Assessment of RBO-Level Mechanisms for Sustainable Hydropower Development and Management

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Executive Summary

Hydropower is playing an increasingly important role in the Lower Mekong River Basin (LMB) as the riparian countries seek to meet their rapidly growing demand for energy and to provide an alternative to dependency on fossil fuels. The member countries of the Mekong River Commission (MRC) – Cambodia, Lao People's Democratic Republic, Thailand, and Vietnam – aim to use this hydropower potential to promote socioeconomic development and welfare in the region. In the past years several hydropower projects for the LMB mainstream have been proposed and further hydropower development is also expected for the LMB tributaries.

Transboundary cooperation in hydropower development and management can significantly increase project benefits to all riparian states while reducing the potential for negative transboundary impacts. It may allow for the more efficient location and operation of infrastructure. Sharing of project related costs and benefits can generate win-win situations, which would not have been possible unilaterally. Cooperation between riparian countries, as well as with national stakeholders and local communities, is also necessary to effectively mitigate social and environmental impacts that regularly come along with large infrastructure projects.

How can sustainable transboundary hydropower cooperation be set up in regulatory and organisational terms? What impact mitigation measures and cost-benefit sharing arrangements exist, and what are the challenges in implementing these? This report documents lessons learnt on transboundary cooperation mechanisms that can support the sustainable development and management of hydropower projects. The lessons are drawn from a comparative assessment of mechanisms and tools applied in five case studies: the Manantali Dam (Senegal, Mali, and Mauritania), the Itaipu Dam (Paraguay/Brazil), the Columbia River Project (USA/Canada), the Kariba Dam (Zambia/Zimbabwe), and the Kosi Dam (Nepal/India).

The analysis shows that various legal and institutional frameworks have been chosen by riparian countries to establish cooperation in hydropower projects. Several approaches can also be taken to mitigate environmental and social impacts and to sharing costs and benefits. While the detailed design of mechanisms and measures depends on the nature of the issues at hand and the existing cooperative framework, the following general lessons can be drawn from these other river basins:

- **Basin-wide institutions can provide an essential framework for coordinated hydropower development and management.** Where hydropower schemes with potential transboundary impacts exist or are planned in a basin, coordinated development and management is necessary to achieve the optimal hydropower output of all included projects while effectively mitigating social and environmental impacts. This type of management is best founded on institutionalised cooperation mechanisms and trustful riparian relationships, such as may be established in river basin organisations.

- **Designating or creating a specified agency for dam operations management can facilitate day-to-day cooperation.** Frequent consultation between riparian countries is necessary for decision making in day-to-day dam operations and to flexibly respond to upcoming management challenges (e.g. floods and drought).

Where basin-level organisations exist, agencies mandated with dam operations management regularly are established as subordinate bodies to these.

- **Cost-benefit sharing mechanisms need to be fair and flexible.** Cost-benefit sharing schemes are a valuable tool that aims to provide maximum project benefits while compensating each party involved or affected according to the costs they have to bear. In order to achieve this goal, the case studies reveal that effective schemes should not only encompass one-off payments, but also flexibly designed cost and benefit sharing arrangements that allow contracting parties to react to political and economic changes that affect the use of the respective dams by the riparian countries.

- **Social and environmental mitigation measures as well as their financing need to be considered from the planning stage.** Where past hydropower projects did not adequately address social and environmental effects, corrective measures have had to be introduced at a later stage, often as a result of social pressure or international disputes. In order to promote sustainability and prevent conflict and unexpected costs, experience from these international river basins shows that mitigation measures as well as sustainable financing concepts for their implementation need to be considered from the early project stage.

- **Cooperation on the regional as well as local level is necessary to effectively design and implement social and environmental mitigation measures.** Social and environmental impacts of hydropower projects are interrelated and often complex. Mitigation measures thus need to be based on a thorough understanding of the interrelationships across the basin as well as of the specific situation upstream and downstream of the dam. Cooperation and the exchange of data and information locally as well as across borders are crucial to designing the most appropriate mitigation measures for each dam and to monitoring their effectiveness. Joint monitoring and implementation of mitigation measures should be institutionalised, for example as part of specific programmes or sub-agencies. Agencies mandated with the operation of hydropower schemes, as well as local communities, can also play important roles in implementing and monitoring mitigation measures.

