n.d.).

Aerial shot of Red River flowing through the Netley-Libau Marsh and into Lake Winnipeg. © Richard Grosshans

Flood-control measures planned by one or other of the two countries that share the Basin can have impacts in the neighbouring nation and contribute to conflict between them. For example, between 1993 and 2004, waters in Devils Lake, North Dakota rose by 7.77 m and the volume increased four-fold, causing $450 million in flood damages. The State built a canal to divert water into the Sheyenne River, despite a study finding it would have adverse transboundary environmental impacts. When the canal was completed in 2005, the two countries signed an agreement to jointly monitor and assess the lake, mitigate impacts, and cooperate to reduce the risk of invasive species entering the Red River. Another controversy developed over the proposed Garrison Diversion, which would transfer water from the Missouri River to the Red River (Hearne 2007). The water, intended for irrigation, would have crossed the continental divide and would require the International Joint Commission's approval, especially since it risks transferring harmful invasive species into the Hudson Bay. In 2005, the U.S. District Court found that the Garrison Diversion's Northwest Area Water Supply (NAWS) project had been improperly assessed. In 2009, when the U.S. and North Dakota governments requested the injunction on further work be lifted, Canadian and several U.S. states and NGOs filed a lawsuit against it due to the considerable risk of harm to Manitoba. Finally, in March 2010, the U.S. District Court refused to lift the injunction due to inadequate assessment of the consequences of biota transfer to the Hudson Bay drainage basin. It is considered a landmark decision in its consideration of invasive species in large-scale inter-basin transfers (Anon 2010).

The Red River basin is the largest contributor of nutrients to the downstream Lake Winnipeg. Runoff from agricultural land has led to high concentrations of suspended sediment and there have been recent algae blooms in Lake Winnipeg that indicate high phosphate and nitrogen levels in the Red River. Eutrophication in Lake Winnipeg has had a negative impact on the fishery and also threatens

the lake's tourism sector (Hearne 2007). Finally, climate change also threatens the basin's water resources and their ES. The eastern Prairies are very sensitive to climatic fluctuations and climate change will affect flooding, water quality, and watershed processes and will likely increase the frequency and extent of algae blooms in Lake Winnipeg (Runnalls 2007) (RRBC 2005).

## Basin Management

The International Joint Commission (IJC), created by the 1909 Boundary Waters Treaty to prevent or resolve disputes, is the key political mechanism governing transboundary water (and air) management between the two countries. The IJC runs the International Watersheds Initiative (IWI) to anticipate, prevent, or resolve water issues and environmental problems at the local level and prevent them developing into international issues. It has adopted the 'watershed approach', a broad, systemic, and integrated ecosystem perspective of the watershed, and established the International Red River Board (IRRB) to implement it. Its strategic objectives include the adoption and implementation of a Comprehensive Flood Mitigation Strategy (CFMS); new objectives for nutrients; and the expansion of outreach and cooperation, including strong working relationships with local and regional water and watershed organizations and with First Nations and Native Americans in the Basin. One of its recent accomplishments is a comprehensive assessment of more than 5,000 fish, which possibly represents the largest single fish health assessment in North America (IRRB 2009) (IJC 2009).

The Red River Basin Commission (RRBC) is the leading agency fostering cooperation in transboundary water management. It is an international, not-for-profit organization "dedicated to wise and innovative management of the Red River Basin's water resources." Members represent the two governments, cities, rural counties and towns, aboriginal communities, and water and soil related boards and districts as well as other local interests (RRBC 2009). It developed a Natural Resources Framework Plan (NRFP) to guide transboundary ecosystem management. The NRFP provides a series of thirteen basin-wide goals promoting integrated, ecosystem-based management in the RRB. These goals include managing natural resources in the RRB by watershed rather than within political boundaries; integrated natural resources management; improving stakeholder participation; and awareness of land and water issues. There are also goals for the management of specific basin-wide ecosystem services such as flood mitigation, water quality, soil conservation, biodiversity and fish/wildlife habitat, as well as basin-wide recreational value.

The NRFP is meant to guide relevant entities in the RRB in their decision making, and help the basin move forward with a unified purpose and unified voice (RRBC 2005) (Government of Manitoba 2009). In 2009, RRBC's work included a million-dollar project funded by Minnesota and North Dakota on long-term flood solutions. It is also preparing ecological indicators for the basin and it has formed nine assessment teams to assess the status of the Basin's land and water management problems, issues, and opportunities (Smith 2009).

In 2000, the RRBC, at the time called the Red River Basin Board, also produced nine inventories reporting on aspects of the RRB's land and water management problems, issues and opportunities[2]. Inventory team members included representatives from state and federal agencies, local city and county governments, and local interest groups. These nine inventory reports discuss Water Law, Water Institutions, Hydrology, Water Supply, Water Quality, Drainage, Flood Damage Reduction, Conservation, Fish, Wildlife, and Outdoor Recreation. While these are not explicitly termed 'ecosystem services' assessments, they clearly represent ES inventories and analysis.

[2] See http://www.redriverbasincommission.org/Reports/reports.html.

Healthy marsh shorelines provide a range of ecosystem services in the Red River Basin. © Richard Grosshans

The RRBC continues to work on restoring the RRB to produce a strong suite of ES, and has been working with the International Institute for Sustainable Development (IISD) since 2009 to implement an ecological infrastructure project in the RRB with the goal of providing ES as cost-effective alternatives to built infrastructure. It is expected to provide co-benefits such as improving habitat and carbon sequestration and sustaining livelihoods in addition to controlling nutrient flows into water bodies and buffering the potential impacts of climate change (IISD 2008) (Voora 2009). The project is in its initial phase from 2009-2010.

## Lessons Learned

Cooperation among the governments has helped to improve flood mitigation and flooding impacts in the RRB, with "considerable success in projects and programs that keep water away from people and less success in programs that keep people away from water" (Halliday 2003). The IWI's adoption of an integrated ecosystem approach should continue to help to steer actions towards 'softer' approaches to flood management. The RRBC/IISD project integrates work to address the land-use changes that have impacts on the Red River's water resources, but neither the IRRB's or the RRBC's mandates and goals include the explicit aim of integrating PES in water resources management.

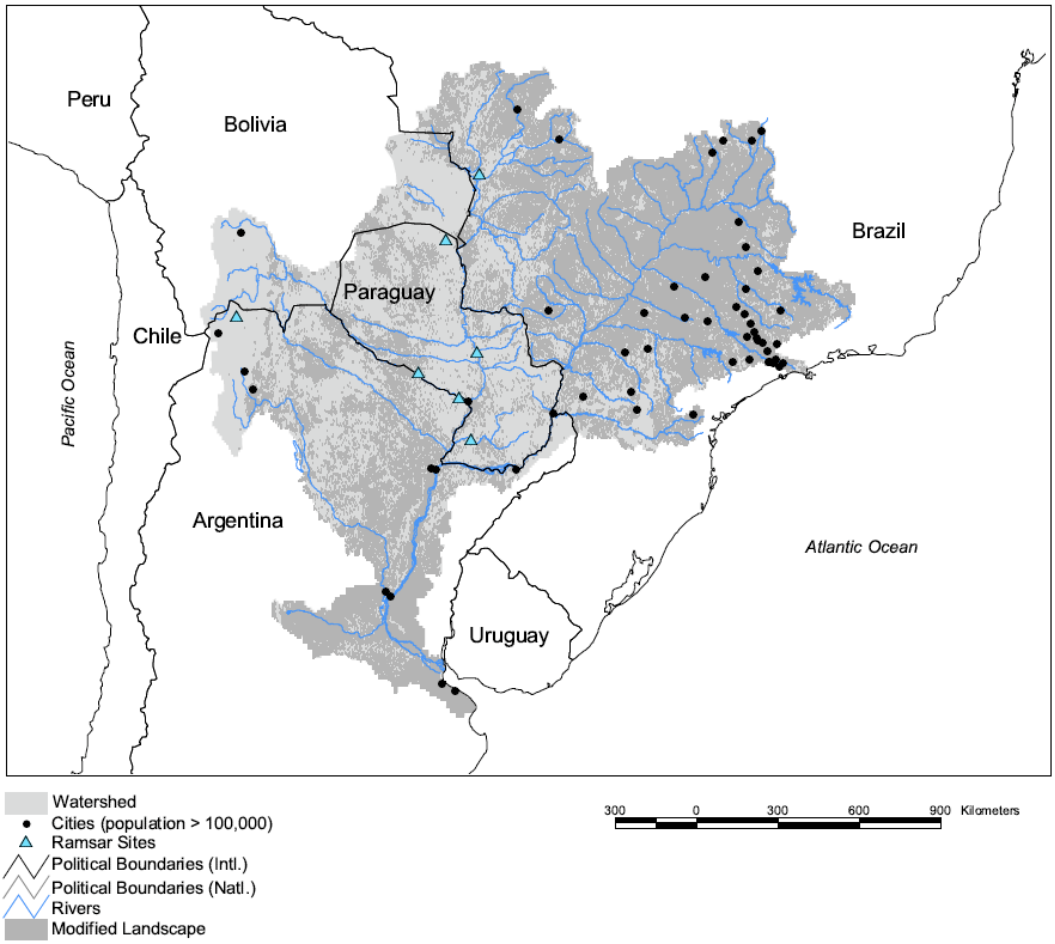
There is an expressed will to implement IWRM in the Red River Basin, in the form of bilateral governance structures, the IJC and the International Red River Board (IRRB), both of which take the watershed approach to managing the Basin. International watershed boards further strengthen the political structures. Political challenges to strengthening international cooperation in IWRM include

issues of sovereignty over territorial waters and the limited mandate of the IRRB which intervenes only when invited.

Institutionally, the Red River Basin is well served by the international not-for-profit Red River Basin Commission (RRBC), which produced a plan for transboundary integrated natural resource management and unifies entities in implementing it. On the other hand, the decentralized and uncoordinated nature of water management structures remains a challenge to IWRM and the ecosystem approach to water management (Hearne 2007). Technically, the IRRB has the ability through its nine inventory teams to undertake surveys and assessments that inform IWRM, although the coordination of data collection and data sharing among multiple political jurisdictions remains a challenge (RRBC 2005).

# The La Plata River Basin

**Figure 4: La Plata Transboundary Watershed**




Source: (C. S. Revenga 1998, 2-157)

## Ecosystem Services (ES) and Drivers of Change

The impacts of urbanization, deforestation, agriculture, fisheries, mining, hydropower development, land-use changes, and hazardous weather events threaten the integrity of the La Plata Basin's (LPB) ES, with impacts on the region's economy (IDRC n.d.) (WWAP 2007). For example, encroachment by development, pollution, habitat loss, and the contraction of migration corridors for many species affects the capacity of the Pantanal wetland (Box 1) to store and regulate water flows, which in turn affects navigation and hydropower capacity. Climate change is expected to exacerbate these impacts. Deforestation for agriculture and as the result of dam construction has reduced the land's ability to capture and store carbon and water and to anchor soils, leading to erosion, declining rainfall, sedimentation, and changes in water availability (WWAP 2007) (GEWEX 2005).

**Table 7. La Plata Basin**

| | |
|---|---|
| **Location** | South America |
| **Area** | >3,100,000 $km^2$ |
| **Length** | 3,998 km |
| **Riparian nations** | Argentina, Bolivia, Brazil, Paraguay, and Uruguay |
| **Population** | 101 million |
| **Geographical regions** | • Upper region: the divide between the Amazon and La Plata River basins<br>• Three tributaries: Paraná (47.8%), Paraguay (35.3%); and Uruguay (1.8%)<br>• La Plata estuary (4.2% of the Basin) |
| **Characteristics** | • Second in size to the Amazon Basin<br>• 20% of total surface water reaches the sea; 80% evaporates or infiltrates the ground<br>• 150 hydroelectricity stations, 72 of which have outputs of over 10 MW |
| **Major Ecosystems** | • Guaraní Aquifer: world's largest freshwater wetland<br>• The Cerrados: vast ecosystem of grasses and low and sparse tree cover<br>• The Pampas: huge, fertile grassy plain in northern Argentina<br>• The Chaco region: shallow plain of dry woodlands and savannas with alluvial sediments<br>• The Atlantic Rainforest |
| **Climate** | Average annual precipitation as a whole: 1,100 mm |

Sources: (WWAP 2007) (WWF n.d.) (GEWEX 2005)

As a result of agricultural development, about half of the LPB's natural vegetation has been changed to pasture (GEWEX 2005). Industrial agricultural practices, the intensification of soybean production since the early 1990s, and the development of one of the world's largest livestock raising industries have led to problems of sedimentation, soil compaction, reduced water infiltration, and increased surface runoff (WWAP 2007). La Plata River carries a high percentage of suspended solids associated with erosion, with resulting impacts on navigation, water quality, and infrastructure (WWAP 2005).

**Box 1. The Pantanal Wetland**

The Pantanal is a continental savannah wetland occupying an area of 147,574 $km^2$ shared by Brazil (80-85% of the total), Bolivia (10-15%), and Paraguay (5%). Its seasonal flooding covers 80% of the ecosystem in the wet season but evaporates or returns to waterbeds in the dry season. This vital ecosystem captures, stores, and regulates water and its flow; helps to mitigate droughts and floods; regulates weather patterns in the region of Santa Cruz; retains soils and nutrients and filters pollutants; captures and stores carbon; conserves its rich biodiversity; and in addition to water for drinking, hygiene, transportation, recreation, and tourism, provides other ecological goods, such as food and materials that are important for rural livelihoods (WWF n.d.) (Alho 2008).

To provide an idea of the Pantanal wetland's economic value, Seidl and Moraes (2000) applied the approach used by Costanza et al. in their seminal *Nature* paper (1997) to the Pantanal sub-region of Nhecolandia. Measuring waste treatment, cultural values, and water regulation, they derived a value of more than US$15.5 billion annually, or US$5 million annually per resident (Seidl and Moraes 2000).

Rio La Plata. © Evelio Gonzalez/Dreamstime.com

Numerous activities are modifying the Pantanal's hydrology (Box 1) and causing wildlife habitat and biodiversity loss, including deforestation (which has affected 17% of the wetland and 63% of the uplands surrounding it), cattle ranching, agriculture, mining, tourism, and fire (Alho 2008).

The building of dams and reservoirs for hydroelectricity has transformed some rivers into standing waters, enlarged other water bodies, and inundated terrestrial ecosystems. The results include the loss of more than 30% of international river length, changes in fish communities and structures, the loss of wildlife habitat and biodiversity, and the degradation of other environmental services (Mugetti, et al. 2004). The associated increase in industrial, agricultural, transportation, and urban developments has caused more deforestation, erosion, degraded water quality, and declines in fish. It also led to pollution in the LPB's waters, especially in the highly developed corridor from Rosario to Buenos Aires where the impacts of sewage effluents include high algae concentrations, turbidity, and fish mortality (WWAP 2007).

Climate change will increase the frequency, duration, and intensity of extreme hydrologic events (Rucks 2008), which have already increased notably since the early 1990s. Floods already occur in most cities of over 20,000 inhabitants (WWAP 2005).

## Basin Management

The 1969 La Plata Treaty, established by an Intergovernmental Coordinating Committee (the CIC), is the main vehicle for cooperation in the watershed's management (Gilman, Pochat and Dinar 2008). Its goals include identifying common research interests, programs, and instruments to address navigation issues, water use, and biodiversity, and to undertake other projects such as inventories and assessments of the Basin's natural resources (WWAP 2007). Common goals relate to hydroelectricity generation and navigation, with much less focus on water quality and other issues (WWAP 2007).

In 1976, FONPLATA, the Financial Fund for the Development of La Plata Basin, was created as the banking mechanism to ensure stable, non-contentious funding, and in 1991, the CIC created a Technical Projects Unit to link the Basin's technical and financial institutions (Kempkey, et al. 2009). In 1989, the La Plata Basin Treaty incorporated the Paraná Waterway Program ('Hydrovia' Project) to connect Brazil and Uruguay by creating a 3,400 km waterway. The plan would alter and dredge portions of the Paraná and Paraguay Rivers and the Pantanal wetlands to allow year-around barge transportation and access by Bolivia and Paraguay to the ocean (WWAP 2007).

Of 15 treaties signed between 1946 and 2006, three are basin-wide treaties (1969 La Plata; 1974 FONPLATA; and 1989 Waterway agreement); the remaining 12 were signed between two or three basin countries only and represent important sub-basin agreements in water management (Gilman, Pochat and Dinar 2008). These bilateral and trilateral agreements and others that followed created joint projects that significantly improved the member country's economies, especially by generating electricity for domestic use and export, although some have incurred heavy debt burdens as well and the equitable sharing of benefits of others has been questioned (Gilman, Pochat and Dinar 2008).

By the mid-2000s, it became evident that treaty successes in harnessing hydropower had come at large environmental, financial, and human costs. Since the mid-1990s, these agreements increasingly incorporate environmental concerns. Examples include the 1995 Argentina-Bolivia agreement to manage the Bermejo and Grande de Tarija Rivers and the agreement among Argentina, Bolivia, and Paraguay to manage the Pilcomayo River (Gilman, Pochat and Dinar 2008).

At the Basin level, the CIC drew up a new Action Plan and a Framework Programme with funding from GEF that focuses on protecting and managing water resources, including addressing flooding and drought (Gilman, Pochat and Dinar 2008). New funding in 2005 supported stakeholder input to devise four new programmes and strengthen the integrated management of the Basin's water resources. These focused on exchanges with other basins for mutual learning and a pilot project to sustainably manage the Yerendá-Toba-Tarijeño aquifer. One of the most successful transboundary projects is a GEF/World Bank sponsored one involving all four countries that share the Guaraní aquifer (Box 2).

The implementation of the Hydrovia project faced significant obstacles that helped highlight the need to plan for sustainability. Alterations already accomplished to date increased river transport from 70 thousand tons to 13 million tons between the 1990s and 2004. Should the Hydrovia project proceed, it will have significant impacts on rivers and ecosystems, especially the Patanal wetland, which has prompted strong opposition to its further development (WWAP 2005) (Gilman, Pochat and Dinar 2008).

### Box 2. The Guaraní Aquifer

The Guaraní aquifer underlies a surface area of 1.2 million $km^2$ and holds 45,000 $km^3$ of fossil water (WWAP 2007). It supplies drinking water to 15 million people. Water consumption is rising rapidly and parts of the aquifer have been over-pumped and agricultural chemicals are threatening others. In 2003, the Global Environment Facility (GEF) supported the establishment of an integrated water management plan for the aquifer. Bi-lateral agreements have now mainstreamed groundwater conservation and protection into both national and regional institutions and actions are being taken at local levels in many areas. The project has become a model of transboundary cooperation in managing shared water (GEF 2008).

## Lessons Learned

Opposition to the Hydrovia project is highlighting the links between the development of water works and the potential impacts on ecosystems and their services. The annual flooding pulse in the Pantanal would be affected, raising the risk of downstream floods and droughts (Wolf and Newton 2008). The treaties and management plans do not yet appear to address this issue nor the links between agricultural and other development and the ecological, human, and economic impacts related to resulting siltation, sedimentation, navigation issues, and degraded water quality, among others. There is also controversy over the Yacyreta hydro project, due to its significant impacts on the ecosystem (Wolf and Newton 2008).

An appreciation of the value of the ES provided not only by the waters themselves, but by the lands and vegetation in the watershed, would inform the need to protect them and prevent ecological damage and economic and human impacts. Examples include protecting the Pantanal wetland and its role in preventing floods, filtering water, and regulating the climate. In turn, these services help to maintain the viability of farming, fishing, and ecotourism activities in the region.

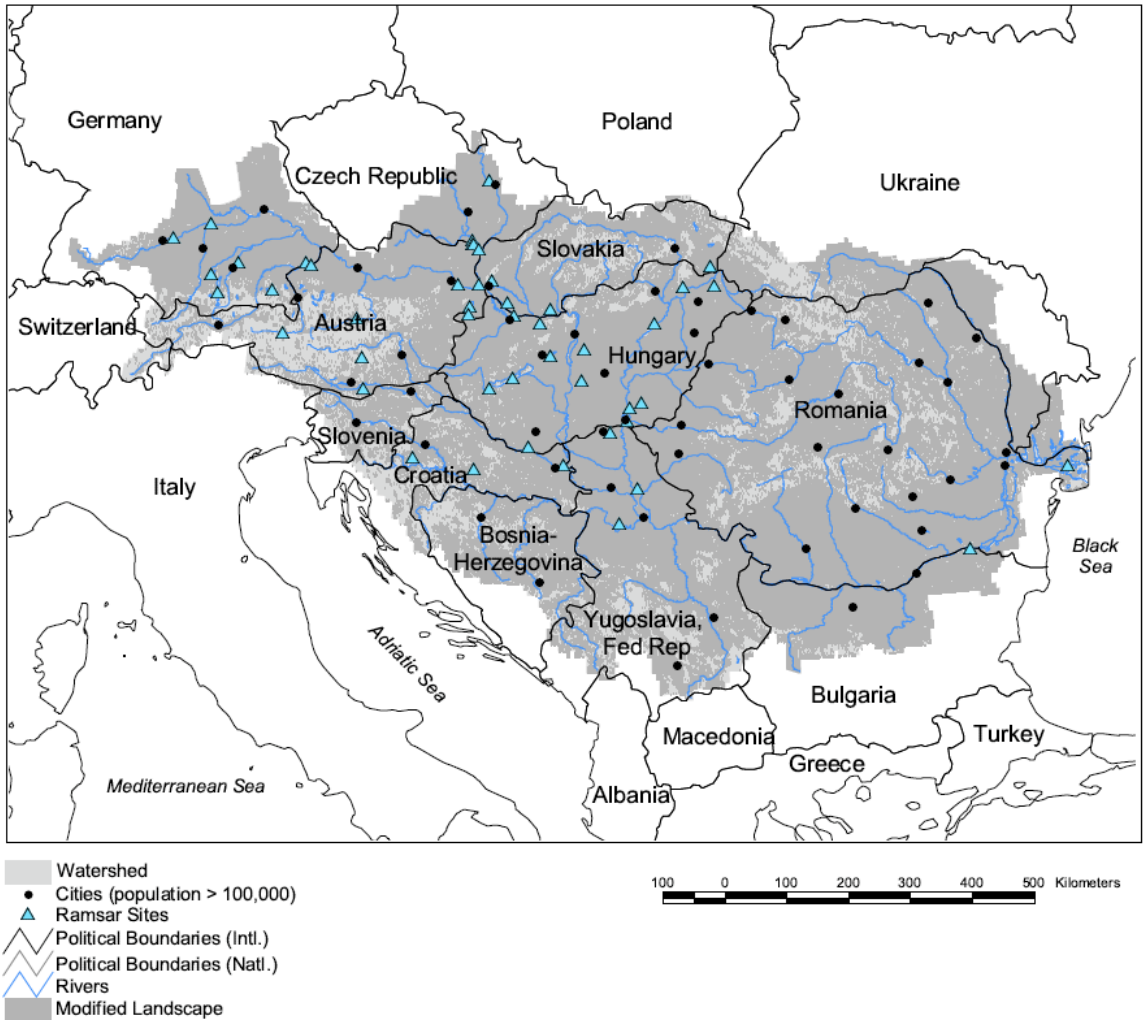
Although the La Plata Treaty and the CIC have created a space for civil society actors to participate in water management decisions (Kempkey, et al. 2009), environmentalists and those whose livelihoods depend on traditional economies have expressed trepidation at the project. Similarly, indigenous peoples affected by the bilateral Yacyreta Treaty claim they were not part of the planning process and have not been compensated for their lost lands (Wolf and Newton 2008).

Some bilateral and trilateral treaties have faced problems with the equitable sharing of benefits from the electricity produced by shared dams, and corruption has also been a problem in several instances (Gilman, Pochat and Dinar 2008) (Wolf and Newton 2008). On the other hand, years of negotiation among the countries have helped establish the mechanisms by which a measure of cooperation can be achieved and power disparities dispelled (Gilman, Pochat and Dinar 2008).

Politically, the CIC and La Plata Basin Treaty provide a firm basis for international cooperation, while bilateral treaties have fostered collaboration among regions. These arrangements have integrated sustainability goals without explicitly mentioning IWRM, although bilateral agreements in the Guaraní aquifer include model integrated water management plans. At the institutional level, sectors, issues, nations, and bilateral organizations remain fragmented in the approach to water management. FONPLATA ensures stable, non-contentious funding, while the CIC ensures links among the Basin's technical and financial institutions. Thus, there is an opportunity and a strong basis for the explicit adoption of IWRM goals and ES approaches in treaties, institutions, and financial mechanisms in the La Plata Basin.

# The Danube River Basin

**Figure 5: The Danube Transboundary Watershed**




Source: (Revenga, et al. 1998, 2-38)

## Ecosystem Services (ES) and Drivers of Change

The Danube River Basin (DRB) has been extensively altered and polluted by human activities in the many countries that share its waters. The quality of the Danube River's water also affects other states in the Black Sea region, including Bulgaria, Russia, Georgia, and Turkey (Global Water Partnership 2008) (Gerlak 2004).

The DRB has a long history of navigation, hydropower, flood control, and other engineering works, with important impacts on ES in the Danube watershed (IW: Learn 2006). Between 1910 and 1990, the natural channels in the Delta were artificially extended to improve access and one quarter of the Danube delta has been dyked.

**Table 8. Danube River Basin**

| | |
|---|---|
| **Location** | Central and Southeastern Europe |
| **Area** | 801,463 km² |
| **Length** | 2,850 km |
| **Riparian nations** | Austria, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Macedonia, Moldova, Poland, Romania, Serbia and Montenegro, Slovakia, Slovenia, Switzerland, and Ukraine |
| **Population** | 81 million |
| **Geographical regions** | • Upper Danube Basin: from the Black Forest Mountains to the Gate of Devín and eastwards towards Vienna<br>• Middle Danube Basin: includes the area from the Gate of Devín to the Iron Gate, dividing the Southern Carpathian Mountains in the north from the Balkan Mountains in the south<br>• Lower Danube Basin: Danube sub-basins in Romania downstream of the Cazane Gorge extending to the Danube Delta and the Black Sea |
| **Characteristics** | • Europe's second-largest river basin, after the Volga<br>• Terminates at the Black Sea, which has minimal tidal activity with little water exchange between it and the Mediterranean, so nutrients tend to build up, water renewal is slow, and its ecosystems are especially sensitive to change |
| **Major Ecosystems** | • Danube Delta, 6,750 km$^2$, Europe's second-largest wetland area<br>• High glaciated mountains, lower forested mountains, foothills, upland plateaus, lowland plains and wetlands. Coastal waters include Romania's entire coastline and a section of Ukraine's shore |
| **Climate** | Average precipitation: <500 to >2000 mm |

Sources: (UNDP|GEF 2006) (IW: Learn 2006) (Global Water Partnership 2008) (Gerlak 2004) (Sandu and Kutzenberger 2009)

Impacts include a great reduction in the amount of suspended sediments transported in the entire Danube Basin. A doubling of the total channel length by artificially extending the natural channel network has allowed nutrient-laden silt to go directly into the Black Sea and the dredging of 1,753 km of artificial channels changed the water-runoff pattern and increased sedimentation (Global Water Partnership 2008). Since the 1950s, engineering works, largely for agricultural purposes, have cut off some 15-20,000 km² of the Danube floodplains from the river, leading to the destruction of an area important for fish reproduction and the biology of aquatic bird species. Most of the basin's wetlands have been lost and biodiversity in the lower Danube has declined markedly through decreased productivity and trophic-web simplification (Global Water Partnership 2008) (WWF n.d.).

More than 30 rivers carry the effluent of 160 million people living in almost one-third of Europe to the Black Sea (Gerlak 2004). The Danube River and its tributaries also carry nitrogen and phosphorus from agricultural runoff, accounting for approximately half of the loads to the Black Sea (Global Water Partnership 2008) (Black Sea Environment Programme Coordination Unit 2007). These inputs have intensified eutrophication and changed flora and fauna structures in the Danube Delta and the Black Sea. Reduced water transparency has led to declines and extinction of some of the more sensitive fish species (Global Water Partnership 2008).

Disused and active industrial sites and shipping and mining activities have discharged hazardous substances into the Danube watershed. Profiles of the pesticides lindane and DDT are increasing from the upper to the lower Danube and there is a trend of increasing PAH concentrations in mussels

downstream in the Danube Delta. There are also elevated levels of heavy metals, especially cadmium and lead, downstream in the DRB (IW: Learn 2006).

## Basin Management

By the early 1990s, scientists and politicians had recognized the devastating ecological, social, and economic impacts of human activity in the Danube and the Black Sea and called for international action (Gerlak 2004). In 1994, 11 Danube riparian states and the European Commission signed the Convention on the Protection and Sustainable Use of the Danube River (The Danube River Protection Convention—DRPC). They were encouraged by new opportunities for regional cooperation after the enormous political changes in 1989, and driven by their partnership in the 1992 United Nations Economic Commission for Europe (UNECE) Convention on the Protection of Transboundary Rivers and Lakes, which obliged them to prevent transboundary impacts on watercourses and to cooperate through river basin management agreements (IW: Learn 2006).

The DRPC entered into force in 1998 with the objective "to ensure that surface waters and groundwater within the DRB are managed and used sustainably and equitably." The International Commission for the Protection of the Danube River (ICPDR) became the operational body responsible for coordination (ICPDR 2008). The 1994 Strategic Action Plan (SAP) directs member countries in how to achieve the goals on regional, integrated water management and riverine environmental management (Global Water Partnership 2008). The DRPC process involves stakeholders from industry, agriculture, environmental and consumer organizations, private industry, and local and national authorities (ICPDR 2008) (Global Water Partnership 2008). The Danube River Basin Management Plan (DRBMP) was released in December 2009 and sets targets and guidelines for 2015.

The ICPDR's Joint Action Plan has led to progress in stemming nitrogen inputs in the Danube basin and in stabilizing phosphorus loads: between the early 1990s and 2006, nitrogen emissions declined by 20% and phosphorus by nearly 50%. Declines in nutrient loads have helped decrease eutrophication in the Danube Delta and Black Sea (UNDP|GEF 2006). They have been largely due to the early-1990s economic crisis in central and Eastern Europe, however, and the associated closing of large animal farms and huge declines in the production and use of chemical fertilizers. It is expected that as these industries and intensive agricultural practices recover, nutrient loading and eutrophication are likely to re-emerge as challenges to the Black Sea ecosystem (Global Water Partnership 2008) (Gerlak 2004). In 2010, the ministers of ICPDR countries adopted the DRBMP, in line with the EU Water Framework Directive that covers transboundary issues and prescribes concrete measures to reduce pollution. The European Commission will monitor the plan's implementation and any failures will result in legal action against Danube EU member states.

In October 2000, the Danube countries adopted the European Water Framework Directive (WFD) for integrated water management. It established the DRBMP and associated operation plans (European Commission 2009). The first priority was to implement the WFD using Integrated River Basin Management (IRBM) as the guiding approach (UNDP|GEF 2006). Non-EU members in the DRB are not obliged to adopt the WFD, however, which presents a challenge to implementing management plans, although some non-EU nations adhere to the framework nevertheless (Schmedtje 2005). In 1991, the first part of the EU Water Framework Directive was implemented in all EU and non-EU states in the Danube Basin (The Danube River Project—DRP). It supported a range of management activities to stem nutrient runoff (IW: Learn 2006).

The Global Environment Facility (GEF) has been instrumental in funding and providing incentives to implement actions required by these transboundary agreements (Gerlak 2004). The United Nations Development Programme (UNDP) led a transboundary diagnostic analysis (TDA) of water issues and produced a Strategic Action Plan (SAP). The TDA-SAP process specifically promotes IWRM and

focuses on the core concepts of “sustainable development, the precautionary principle, clean technologies, transparency and public participation, and economic instruments” (Gerlak 2004).

Pelicans on the Danube. © Harju Alexandru/Dreamstime.com

The GEF helped participating countries jointly prepare the TDA, which included support for NGO networks (the Danube Environmental Forum (DEF) and the Black Sea NGO Network) to ensure greater public participation and allow them observer status at regional commissions (Gerlak 2004). In addition, the World Wildlife Fund (WWF) works to build capacity and strengthen the NGO network.

In 2001, a notable Memorandum of Understanding (MOU) between the Danube and Black Sea Commissions was signed. The Danube-Black Sea (DABLAS) Task Force for cooperation on water protection in the wider Black Sea Region was set up. It provides practical support to all Basin countries in implementing the EU Water Framework Directive, including developing an investment portfolio. The goal is to reduce nutrient and hazardous discharges into the Black Sea and Danube Basins to below 1990 levels, and to eventually achieve ecosystem conditions comparable to those in the 1960s (Global Water Partnership 2008).

Thus, since the early 1990s, strong legal instruments have been instituted to protect the Danube River Basin. Large investments have also been made in research and capacity building from a wide range of donors. The outcome has been a relatively clear understanding of the issues affecting the basin and significant reductions in pollution inputs. In addition, a number of projects have also stopped floodplain and wetland destruction and helped restore some original riverbeds (Global Water Partnership 2008).

## Lessons Learned

The Black Sea and Danube River TDA-SAP process in IWRM has been a marked success in the Black Sea region, while in the Danube River Basin, less progress has been made. The recently released

DRBMP sets baseline data on surface-water pollution, hydrology and groundwater resources and qualitative goals for ecological status and surface and groundwater for the year 2015. It also provides appropriate economic instruments for achieving basin-level goals.

One of the challenges has been coordinating NGO activity, due in part to communication and transportation barriers, and a lack of public understanding of the issues and precedents of NGO activism. Inter-regional work in creating and sharing scientific knowledge strengthened multi-country institutions and processes, however, which in turn improved regional and transboundary convention and treaty implementation (Gerlak 2004). Although there has been exceptional cooperation between the GEF/UNDP and the European Commission, there is still a need to improve linkages among ministries, programs, and sectors (UNDP|GEF 2006). Within the ICPDR, environment and water agencies are well represented, although there is some concern that the agencies more directly aligned with programme funding and implementation of other relevant sectors, such as agriculture, are not. Strong inter-departmental coordination is required to inform and influence agencies, such as agriculture and regional development agencies, for effective implementation. In the absence of such strong inter-departmental coordination, translation of some of the ICPDR goals into national level actions is weak (Beckmann 2009).

ES approaches have yet to be formally integrated into the language of transboundary management governance in the DRB. On the other hand, there have been efforts to include pricing mechanisms to reflect the value of water as an ecosystem service. As stipulated in the WFD, the DRBMP includes the recovery of costs for water services by 2010. This entails putting a price on water and watershed services to include environmental costs. Beneficiary sectors, such as industry, households, and agriculture should make payments to recover the costs of water services when the plan is implemented (EC 2000).

WWF has been working with the EU to incorporate IWRM language into its funding goals with the aim of directing some spending towards developing integrative and ecosystem services approaches. It is also working at national and local levels to foster both bottom-up and top-down information flows about opportunities to introduce PES schemes (Beckmann 2009). In 2002, WWF introduced a PES project in the Danube Basin, but the project is still in the research phase (WWF n.d.) (Beckmann 2005). A WWF *One Europe, More Nature* (OEMN) pilot project in the Maramures region of Romania is operating on the ground. It is a PES approach introducing a new herd of cattle, the sale of organic meat produce and ecotourism (WWF n.d.)

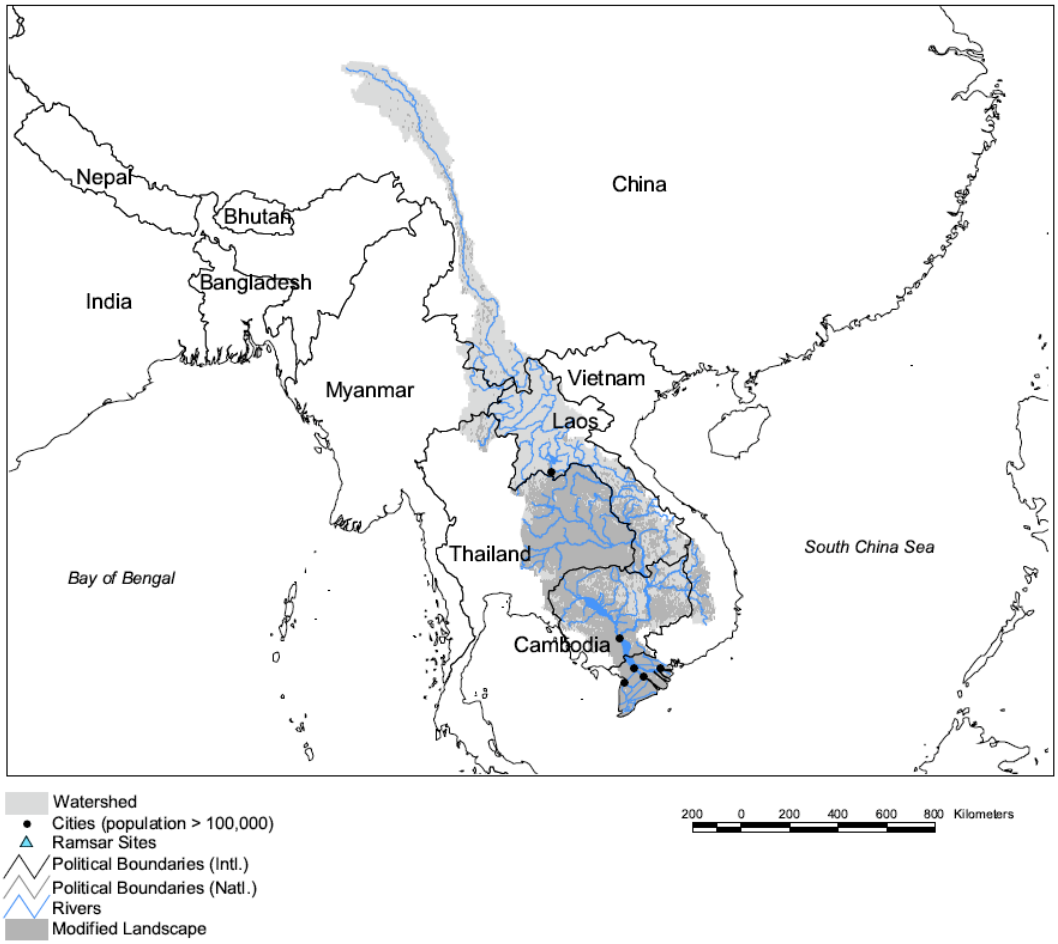
Natura, the European Union's central nature and biodiversity policy, is undertaking numerous initiatives aimed at ecosystem services restoration, biodiversity conservation, and wetland conservation and restoration in particular (Sandu and Kutzenberger 2009) (EC 2008). Non-EU countries in the Danube River Basin are not influenced by the WFD and Natura policies related to ES, however, which means this approach will not be implemented basin-wide.

In sum, the DRB has strong cooperative policies and legal instruments related to IWRM and has made large financial investments in research and capacity building. The development of the recent DRBMP is a significant step towards formalizing goals and actions for basin-level management. The political challenge remains the integration of non-EU countries into the Water Framework Directive's IWRM and ES approaches. Ecosystem management in the DRB has been promoted by agencies such as the WWF, which provides technical capacity and impetus to develop PES projects, as well as by GEF activities that created and shared scientific knowledge related to IWRM among regions. Donor and development agencies provide a range of capacity and funding support to this complex, multi-sectoral and multi-jurisdictional basin. One of the remaining challenges is to strengthen institutional linkages among programs and sectors, for example between the government agencies represented in the ICPDR and those not represented but that are responsible for important aspects of national and

regional funding, prioritization, and programming. Another challenge is to overcome barriers to coordinating NGO activity and stakeholder participation in IWRM decision-making. Stricter implementation of EU directives on water, of existing regulations on nutrients, as well as on the implementation of the Common Agriculture Policy would assist in achieving IWRM goals.

# The Mekong River Basin

**Figure 6: The Mekong Transboundary Watershed**




Source: (Revenga, et al. 1998, 2-92)

## Ecosystem Services (ES) and Drivers of Change

A number of important drivers of change and their current and future impacts on ecosystem services affect the Mekong River Basin (MRB). China is building a series of dams on the Upper Mekong with a total expected capacity of about 15,000 MW. The Manwan, Dachaoshan, and Jinhong dams have been completed and the Xiaowan and Gonguoqiao dams are being built (MRC 2010). The development's proponents claim it will help downstream flooding and drought problems, but the changes will also disrupt natural seasonal floods that support ecosystems and livelihoods (Mehtonen, Keskinen and Varis 2008). China, Thailand, Laos, and Myanmar initiated a project in the Upper Mekong, including the removal of several rapids and reefs to allow the navigation of larger cargo ships. It has been criticized for not addressing the potential impacts on fisheries, however, and has been put on hold (Mehtonen, Keskinen and Varis 2008). Lao PDR has built or is planning a number of dams on its tributaries and Vietnam has also built a dam and is building a second large dam on a Mekong tributary. Cambodia, Lao PDR, and Thailand are planning 11 mainstream dams on the Lower Mekong River for which the Mekong River Commission (MRC) is preparing a strategic environmental assessment (ICEM 2009).

**Table 9. Mekong River Basin**

| | |
|---|---|
| **Location** | Asia |
| **Area** | 795,000 $km^2$ |
| **Length** | 4,800 km |
| **Riparian nations** | China, Myanmar, Thailand, Laos, Cambodia, and Vietnam |
| **Population** | 70 million |
| **Geographical regions** | • Northern region: China and Myanmar<br>• Uplands: Lower Mekong Basin and tributaries issuing from Laos's uplands Thailand's Nam Mae Kak and Sesan, Srepok, and Sekong (3S) watersheds<br>• Golden Triangle (confluence of the Mekong and the Ruak rivers)<br>• Lower basin and Delta |
| **Characteristics** | • High per-capita water availability in the basin<br>• High seasonable variability in flow and height<br>• Predictable annual floods that increase river flows almost thirty-fold<br>• Uplands contribute 65% of total water flow<br>• Originates in Himalayas at 5,000 m |
| **Major Ecosystems** | • Himalayan mountains<br>• Siphandone (4,000 islands; wetland area in Lao PDR)<br>• Lower Songkhram River floodplains in Thailand<br>• Tonle Sap Great Lake (vast inland wetland in Cambodia, and Southeast Asia's largest lake)<br>• Delta (River of Nine Dragons) |
| **Climate** | • Seasonal monsoon rains<br>• Average annual precipitation varies from 1,000 mm to 3,000 mm depending on the region |

Sources: (Mehtonen, Keskinen and Varis 2008) (Varis, Rahaman and Stucki 2008) (Le-Huu and Nguyen-Duc 2003) (Brühl and Waters 2009) (Osborne 2000) (Fox and Sneddon 2007) (Phillips, et al. 2006) (MRC, State of the Basin Report 2003)

The Tonle Sap Great Lake ecosystem downstream (Box 3) is especially sensitive to the cumulative impact of these dams and since they will retain water in the wet season to release it in the dry season and when demand peaks, it will impose "an entirely different flow regime than the natural one to which people and species have adapted" (Fox and Sneddon 2007). Other potentially damaging effects of the mainstream dams in China and those planned in Lao PDR and Cambodia include the trapping of nutrient-rich sediments behind the dams—potentially affecting ecosystem productivity in the Delta and the blockage of fish migration routes essential for sustaining natural fish productivity and biodiversity, including large fish and mammal species like the Giant Catfish and the Irrawaddy Dolphin (MRC 2010).

### Box 3. Tonle Sap Lake and Ecosystem

The Tonle Sap Great Lake's extent fluctuates between 2,700 $km^2$ and 16,000 $km^2$ and its height from just over 1m to as much as 9m (Osborne 2000). This seasonal flooding provides a variety of ES such as maintaining a rich biodiversity of wildlife, including globally threatened species; supporting the Lower Mekong's fishery; flushing away pollutants; recharging wetlands; depositing sediments that sustain flood-recession agriculture; and providing raw construction materials (Brühl and Waters 2009) (Fox and Sneddon 2007). Fish in the Tonle Sap Great Lake contribute more than 60% of the Cambodian people's protein consumption (Osborne 2000).

The Mekong River. © Jjayo/Dreamstime.com

Fish catches have declined significantly and possibly irrevocably where tributaries have been dammed. In the Mekong Delta, harvests are affected by pollution and increased drawing of river water for irrigation and aquaculture and growing problems of salinization as the South China Sea's tides reach further up the Delta. There are also signs of overfishing in the Tonle Sap Great Lake with a reduction in catches of carnivorous fish and dominance of smaller species (MRC 2010). In Thailand, fish catches in the Mun River above and below the Pak Mun Dam have declined by as much as 70%. This is apparently the case downstream of the Theun Hinboun dam as well (Osborne 2000).

## Basin Management

In 1957, Cambodia, Laos, Thailand, and South Vietnam established the Mekong Committee (MC) (Mehtonen, Keskinen and Varis 2008). The MC created hydrological and meteorological stations, aerial mapping, surveying, levelling programs, and improved navigation. The increased integration of these countries also helped to dispel political suspicion among them (Wolf and Newton 2008). In the 1990s, the MC entered a second phase in transboundary water cooperation that focused on both hydropower development and irrigation projects (Wolf and Newton 2008) (Ma, et al. 2008). With political stabilization, cooperation among the riparian countries entered a third phase when the Mekong River Commission (MRC) was established in 1995 among the countries in the Lower Mekong Basin (without China and Myanmar). It marked a new focus on sustainable and comprehensive river management. Its vision is for "an economically prosperous, socially just and environmentally sound" Mekong River Basin and its orientation is towards implementing strategic plans, collecting scientific information, and providing policy advice (Mehtonen, Keskinen and Varis 2008).

The Basin Development Plan (BDP) is the MRC's key, long-term planning instrument. Effectively an IWRM plan, the BDP Phase I was developed from 2001 to 2006 with participation from stakeholders in each country, organized by the National Mekong Committees (Brühl and Waters 2009). Phase II

from 2006-2010 is developing an IWRM-based Basin Development Strategy with extensive stakeholder participation (MRC 2010). It has facilitated many transboundary water management activities in the Lower Mekong Basin, including reporting and mapping, monitoring, species protection, fisheries co-management, training, and information exchanges (Varis, Rahaman and Stucki 2008) (Mehtonen, Keskinen and Varis 2008). In 2008, work related to the BDP included oversight of a participatory process to develop a 'Stakeholder Participation and Communication Plan for Basin Development Planning in the Lower Mekong Basin' (SPCP). It will be used to guide meaningful participation in implementing the MRC's planning process (Brühl and Waters 2009). One of the BDP's major challenges is to build a sustainable planning process with strong connections between the MRC and national planning processes and implementation agencies pivotal to establishing an integrated procedure linking all planning levels in the basin. While the absence of China and Myanmar as official members is a challenge, there is a current movement towards closer cooperation with both countries, mainly related to data exchange.

In addition to the MRC, IWRM governance includes many international and regional conventions, treaties, protocols, and declarations respecting water and land management and at least 40 regional or international organizations, including UN agencies, NGOs, and universities. Partnerships among them are important, especially with the Association of South East Asian Nations (ASEAN), the Asia Development Bank's Great Mekong Subregional Economic Cooperation Programme, and the World Bank-ADB Mekong Water Resources Assistance Strategy (MWRAS) (Brühl and Waters 2009, CBFP 2006).

Established in 1996, the ASEAN Mekong Basin Development Cooperation (MBDC) initiative is a sub-regional arrangement under the ASEAN. It aims to "enhance economically sound and sustainable development of the Mekong basin" (Mehtonen, Keskinen and Varis 2008). The ASEAN Working Group on Water Resources Management defined a vision for water in Southeast Asia by 2025 as: "The attainment of sustainability of water resources to ensure sufficient water quantity of acceptable quality to meet the needs of the people of Southeast Asia in terms of health, food security, economy and environment"; it forms the basis for the proposed MOU between MRC and the ASEAN Secretariat.

The MRC collaborates with the ADB and the World Bank in the Mekong Water Resources Assistance Strategy (MWRAS), which focuses on transboundary regions of the Mekong Basin where water infrastructure development projects are likely to have an impact. This strategy has been transformed into action through the Mekong IWRM project. Supported by the World Bank, ADB, the Australian Government's overseas aid programme (AusAID) and other donors, it includes national, Transboundary, and regional components all focused on increasing regional IWRM capacity and cooperation.

There is evidence of ecosystem-based economic valuation approaches in the State of the Basin Report (MRC 2010), where the total economic value of wetlands includes direct-use values, such as agricultural production and fisheries; indirect-use values, such as flood mitigation and climate regulation; option values, such as future patents and future leisure and tourism; and non-use values such as cultural significance and biodiversity. Other evidence of emerging ecosystem-based thinking is seen in reports on the impacts of climate change on basin ecosystems (MRC 2010).

## Lessons Learned

The MRC has achieved much in strengthening ties and cooperation in water matters among the riparian countries (Phillips, et al. 2006). Nevertheless, there remain a number of challenges to effective and comprehensive IWRM. One of the most significant is an insufficient recognition and concern for the links between development and impacts that affect downstream ecosystems and

economies. For example, although the MRC member countries have signed on to IWRM, do not take impacts on downstream nations into consideration. An ecosystem approach to development in the whole watershed would enhance a range of ecosystem services, including managing the flow of annual floods as well as managing nutrients, sediment, energy, fish, and other aquatic species. The current focus on the Mekong mainstem and transboundary tributaries (such as the 3S Rivers—Sesan, Srepok, and Sekong) is being discussed using an approach that defines 'significant tributaries' by considering basin-wide and transboundary aspects.

Some elements of an integrated ecosystem management approach and the widespread use of ES based management are included in the MRC State of the Basin report (MRC 2010). While there is increased understanding and use of wetland-based goods and services and their total economic value, there is also a need to understand and value the links among the MRB's forested upland areas (where precipitation contributes 65% of the Mekong River's total water flow), and seasonal flooding that supports fishing and flooded agriculture, navigation, hydropower, and irrigation. An ES approach would value the importance of the Tonle Sap ecosystem, which produces food and sustains the livelihoods of millions of mostly poor people in the Mekong watershed (Fox and Sneddon 2007).

The MRC's 2009 'Stakeholder Participation and Communication Plan' (SPCP) was developed in a participatory manner and aims to improve stakeholder involvement in MRC deliberations (MRC 2009). Although the MRC has included a range of stakeholders in its consultation and training processes, its orientation towards harnessing the economic potential of the Mekong river has raised concerns about the likelihood that all stakeholders, especially non-state actors, will be consulted (Mehtonen, Keskinen and Varis 2008). The rights of sub-national and transnational NGOs that oppose transboundary dam building are often not recognized (Fox and Sneddon 2007). There is also a concern that the poor, whose livelihoods depend on ecosystem vitality, are not likely to have much say in such projects (Phillips, et al. 2006).

From a transboundary management perspective, official commitment from all riparian nations will enable a more effective management process. Currently, water allocation principles in the MRC agreement are based on the water's historical flows before dams were built in the upper reaches; changes in flows could undermine cooperation (Phillips, et al. 2006). Also, there is little cooperation among different governmental levels; political instability in some areas; pervasive notions of national sovereignty, which trump multi-lateral efforts at cooperation (a reluctance to favour the MRC over national interests, for example); persistent centralized decision making; weak domestic implementation of MRC policies by co-riparians; and the many different jurisdictions and their significant economic and political differences. Institutionally, water and natural resource authorities have relatively weak capacities; and financially, the MRC is funded predominantly by donors (Mehtonen, Keskinen and Varis 2008) (Varis, Rahaman and Stucki 2008).

Finally, in terms of the risk of conflicts arising over shared water resources, there are two potential threats: if development in the upper reaches causes drastic flow-regime changes, domestic tensions could rise in response to local water scarcity; and inter-State rivalry may occur in the event of sub-optimal regional development (Phillips, et al. 2006). Implementing IWRM and PES schemes that would allow a form of benefit sharing that all parties find acceptable could help to address these issues.

# The Jordan River Basin

**Figure 7: The Jordan Transboundary Watershed**


Source: UNEP/DEWA/GRID~Europe

## Ecosystem Services (ES) and Drivers of Change

The most critical ES in the Jordan River Basin (JRB) are related to water supply. Problems of water scarcity and competition for the resource means the needs of ecosystems and their services are often overlooked (FoEME n.d.). Water availability depends on the integrity of the entire hydrological cycle and the water regime and "These benefits are … directly linked to downstream economies and livelihoods" (Al-Jayyousi and Bergkamp 2008).

**Table 10. The Jordan River Basin**

| | |
|---|---|
| **Location** | At the junction of Asia, Africa, and Europe, in the Great Rift Valley |
| **Area** | 18,000 $km^2$ |
| **Length** | >200 km |
| **Riparian nations** | Syria, Israel, Jordan, Lebanon, and Palestine |
| **Population** | 32.8 million (2000) |
| **Geographical regions** | • The Jordan valley depression of Al Ghor, at 200-400 m below sea level<br>• The highlands, which cross the region from north to south and rise to over 1,000 m above sea level |
| **Characteristics** | • Starts from the foothills of the Herman Ranges, meanders from the Sea of Galilee (Lake Tiberias or Lake Kinneret)[3] to the Dead Sea<br>• World's lowest river<br>• Dead Sea is world's saltiest large water body<br>• Biodiversity hotspot<br>• Rainfall and water storage in the north; agricultural areas in the centre<br>• Demand greatest in the summer but most rainfall in winter |
| **Major Ecosystems** | • Dead Sea (mineral waters)<br>• Azraq Oasis (Ramsar wetland)<br>• Sea of Galilee<br>• Saline subterranean springs<br>• Mountain aquifer |
| **Climate** | • Annual average precipitation: 50 mm to almost 1,000 mm<br>• Headwaters average annual precipitation: 400-800 mm<br>• Dead Sea average annual precipitation: <200 mm |

Sources: (Hudes 1997-1998) (FoEME n.d.) (Suleiman 2003) (GLOWA n.d.) (Rosenthal 2009) (Phillips, et al. 2006) (Mimi and Sawalhi 2003)

Israel, Jordan, and Syria divert at least 90% of the Jordan River Basin's fresh water for domestic and agricultural use. During the last half of the 1990s, the lower river's annual flow declined from more than 1.3 billion $m^3$ per year to less than 100 million $m^3$. All three countries have built dams and pumping stations on the Lower Jordan's tributaries and large amounts of untreated sewage and saline spring waters are discharged into the river (FoEME n.d.). Aquifers are also being drawn down and polluted. There are three related water problems in the Jordan River Basin: supply and demand; deteriorating water quality; and the equitable sharing of the resource (Lonergan and Brooks 1995). For example, recent data from Friends of the Earth Middle East (FoEME) show that the historic flow of the Lower Jordan River has been reduced from 1.3 billion $m^3$ to an estimated 20-30 million $m^3$ (Gafny, et al. 2010).

Despite improvements in infrastructure, efficiency, and water recycling, demand has exceeded water supplies since the mid-1970s to satisfy the needs of natural population growth, immigration (including refugees into Jordan), and rising living standards (GLOWA n.d.). In the future, climate change is likely to exacerbate water shortages (Rosenthal 2009). It is expected that future total water use will rise from just over 3,000 million $m^3$ in 1990 to over 4,000 million $m^3$ by 2010 (EXACT 1998).

[3] For the sake of consistency, in the case of Lake Tiberias/Lake Kinneret/Sea of Galilee, the report uses 'Sea of Galilee'.

Agriculture-focussed land use in the Western Galilee Region of Israel showing settlement patterns, cropping and water storage. © Bryan Oborne

The amount of water available per person per capita is one of the lowest in the world (GLOWA n.d.). Palestine's per capita freshwater availability is only 70 $m^3$/year and Jordan's is 160 $m^3$/year (Phillips, et al. 2006). Another measure of water availability is 'annual safe yield', which refers to the average volume of water a region can use without damaging its hydrological integrity. This indicator is 1.9 billion $m^3$ for the whole territory west of the Jordan River, of which 0.9 billion $m^3$ is safe yield for the Kingdom of Jordan, and only 80 million $m^3$ is safe yield for the West Bank. (Rosenthal 2009). In the West Bank, the Palestinian Water Authority estimates total needs to be around 120 million $m^3$. This means that the amount of water needed to fill the water gap is about 40 million $m^3$. Unlike Israel, Jordan, and Palestine, Syria and Lebanon do not rely on the shared waters of the Jordan Basin as their primary source of water resources (Rosenthal 2009).

Economic sectors also compete for water within the riparian nations, especially given the subsidies each one provides to their agricultural sectors (Phillips, et al. 2006). Dams, reservoirs, and pipelines draw water from the JRB's surface and groundwater for domestic and agricultural uses. Irrigation for highly subsidized agriculture uses about two-thirds of this water (GLOWA n.d.). One of the results has been reduced flows into the Dead Sea, which has contracted by 30% since the mid-1980s (FoEME n.d.); its rate of evaporation is estimated to be between 1.05 and 2.0 m/yr (Al-Khlaifat 2008). The environment has also deteriorated due to mineral extraction and solar evaporation industries. The impacts include dehydrated micro-ecosystems, sink holes, and a compromised landscape, which threatens future tourism (MELIA 2003) (FoEME n.d.).

Saline subterranean springs make the Jordan River naturally salty, with salinity increasing as it flows south until it reaches the Dead Sea, which is much more salty than the ocean. Israel's extraction of

surface waters to feed into the National Water Carrier, Jordan's to feed the East Ghor Canal and Syrian dams on the Yarmuk have exacerbated this natural salinity. The river's water quality is also deteriorating due to industrial, municipal, and agricultural waste effluents. Untreated sewage from Israel, Jordan, and Palestine dramatically affect water quality downstream of the Alumot dam approximately 1.5 km downstream of the Sea of Galilee. New wastewater treatment plants being built in Israel and Jordan and expected to become operational in 2011 will remove the sewage and saline waters currently discharged into the lower Jordan River so waters can be withdrawn for treatment and agriculture (Gafny, et al. 2010).

## Basin Management

Managing the JRB's transboundary water resources (and related ES) can be a source of conflict among the already contentious riparian countries, since water is fundamentally related to the controversial issues of land tenure, refugees, and sovereignty (Wolf and Newton 2008). The region's history includes negotiations about how to share water. Until 1991 and the beginning of recent Arab-Israeli peace negotiations, political problems and water issues had been addressed separately. Water negotiations and agreements included the mid-1950s Johnston negotiations; attempts in the late-1960s at 'water-for-peace' through nuclear desalination; discussions about the Yarmuk River in the 1970s and 1980s; and the 1991 Global Water Summit Initiative. Because they were negotiated separately from political talks, none was completely successful (Wolf and Newton 2008). At the same time, since 1955 most water- resource developments were undertaken unilaterally and at the expense of other nations. Since then, groundwater has become another issue of importance (Lonergan and Brooks 1995).

In 1994, agreements about freshwater and desalinated water allocations and allowances for the building of regulating and storage dams were written into the Jordanian-Israeli Peace Treaty, while over the years, there have been other bilateral arrangements governing water use between Israel and Palestine (FAO 2008). This 1994 Treaty as well as the OSLO II Interim Agreement between Palestine and Israel contain the concept of mutualism on specific water sharing schemes and the establishment of the Joint Water Commission (JWC) (Al-Jayyousi and Bergkamp 2008). The JWC would manage shared water, operate joint water-quality monitoring stations, and alleviate water shortages (OSU n.d.). In addition, in 1995, a Water Commission was set up to coordinate agreements on water and sewerage between Israel and Palestine (Al-Jayyousi and Bergkamp 2008).

Building on the work of the two commissions, Jordan, Palestine, and Israel signed a common Declaration of Principles for Joint Development of Water Resources in the Jordan-Yarmouk Basin. This treaty focuses on jointly developing new water resources in the basins and calls for full coordination among water institutions on water law issues among the three parties (Al-Jayyousi and Bergkamp 2008). While this agreement "helped to create a sense of trust and contributed to confidence-building measures between the two sides (Israel and Palestine), political realities on the ground prohibit further cooperation …" (Al-Jayyousi and Bergkamp 2008).

In 2005, Jordan, Israel, and the Palestinian Authority agreed to investigate the potential for a 110-mile canal between the Red Sea and the Dead Sea that would pump up to 850 million $m^3$ of seawater from the Gulf of Aqaba about 177 km south of the Dead Sea and generate hydroelectricity for desalination. Amidst widespread controversy and after repeated calls for a study of alternatives, the World Bank finally agreed to incorporate such a study into its feasibility study and social and environmental impact assessment. However, the commissioning of this study lacks adequate transparency and controversy lingers over a plan announced in 2009 for a pilot project to commence before the feasibility study is completed in 2011 (Allbritton 2007) (IRIN 2009) (Friends of the Earth Middle East n.d.).

The Banias Waterfall emerging from the foot of Mount Hermon—one of the main contributing sources of the Upper Jordan. © Bryan Oborne

Although there is no overarching and unified IWRM plan in the Jordan River Basin and there has been little cooperation among the riparian nations, except at bi-lateral levels (Phillips, et al. 2006), there are presently a number of organizations that are implicitly using various IWRM criteria to foster cooperative and sustainable water management in the region. GLOWA (Global Change and the Hydrological Cycle) Jordan River is a multilateral interdisciplinary research consortium addressing the vulnerability of water resources in the JRB, especially in light of climate change. It takes an integrated approach to providing scientific support for sustainable and cooperative management practices. It focuses on both conventional and non-conventional water management methods related to agriculture, wastewater treatment, and reservoir practices, among others, and their ecological and socio-economic implications (GLOWA n.d.).

Green Cross International's Water for Peace programme implemented a number of workshops and focus groups towards education and awareness involving the full spectrum of stakeholders in Jordan, Palestine, and Israel to strengthen the dialogue among the riparians. It completed a joint water resources database for Syria, Palestine, and Jordan, among other accomplishments (MELIA 2003), but the project has been inactive in the last few years.

Friends of the Earth Middle East (FoEME) brings together Jordanian, Palestinian, and Israeli environmentalists to promote cooperation in protecting the transboundary environment, especially water resources, in the JRB region, and advance both sustainable regional development and conditions for lasting peace. Its Good Water Neighbours (GWN) project currently operates in 25 cross-border communities to develop dialogue and cooperation on sustainable water management;

cooperative ventures include the installation of water-saving devices in public buildings and schools that cut water use by a third. It also fostered the creation of a network of Mayors and several Memoranda of Understanding promoting cooperative solutions to environmental problems. Action plans have been developed to restore the river's ecology and promote ecotourism, cultural activities, and sustainable agriculture, including the diversification of crops and trees that use less water (FoEME n.d.). In 2010, FoEME published two complementary studies: an environmental flow study to identify the current state of the river and establish a regional rehabilitation strategy (Gafny, et al. 2010), and an economic analysis of opportunities to return fresh water resources to the basin from the water economies of Israel and Jordan (EcoPeace/Friends of the Earth Middle East 2010). Both of these studies were undertaken by teams of experts from Palestine, Jordan, and Israel and support the establishment of a formal body to manage the transboundary basin.

FoEME also established the first Regional Advisory Committee, the only forum currently focussed on the Lower Jordan River, bringing together expert stakeholders and government representatives from Israel, Palestine, and Jordan. The forum is an important medium for the region's experts to exchange information and discuss scenarios for the river's rehabilitation (Gafny, et al. 2010). FoEME's expert studies, with input from the Regional Advisory Committee, concluded that that 400-600 million $m^3$ of water are needed to rehabilitate the Lower Jordan River and it prescribed specific allocations for Israel, Syria, and Jordan to meet this rehabilitation goal.

The Economic Analysis of Policy Options for Water Conservation in Jordan, Israel, and Palestine concludes with specific amounts of water that can be saved/produced in the respective countries at less than the marginal cost of water. In all, nearly a billion cubic meters of water can be saved in the region—part of the water from Israel and Jordan can be used to meet the rehabilitation goal for the Lower Jordan River and to restore Palestinian water rights.

Lake Agmon, a partially restored/engineered wetland in the Hula Valley of Northern Israel. © Bryan Oborne

Implementing this strategy is increasingly urgent to restore the river and its basin's ecological integrity. Without concrete action, the Lower Jordan River (LJR) is expected to run dry by the end of 2011. While the removal of serious sewage and saline pollutants by new wastewater treatment centres after years of advocacy efforts is an achievement, if this progress is not coupled with the allocation of fresh water resources, the LJR will run dry. These recent developments make a coordinated regional effort to return fresh water resources to the LJR ever more critical.

In early 2010, the Israeli Ministry of Environment released the Terms of Reference (ToR) for their proposal to rehabilitate the LJR from the Sea of Galilee to Bezeq Stream (the border with the Palestinian West Bank). The Israeli side presented the ToR to Jordanian and Palestinian stakeholders for comments during FoEME's February 2010 Regional Advisory Committee. Jordan and Palestine have expressed interest in developing their own plans for their respective sections of the Lower Jordan River (FOEME 2010).

## Lessons Learned

Although there is no unified plan for the basin and there have been many cases of inequitable water sharing among Israel, Palestine, Jordan, Syria, and Lebanon, water is an issue around which Arabs and Israelis have made genuine efforts to cooperate and there have been many water-allocation schemes and other plans that attempt to divide water use and develop water projects fairly (Rosenthal 2009) (FoEME n.d.). IWRM, however, has not been an active part of the many political arrangements to ease conflict over water among the countries that share the JRB.

In a politically insecure climate, there is a need for an overarching water-management plan, equitable water sharing, and on-going competition for available water among the riparian nations and between economic sectors to avoid potential conflict over shared water resources. In fact, security issues so heavily influence the potential for cooperation that it is unlikely that the co-riparians can entertain benefit-sharing as a solution. Rather, it has been proposed that the most promising international strategy to sharing the resource would involve allocating fair water volumes and establishing a joint management agency to monitor the hydrology, abstraction rates, and other technical issues. A basin-wide agreement on equitable water use must be consistent with the region's insecure political reality; such an agreement would help to defuse potential conflict (Phillips, et al. 2006).

At the institutional level, there is an opportunity to overcome the lack of linkages among the ministries related to water and other natural resources so that collaboration in IWRM can be effectively introduced (Al-Jayyousi and Bergkamp 2008). In terms of the technical approaches to water management, projects devised by NGOs and the scientific consortium GLOWA and carried out at the grassroots have been successful in integrating water management methods. They have also integrated the full range of stakeholder perspectives into their water management plans and actions.

Maintaining the functioning of ecosystem services dependent on water has been ignored by the formal efforts to share water in the JRB. The introduction of an ecosystem approach that would foster innovations and identify existing local rights-based approaches to reduce water use in agriculture and through land-use modification could help to enhance ecosystem services for local livelihoods throughout the Jordan Basin. Given the rising demand for water and the potential impacts of climate change, it is increasingly important to create economic incentives to protect and restore water availability and quality in the JRB, in addition to planning on how to share the resource among the riparian countries. The value of ecosystem services needs to be incorporated in water planning and decision making (Al-Jayyousi and Bergkamp 2008).

# Case Study Synthesis and Lessons Learned

The lessons from these seven watershed case studies are diverse, yet there is some resonance among them in the challenges faced at this complex transboundary level. This section synthesizes some common elements from this case study research and provides some high-level recommendations that would advance IWRM and the use of PES in transboundary watersheds.

## Case Study Synthesis

### IWRM Integration and Implementation

This research on IWRM planning and implementation in transboundary case studies demonstrate the successes and challenges in applying such an integrated approach at the international level. The case studies demonstrate that while IWRM planning and implementation is generally stated as a priority at national and transboundary levels, IWRM implementation remains weak and marginalized from mainstream governance and resources. As a result, none of these case studies demonstrated an advanced level of IWRM implementation.

For example, in the Congo Basin, it was only in 2007 that the International Commission of the Congo-Oubangui-Sangha Basin (CICOS) added IWRM to its mandate, which had previously focused almost exclusively on inland navigation. In addition, IWRM is still under development in CICOS's Strategic Action Plan and to date there is a clear lack of IWRM tools in the region. Similarly, sustainability goals have only recently been included in bi- and multi-lateral water treaties in La Plata River Basin; such treaties previously focused on hydroelectricity development and there is no explicit mention of IWRM. In the Jordan River Basin, there is no unified plan for water management and IWRM goals in treaties related to water are absent. On the other hand, NGOs and multilateral projects in the region have incorporated such criteria on the ground. The Permanent Okavango River Basin Water Commission (OKACOM) is dedicated to IWRM in the Okavango Basin, but implementation is pending since its integrated basin flow assessment will only be completed in 2010.

On the other hand, there is evidence of incipient efforts among some transboundary basins to incorporate IWRM into cooperative arrangements or to act on implementing IWRM, regardless of formal obligations. Although a lack of basin-wide commitment to the MRC and its processes constitutes a significant challenge to IWRM efforts in the Mekong River Basin, the 1995 Basin Development Plan (BDP) is in effect an IWRM plan and the 2002 ASEAN working group is specifically devoted to IWRM. There is evidence that the BDP for IWRM will be implemented in the Lower Basin at sub-basin, national, and basin-wide levels. In North America's Red River Basin, there is a basin-wide approach to Integrated Natural Resources Management (INRM), with regional entities responsible for acting on plans, although progress is slow. More progress is being made in integrating IWRM into governance and implementing it on the ground in the Danube River Basin: the first priority of the International Commission for the Protection of the Danube River (ICPDR) is to implement the European Water Framework Directive (WFD) using the recently released DRBMP as guidance for goals and processes. The Transboundary Diagnostic Analysis/Strategic Action Plan (TDA/SAP) process specifically promotes IWRM, and Global Environment Facility IWRM projects are being implemented.

In this assessment, the challenges to IWRM planning and implementation are organized into political, institutional, financial, and technical categories. Some of these challenges and the use of ecosystem management approaches and incentive mechanisms, such as PES, to overcome them, are highlighted below.

**Political challenges to IWRM:** Clear consensus on transboundary planning is not easy to achieve. While the case of the Danube Basin shows the value of political oversight and buy-in (through the European Water Framework Directive or WFD), political challenges remain due to the presence of non-EU countries in the basin that are not influenced by the European WFD and the Natura policies related to ES. Other cases such as the Mekong Basin and Jordan Basin show that the lack of political commitment from all riparian nations in the basin has clear repercussions for the integrated management of resources, with impacts on both ecosystems and people. In the Red River Basin, strong bilateral IWRM strategies and efforts to evaluate ES could help resolve disagreement over proposals for water transfers from one basin to another. La Plata Basin "is ripe for integrated water management based on political consensus. If the basin approach fails, national policies are incomplete and ineffective, because they are only able to face limited issues with limited plans" (Laborde 2008). This research determines that the political will to adhere to IWRM is based at least in part on the benefits nations perceive can be derived from the integrated management of river basins. This dynamic of benefits can be significantly altered to create political will through the identification and valuation of ES, and by creating payment structures to manage these services.

**Institutional challenges to IWRM:** While closely linked to political challenges, these are more closely associated with the institutions created to oversee the development and implementation of IWRM plans. An institution with a clear mandate and effective participation from member riparian nations (such as the ICPDR in the Danube Basin) shows more progress that those with less capacity and participation from all co-riparians. A key institutional challenge in the Okavango River Basin is OKACOM's strictly advisory role and its lack of a mandate to actively manage transboundary water resources. In some basins, a lack of formal commitment from some riparian nations has posed significant challenges to the realization of basin-wide development and management goals. In the La Plata basin, sectors appear to work in silos, so "the fresh approach for the La Plata basin consists of overcoming the present fragmentation in sectors, matters, countries, bilateral organizations and to build a fluent interaction between those factors. Adapting the existing institutional framework to new demands for cooperation between national and international entities would reflect the vitality of the system and its present usefulness" (Laborde 2008). Valuation and PES schemes would in part enable the resourcing of relevant institutional capacity for IWRM planning and implementation in transboundary basins.

**Financial challenges to IWRM:** Clearly the demand for financial resources is a barrier to effective IWRM, which is often poorly funded through the riparians in a shared transboundary basin. In the Congo Basin, for example, the funds already mobilized are insignificant compared to the actions needed to implement IWRM. A possible reason for this is that management costs in one area of the watershed may financially benefit another riparian (often downstream). A whole-basin cost-benefit understanding would potentially enable a basin-wide PES programme. A number of the cases studied here have accessed funds from international organizations, but a sustainable funding source would enhance the efficacy and sustainability of IWRM planning. Valuing and PES could provide a significant part of this funding and can be a means to demonstrate the value of a 'benefits sharing' system exemplified by an ecosystem approach.

**Technical challenges to IWRM:** IWRM planning and implementation is clearly a time-consuming, complex process and a lack of the necessary technical capacity needed to develop and use appropriate tools challenges its implementation. To effectively use ecosystem management approaches, knowledge and capacity are needed to identify and value ES, develop programs for PES, and to manage these better. Coordinating data collection and harmonizing and sharing data among multiple political jurisdictions remain a major challenge. The use of technical capacity provided by relevant NGOs and academic institutions (such as the WWF in the Danube Basin, NGOs in the Jordan River Basin, the University of Botswana in the Okavango River Basin, IISD in the Red River Basin, etc.)

are examples of such capacity inputs. Resources generated through PES programs in the basins could potentially fund these technical inputs.

**Use of Ecosystem Management Instruments in IWRM**

This analysis of the use of ecosystem management approaches in the transboundary IWRM processes revealed weak and under-developed application, with attempts at ecosystem services-based valuation done on a smaller scale in four of the seven selected cases (Danube, Red River, Okavango, and La Plata). The World Wildlife Fund (WWF) is researching PES opportunities in the Danube River Basin and there is a pilot project in operation in Romania under the 'One Europe, More Nature' initiative. In the Red River Basin, the Red River Basin Commission (RRBC) and the International Institute for Sustainable Development (IISD) initiated an ecological infrastructure approach that focuses on restoring and managing ES as a cost-effective alternative to built infrastructure. The approach is designed to allow numerous co-benefits, such as improving habitat and carbon sequestration, sustaining livelihoods, controlling nutrient flows into water bodies, and buffering the potential impacts of climate change. OKACOM in the Okavango River Basin has applied ecosystem-based principles in the integrated flow assessment, to be completed in 2010. In La Plata Basin, researchers have studied and put a value on the ecosystem services of a section of the Pantanal wetlands.

**Opportunities for Incorporating ES Methods into IWRM**

There are a number of opportunities for incorporating ES mechanisms to further IWRM planning and implementation in the selected transboundary watersheds. These opportunities include those that emerge or are enhanced in light of predicted impacts of climate change in these basins.

The case of the **Congo River Basin** truly provides the most compelling example of the absolute necessity of linking IWRM processes closely with ecosystem services management. The Congo Basin's forests are responsible for creating 75-95% of the region's rainfall through evaporation and evapotranspiration, and it is crucial that IWRM in the basin recognize and place a value on the need to protect the region's forests and their ecosystem services. Regional organizations and projects are aware of the value of carbon sequestered in the region's forests and there are some plans to eventually introduce a carbon market that would provide economic incentives to maintain forests intact, which in turn would help to protect the Congo Basin's Water Towers. Links between the forest's capacity to generate rainfall, the serious problem of deforestation in the Congo, and the significant decline in river discharges and consequent reduction in days of navigation have not been made in the action plans and projects. There is an opportunity for forest and water organizations to work together to protect ecosystem services and for markets to be set up to pay for those services.

Opposition to the Hydrovia project in **La Plata River Basin** highlights the links between the development of water works and the potential impacts on ecosystems and their services. The annual flooding pulse in the Pantanal wetland, for example, is critical for its socio-economic and ecological integrity and wetland loss or degradation due to development could raise the risk of downstream floods and droughts. An appreciation of the value of the ES provided not only by the waters themselves, but by the lands and vegetation in the watershed, would inform the need to protect them as a way to prevent ecological and socio-economic damage. Examples include protecting the Pantanal wetland and its role in providing priority ES, such as preventing floods, filtering water, and regulating the climate. In turn, these services help to maintain the viability of farming, fishing, and ecotourism activities in the region. It is likely that climate change will increase the frequency, duration, and intensity of extreme hydrologic events, perhaps reduce precipitation in the La Plata Basin and have significant impacts on agricultural and hydroelectricity production. ES processes

incorporated into a planned basin-wide response to climate change would potentially provide momentum for institutional and financial capacity for IWRM.

Okavango sunset. © Chaminda Rajapakse

In the **Mekong River Basin**, there is a need to understand and value the links among the Basin's forested upland areas (where precipitation contributes 65% of the Mekong River's total water flow), and seasonal flooding that supports fishing and flooded agriculture, navigation, hydropower, and irrigation. An ecosystem approach would value the importance of the Tonle Sap ecosystem, which produces food and sustains the livelihoods of millions of people in the Mekong watershed. (Fox and Sneddon 2007).

In the **Okavango basin**, OKACOM has initiated an integrated basin flow assessment that considers a climate change scenario. GLOWA, an interdisciplinary scientific project in the **Jordan River Basin**, addresses the vulnerability of its water resources, especially in light of climate change. In the **Danube River Basin**, the ES approach would be valuable in addressing the impacts of increasingly frequent floods, due largely to the effects of climate change, and the restoration of ecological infrastructure for mitigating and adapting to new conditions.

In the **Red River Basin**, climate change will disrupt the hydrologic cycle, with numerous impacts on flooding, water quality, and watershed processes, including the potential to increase the frequency and extent of algae blooms in Lake Winnipeg. ES processes in IWRM approaches would do well to include plans to mitigate and adapt to such potential impacts. The Intergovernmental Panel on Climate Change (Kundzewicz *et al*. 2007), argues that the vulnerability of freshwater systems to climate change is generally reduced through the application of IWRM principles, while the International Water Management Institute has recommended that agricultural watersheds [such as the Red River Basin] be managed for multiple ecosystem services (Molden 2007).

## Table 11. IWRM Implementation and Use of Ecosystem Management Approaches in Selected Transboundary River Basins

| | Congo | Okavango | Red | La Plata | Danube | Mekong | Jordan |
|---|---|---|---|---|---|---|---|
| **IWRM integration and implementation** | IWRM added to CICOS mandate in 2007, which previously focused on navigation. DRC has not yet ratified the addendum, but a Strategic Action Plan is being prepared nevertheless; Actions under this plan are not clear and there is lack of IWRM tools to date. Lake Tanganyika Authority (LTA) explicitly oriented to IWRM. Links between CICOS and LTA initiated. | OKACOM dedicated to sustainable management of transboundary water resources (IWRM) and is conducting integrated basin flow assessment that will assess "triple bottom line" impacts—to be completed in 2010. Stakeholder participation among all affected parties a key component of the Okavango Delta Management Plan (ODMP). | The IJC-IWI takes an integrated, ecosystem approach; the RRBC and framework plan explicitly take a basin-wide approach to IWRM. Regional entities are entrusted with putting plans into action—it is not clear how much has been achieved. RRBC focuses on integrating land and water issues, and both RRBC and RRBB involve a large range of stakeholders in a basin-wide approach. | Recent integration of sustainability goal in treaties, which had previously focused on hydroelectricity development; no explicit mention or implementation of IWRM. Impacts of Hydrovia and of agricultural development on Pantanal wetland not taken into account in basin planning. Incorporation of stakeholders in international CIC seen as a model for bi- and tri-lateral agreements. | ICPDR's first priority is to implement the WFD using IRBM as guiding approach. TDA-SAP process specifically promotes IWRM and GEF IWRM projects being implemented. The DRPC stipulates active public involvement. The WFD also strengthens cooperation but doesn't apply to non-EU countries. | A 1995 Basin Development Plan (BDP) is in effect an IWRM plan. 2002 ASEAN working group is specifically devoted to IWRM. Evidence that IWRM in Lower Mekong Basin will be implemented at sub-basin, national, and basin-wide levels through Mekong BDP. China and Myanmar not part of process. MRC not empowered to override national actions with negative ecosystem implications for neighbouring riparians or the basin as a whole. | There is no unified plan for water management in Basin. No IWRM goals in treaties nor actions taken; although no explicit mention is made of IWRM, NGOs and multilateral projects have incorporated such criteria on the ground. |
| **Use of ecosystem management approaches including the use of ecosystem services tools** | While any basin-wide ecosystem management approach is still needed, attempts have been made to link with forest organizations. Opportunities exist to establish carbon markets to protect forests as "Water Towers". | A special component on PES will be built in the SAP to reinforce the possible metho-dological options of a tri-country benefit sharing approach. A study on economic valuation of the Okavango Delta goods and services was included in the ODMP. | While a basin-wide ecosystem approach is still needed, RRBC has recently partnered with IISD to implement an ecosystem infrastructure project to take steps to protect and restore land-use configurations that provide ecosystem services. | Bi-lateral and tri-lateral agreements exist on the sharing and management of hydropower. A GEF-funded programme focuses on managing priority ecosystem services such as flood and drought mitigation. These may be the basis for a broader ecosystem-based management approach. | WWF researching PES opportunities and applying small scale PES methods within the basin. There is a pilot project in Romania under the 'One Europe, More Nature' Initiative. | The State of the Basin report (2010) includes ecosystem-based economic valuation for wetlands, agricultural production, fisheries, flood mitigation, climate regulation, future patents and future recreation, as well as cultural significance and biodiversity. | In 2010, FoEME published two relevant studies; an environmental flow study to identify the current state of the river and establish a regional rehabilitation strategy, and an economic analysis of opportunities to return fresh water resources to the basin from Israel and Jordan, |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Opportunities for use of ES as a tool for enhancing IWRM** | Forests in the Congo River Basin create 75-95% of the region's rainfall through evaporation and evapo-transpiration. Recognition of the linkages between forest protection and watershed-based ecosystem services provision is important for basin management. Economic incentives through ES valuation can finance and maintain the basin's 'Water Towers'. Linkages to international carbon markets on the basis of the forest's carbon sequestration potential is an important opportunity. | Opportunities exist at a number of levels to enhance the significant biodiversity and forest-based ecosystem services in the basin and Delta in light of the following: Okavango provides the only water flowing in Namibia; intra-basin population depends on water for livelihoods; extra-basin pressures from urban and tourism demands; new demands for municipal and industrial water, particularly in Namibia's central area; increasing demand from Botswana's mineral industry and growing urban centres on the Delta's fringe; important demand from tourism industry in the Delta. OKACOM has initiated an integrated basin flow assessment that considers a climate change scenario. | A whole-basin approach to manage water quality and quantity has significant potential in light of problems such as recurrent droughts, floods and nutrient overloading. ES valuation and markets can potentially mitigate climate change impacts and help adapt better to it. | Opposition to the Hydrovia project is highlighting the links between development of water works and negative impacts on downstream wetlands. Potential ecosystem services management include protecting the Pantanal wetland and its role in preventing floods, filtering water, and regulating the climate. In turn, these services help to maintain the viability of farming, fishing, and ecotourism activities in the region. (Tazik, Ioris and Collinsworth 2003) ES processes incorporated into a planned basin-wide response to climate change would potentially provide momentum for institutional and financial capacity for IWRM. | ES identified by the WWF include flood, erosion, and sedimentation control, water quality, maintenance of aquatic habitats and dry-season flows, forest and biodiversity conservation, carbon sequestration, and the protection of landscape beauty. Recognition of the value of an ES approach to address climate change impacts of increasingly frequent floods, and the restoration of ecological infrastructure for mitigating and adapting to new conditions. | Although the forested upland areas in the Basin receive high rainfall and contribute 65% of the Mekong River's total water flow, there is no evidence of links to protecting the 'Water Towers' that ensure continued precipitation that provides water for seasonal flooding, navigation, hydropower, and irrigation. In addition, development in upstream areas potentially has an impact on the Mekong's natural seasonal flooding and could threaten the health of the Tonle Sap wetlands and the food and livelihoods it provides. | "New approaches are required to revitalize basin management that create an innovation dynamics around water allocations in the Jordan Basin. A way forward is the development and implementation of an ecosystem approach to water management for the Jordan Basin" (Al-Jayyousi and Bergkamp 2008). |

## Conclusions: Ecosystem Management for Effective IWRM

In 2005, the Millennium Ecosystem Assessment (MA) made a strong case for using an ecosystem services approach for effective IWRM. It provided two major insights in this regard. Firstly, the MA stated that a future scenario consistent with improved ES provision is one in which "regional watershed-scale ecosystems are the focus of political and economic activity" (Millennium Ecosystem Assessment 2005). Local institutions are strengthened and local ecosystem management strategies are common; societies develop a strongly proactive approach to managing ecosystems consistent with principles of Integrated Water Resource Management.

The MA's second major insight is the need to greatly increase the use of economic instruments based on ES that mitigate or reverse serious ecosystem degradation, such as payments to landowners in return for managing their lands in ways that protect ecosystem services that are of value to society, such as water quality and carbon storage; and market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way. The MA notes that payments for water conservation can increase water availability but cautions that payments for watershed-based services that are narrowly focused on the role of forests in the hydrological regime should be developed in the context of the entire flow regime, including land cover, land use, and management practices.

Effective transboundary water management can enhance a range of ecosystem services globally and provide much needed management action in transboundary watersheds with high biodiversity value (such as the Congo, Okavango, Mekong, La Plata, and Danube basins). This requires that watershed managers, policymakers, and the international community **better understand, communicate, and disseminate the use of ES mechanisms for effective basin management (i.e., IWRM) and the realization of multiple benefits (including climate change adaptation, building resilience in basin riparian nations, and peacebuilding and conflict resolution)**.

A recent study (Qaddumi 2008) makes a compelling case for 'benefit-sharing' and clarifies that a river basin is a common-pool resource in that use of it by one riparian will necessarily diminish the benefits available to others. In other words, water use in one part of the basin creates external effects in other parts. This argument can be extended to most goods and services provided by watersheds, including water flow, water quality, and the ability to mitigate floods and droughts. If these externalities are not internalized, the overall benefits are reduced and the outcome is suboptimal. Both hydrology and economic arguments concur that a river basin should be treated as a single unit, be used to maintain the physical integrity of the system, and that externalities should be internalized.

If the focus is switched from physical volumes of water to the various values derived from water use—in multiple spheres, including economic, social, political, and environmental—riparian nations will correctly view the problem as one of positive-sum outcomes associated with optimizing benefits rather than the zero-sum outcomes associated with dividing water (Qaddumi 2008).

While the literature does not contain many precedents for ecosystem-based benefit sharing based on a common acceptance of their values, the precedent does exist for sharing specific benefits from a transboundary basin through international negotiations. Most of these cases focus on dam construction designed to generate and use hydropower. The Lesotho Highlands Project on the Senqu/Orange river basin is a multi-billion dollar water transfer and hydropower project implemented by the governments of Lesotho and South Africa. It uses a number of mechanisms, including direct payments for water, purchase agreements, and financing arrangements. On the Senegal River, Senegal, Mali, and Mauritania agreed to share the development costs and benefits of jointly-operated common infrastructure using a burden-sharing formula (la clé de répartition). An agreement between India and Nepal on the Mahakali River includes cost sharing and a power

purchase arrangement. The India-Bhutan agreement on the Chukha hydropower project includes payments made by India to Bhutan for power exports (which represents some 70% of total power generated and is a significant source of revenue for Bhutan). Finally, Kazakhstan, the Kyrgyz Republic, Uzbekistan, and Tajikistan in the Syr Darya basin/Aral Sea have an agreement involving an arrangement for bartering hydropower, gas, coal, and oil.

While these examples do not provide a precedent for PES schemes, they do offer models for international payments for services that are directly derived from ecosystem management and reveal that such arrangements in transboundary watersheds are possible.

According to discussions at the 2009 World Water Week in Stockholm, inserting ecosystem service analyses and valuation discourse into IWRM process and implementation changes not only the 'calculus of benefits' for transboundary basin management, but also the very nature of the institutional dynamics and discourse. Given the rising demand for water and the potential impacts of climate change, it is increasingly important to create economic incentives to protect and restore water availability and quality in transboundary basins. Analysts of the Jordan River Basin, for example, have made the case for incorporating the value of ES in water planning and decision making, especially with regard to a much wider range of services than only those associated with agriculture and domestic use (Al-Jayyousi and Bergkamp 2008).

Based on the timelines of IWRM implementation in this research, it should be recognized that integrating ES into IWRM is not a quick fix to complex, multi-jurisdictional issues. The introduction of a calculus of benefits to stimulate productive discussions and overcome some of the existing political, institutional, financial, and technical barriers, however, is urgently needed.

**Framework for incorporating ES mechanisms into IWRM processes**

Based on some existing models, such as the TWO framework introduced early in this paper, as well as on this study of IWRM implementation in transboundary basins, the authors have developed a schematic demonstrating the potential entry points and value of ES-based approaches in IWRM planning and implementation as shown in Figure 8 below.

**Figure 8. Ecosystem-based management in Integrated Water Resources Management Processes**


Based on our review of IWRM and the use of ecosystem management approaches therein, we believe that there is a strong case to be made for the use of ES based communications, valuation, payments, and monitoring through the IWRM process to strengthen it and make it more tangible and effective for all basin stakeholders. In the schematic above, we illustrated some of the ways in which we see the ES processes fitting closely within a typical IWRM planning and implementation cycle. Short descriptions of this process and implications for the rivers basins included in this study are enumerated below:

- Inserting the ES concept into the development of an IWRM vision and policy from the very initial stage can help generate commitment and inject a tangible "benefits" language around basin management, especially at a scale that is complex and spans international boundaries.
- The assessment stage includes a range of biophysical and social assessments as well as the development of baselines and gaps. This stage also needs to provide the information needed for an accurate baseline for the most important ES as identified by basin stakeholders. Teams conducting this assessment stage should include a range of researchers from the natural and social sciences as well as from the natural resource economics fields. The social assessment phase can help identify the owners and beneficiaries of the ecosystem services, as well as potential current and future markets for these. It can also identify individual, institutional and governance barriers to implementation. Biophysical assessments provide knowledge of the types and locations of ecological assets that in turn provide ecosystem services. They also identify the spatial and temporal flows relative to beneficiaries and the impacts of land and

water transformation on delivery. The ecosystem assessment in this stage provides an evaluation of the relationships between various ES, factors affecting their supply and quality as well as tipping points beyond which alternatives involve time, money and effort. Kremen (2005) provides a useful framework for the ecological assessment of ES and emphasizes the important of measuring the spatiotemporal scales over which services operate. Mapping of services, flows and the impacts of land use changes on these flows is an important part of this assessment but needs to be done in conjunction with some sense of the beneficiaries and potential markets for these. Valuation assessment of basin ES is located at the intersection of the social and biophysical assessments and should be informed by these. Market and non-market values should be included and, where possible, involve consensus amongst informed and involved stakeholders.

- Goals are identified and prioritized ideally through a stakeholder process that allows the riparian nation representatives and others to agree on a set of common goals including social, economic and environmental management for the watershed. ES supplies, values and priorities can help clarify this discussion and allow stakeholders to make more informed decisions based on geographic and temporal priorities in the basin for the greater benefit of all concerned. Scenario planning is a tool that can be used to incorporate assessment data into possible futures and allow stakeholders to grasp the complex dynamics and implications of human management actions. This powerful tool deals with uncertainty by providing plausible, descriptive narratives or pathways to the future. Scenarios can be especially effective when they capture alternative futures visually and dramatically, in such a way as to reduce stakeholder confusion by providing clarity about complex issues and vague language (Cowling *et al.* 2008).
- The planning phase is explicitly collaborative, and involves stakeholders coming together to develop a plan for building on identified priorities and goals. The ES assessment and prioritization can be built into a more explicit benefit-sharing approach and can be clearly articulated to enable political buy-in and support for a basin management plan and its implementation. Specific strategies, instruments and tools as well as implementing agencies are identified at this stage. Specific ES and the impacts of their management on the various stakeholders is a tool that might be useful for motivating stakeholder support and implementation participation. This is also the stage for mainstreaming the ES objectives into decision-making. This would mean that the "rationale, benefits, and mechanisms for safeguarding ecosystem services need to be mainstreamed into all of those sectors that feed into land-use planning, e.g., water, forestry, agriculture, tourism, and urban planning" (Cowling *et al,* 2008). Cooperative policy-making and governance is an important and tricky aspect of this stage that will need to be handled carefully and will be helped by clearly defined ES assessment and prioritization.
- The implementation stage of the Basin plan should incorporate appropriate principles of ecosystem management through the use of instruments such as payments for ecosystem services that explicitly set financial incentives for conservation and management of prioritized ES. Assessing people's willingness to pay for a public good might facilitate the application of a users' fee for water supply, tourism, irrigation or other identified ES.
- Finally, the evaluation stage must adopt the principles of adaptive management, or "learning by doing". This would mean that ongoing monitoring of basin level indicators of social, economic and environmental sustainability would allow basin managers to effectively respond to complex feedback, opportunities and shocks and facilitate an iterative process of re-assessment and re-planning. Ecological indicators would include the conservation and supply of prioritized ES and ensure that the implementation of the basin development plan included the sustainability of ES.

For the river basin organizations working on transboundary basin plan development and implementation, the inclusion of ES identification, valuation, communication and management holds

great merit, not only in converting the IWRM process into a series of tangible and potentially marketable benefits, but also in building social, economic and environmental sustainability explicitly into the IWRM process. It also has the potential to build common ground amongst seemingly fractious stakeholders and build otherwise elusive political support through a benefit-shoring approach that can be quantified and monetized.

**Recommendations for Framework Implementation**

Our synthesis of ecosystem management in transboundary watershed management provided some specific examples of ways in which existing and prospective IWRM processes may be strengthened in the transboundary basins that we studied. In addition, specific opportunities for the inclusion of ES mechanisms were identified for strengthening this process. We build on some of these recommendations and demonstrate the use of our suggested framework as a tool to demonstrate guide this process.

In the **Congo River Basin**, there is an opportunity to enhance the use of ES mechanisms around protecting the Congo Basin's Water Towers. While there are some estimates of the value of carbon sequestered in the region's forests and some efforts to introduce a carbon market to provide incentives to maintain these forests, this process will benefit from a more comprehensive ES assessment in the basin, including social and environmental benefits that affect local and global stakeholders. A more clear understanding of the linkages between current basin level priorities such as navigation and the conservation of forest ecosystems for carbon sequestration can be clearly articulated to convey the synergies between seemingly disparate processes. An assessment of diverse ES, a consensus-based prioritization for basin stakeholders and a basin plan reflecting the priority ES, including navigation and carbon sequestration would strengthen the role of ecosystem based management in basin processes in the Congo River Basin, as well as provide some much-needed integration to its IWRM processes. Valuation studies and clear communications around the economic benefits of management actions would provide some impetus for integrated action.

In the **Okavango River Basin**, a concerted effort is being made to include ES methodologies to communicate the value of well-functioning ecosystems to basin countries. An environmental flows assessment treats the system in an integrated manner and cuts across political boundaries. An explicit goal of the basin organization is to examine how changes to ES will affect the economy and livelihoods of the people. They have included a special component on PES in its SAP, which promises to strengthen benefit sharing in the basin.

In the **Red River Basin**, the Red River Basin Commission has laid out a clear vision via its Natural Resources Framework Plan which articulates 13 basin wide goals and 26 objectives. Communicating the importance of the NRFP could be enhanced by identifying and quantifying the potential shared benefits of implementing the plan. An ecosystem services valuation framework could help translate the fulfillment of the goals and objectives into more tangible shared monetary benefits for the residents of the basin. Furthermore, adopting an ecosystem-based management approach may assist the RRBC with achieving the goals and objectives laid out in the NRFP. For instance, goal #2 which focuses on integrating natural resources management to find a balance in resource preservation, conservation and consumption may benefit from an ES assessment and valuation process. Weighing the ES values associated with preserving and conserving natural environments against the economic benefits of resource extraction and consumption could provide insights to find the desired balance. An ecosystem-based management approach not only provides a language to convey the shared benefits of implementing the NRFP but also a means to realize its goals and objectives. Clear communication of the potential shared benefits of the NRFP using an ecosystem-based management approach will assist the RRBC with appropriating the required resources and funds to implement the plan.

The **La Plata Basin** is yet to embark on a basin-wide management approach but has many of the key characteristics in bilateral agreements. Based on our research, a clear opportunity is offered by the Pantanal wetlands, where an initial EG assessment, including an indication of economic benefits, might provide the necessary impetus for basin-wide action. The wetlands have been clearly linked to ES that benefit the whole region, including flood mitigation, water filtration, climate regulation, ecotourism etc. Other regional priorities such as navigation and hydropower should be included in a more comprehensive basin-wide ES assessment that can be used as a foundation document for basin management and including all riparian nations.

The **Danube River Basin** has one of the strongest transboundary processes amongst our selected case studies. A complex international basin spanning about 18 countries, the Danube has a well-established organization and process for the integrated management of the watershed. The most recent integrated water plan articulates the value of ES such as wetlands and riparian areas. As well, there are economic analyses of water use and the inclusion of economic control tools for watershed management. A comprehensive assessment of basin ES and some high level valuation of priority ES would definitely help the basin countries make more informed decisions about management priorities. A comprehensive assessment identifying linkages, supply and beneficiaries would also enable the development of payments for ecosystem services instruments as part of the basin management process.

In the **Mekong River Basin**, an example of a regionally focussed, integrated approach is the MRC's Strategic Environmental Assessment. This document has been highlighted by the World Economic Forum (2011) as a good example of a study examining the cumulative risks and opportunities of hydropower projects in five separate countries. The report also highlights that this study explicitly considers the links between energy generation, water availability and food production, including second-and third order impacts to ecosystems, social systems and economic development over a 15 year period. An ES assessment clarifying linkages between healthy, functioning ecosystems and the regional priorities – including navigation, hydropower production and regional floods and droughts – would allow for clear communication to all riparian nations of the benefits a basin-wide management approach. An ES valuation study would highlight the importance of the Tonle Sap ecosystem, for example, which produces food and sustains the livelihoods of millions of people in the Mekong watershed. Weak financial and institutional capacity of many Mekong Basin stakeholders can be enhanced by a clearer understanding of the regional and global benefits of ES from the basin and payment mechanisms, when developed, would allow these regional markets and linkages to global markets provide financial resources to basin planning, management, implementation and monitoring.

The **Jordan River Basin** has significant political challenges that need to be overcome before a comprehensive basin management plan, indicative of a successful IWRM process, can be developed. Water and water resources management is an area of work where there one can find examples of genuine efforts by all riparian nations to cooperate and divide scarce water equitably amongst nations. Faced with the rising demand for water and water resources, as well as the impacts of climate change, it is increasingly important to create economic incentives for the protection and restoration of water systems in the region, and to present a compelling argument for a plan to share the resource among the riparian countries, based on a clear understanding of ES benefits and values in the region.

Scholars writing about individual basins have also emphasized the use of financial incentives for ES in water management. Al Jayousi and Bergkamp (2008) make the case for a transition to an ecosystem approach in the Jordan basin by investing in services that are critical to livelihoods and communities. They elaborate on this new form of water resources management in which the first transition is to move beyond the conventional 'blue' water bias to one in which water resources management adopts a whole-systems approach to include ecosystems. The second transition is a shift in science

and engineering that entails developing the practical engagement of science and engineering in enhancing ES, while the third transition is a shift in governance and institutions to break down traditional silos in decision making to enable a more effective integration of IWRM implementation. Transition four is a shift towards active stakeholder participation through truthful negotiations and active contributions.

There is a strong case to include ecosystem approaches to revitalize and inject resources into complex and under-resourced IWRM processes. There is an opportunity for the use of ES valuation and implementation as a means to affect much needed change in the dynamics of transboundary water resources management. This change will shift the focus away from traditional upstream-downstream dynamics to a more holistic, whole-basin approach where there are multiple beneficiaries and providers of ES. This movement can happen in a variety of ways—no doubt a combination of a bottom-up and a top-down approach is most sustainable.

Finally, IWRM is undoubtedly a complex process where monitoring adopted watershed actions must inform adjustments and adaptive management in an iterative way to incorporate new information, technology, values, and priorities. Such iterative and context-responsive IWRM is especially pertinent and necessary in larger basins with higher levels of complexity and multiple political jurisdictions such as transboundary basins, and in the face of uncertainties associated with climate change. Such an adaptive iterative process is also aligned to the Millennium Ecosystem Assessment's 'Adaptive Mosaic' scenario where regional watershed-scale ecosystems are the focus of political and economic activity, local institutions are strengthened, and local ecosystem management strategies are common. In this scenario, societies develop a strongly proactive approach to managing ecosystems (Millennium Ecosystem Assessment 2005).

This research re-asserts the importance of well-developed institutional and technical capacity for effective transboundary management and adaptive and integrated watershed-based management for river basin organizations. In principle, many RBOs acknowledge the need to adopt ecosystem-based approaches to basin management, recognizing that rivers and wetlands provide important ES such as waste assimilation, floodwater storage, and erosion control. There is also an increasing awareness of the social and economic benefits of maintaining these services, including preserving local livelihoods and alleviating poverty within river basins. By taking such a holistic view of the links between ES and human well-being, integrated management of watersheds through IWRM planning and implementation can be achieved more effectively and efficiently at the transboundary level.

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