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List of Abbreviations

AOP	Assured Operation Plan
AfDB	African Development Bank
ANEEL	National Agency for Electricity
BPA	Bonneville Power Administration
CAPCO	Central African Power Corporation
CBT	Columbia Basin Trust
CII	Confederation of Indian Industry
CRT	Columbia River Treaty
DANIDA	Danish International Development Agency
DFID	Department For International Development
DOP	Detailed Operation Plan
EEM	Eskom Energie Manantali
EIA	Environmental Impact Assessment
EMP	Environmental Monitoring Program
GEF	Global Environment Facility
GIZ	German Agency for International Cooperation
GoI	Government of India
GWP	Global Water Partnership
HMGN	His Majesty's Government of Nepal
ICEM	International Centre for Environmental Management
IJC	International Joint Commission
IPPAN	Independent Power Producers' Association Nepal
ISH	Initiative for Sustainable Hydropower
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
JCKGP	Joint Committee on the Kosi and Gandak Project
JCWR	Joint Committee on Water Resources

JMCRW	Joint Ministerial Level Commission on Water Resources
JPO	Joint Project Office
JSTC	Joint Standing Technical Committee
KfW	Kreditanstalt für Wiederaufbau
LMB	Lower Mekong Basin
MoU	Memorandum of Understanding
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
MW	Mega Watt
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NPUA	Non-Power Uses Agreement
OAS	Organization of American States
OMVS	Organisation pour la mise en valeur du Fleuve Sénégal
ONS	National Electricity System
PASIE	Programme d'Atténuation et de Suivi des Impacts sur l'Environnement
RHDP	Regional Hydropower Development Project
SADC	South African Development Community
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
SIDA	Swedish International Development Cooperation Agency
SOA	Supplemental Operating Agreement
SOGEM	Société de Gestion de l'Energie de Manantali
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNECE	United Nations Economic Commission for Europe
USA	United States of America

USACE	U.S. Army Corps of Engineers
USAID	United States Agency for International Development
ZACPLAN	Zambezi Action Plan
ZACPRO	Zambezi Action Plan Projects
ZAMCOM	Zambezi Watercourse Commission
ZESCO	Zimbabwe Electricity Supply Corporation
ZRA	Zambezi River Authority

1 Introduction

Hydropower could play an increasingly important role in the Lower Mekong River Basin (LMB) in the near future, serving as the answer to the rapidly growing demand for energy in the countries of the LMB while providing an alternative to dependency on fossil fuels. Furthermore, considering the magnitude of the hydropower generating potential of the lower Mekong, significant revenue benefits can be expected from electricity exports.

The member countries of the Mekong River Commission (MRC) – Cambodia, Lao People's Democratic Republic, Thailand and Vietnam – aim to use this potential to promote economic development and welfare in the region. In the past years proposals for 12 hydropower projects for the LMB mainstream were submitted by different riparian countries. In addition, a high number of dams are planned to be constructed in the LMB tributaries by 2030 according to the MRC Basin Development Plan (2011).

At the same time the MRC acknowledges the potential adverse effects of these hydropower projects and is working to encourage mitigation of social and environmental impacts. The Strategic Environmental Assessment of Hydropower on the Mekong Mainstream (SEA) prepared for the MRC concludes that, unless mitigated, LBM fisheries, ecosystems, and thus peoples' livelihoods, in major parts of the basin could be affected. The MRC's Basin Development Strategy further points to the need for proposed hydropower projects to contribute to the development of affected communities in the LMB countries through the sharing of costs and benefits of these projects.

The sustainable development and management of hydropower in synergy with the environment and livelihoods is one of the main topics addressed within the MRC cooperation framework. The MRC, via its Initiative for Sustainable Hydropower (ISH), works on solutions which enable the countries to jointly make use of the hydropower potential of the lower Mekong while avoiding and mitigating tensions between the co-riparians as well as negative social and environmental impacts.

To support this aim, the MRC/ISH and GIZ have sought advice on the lessons learnt on transboundary cooperation mechanisms that can support the sustainable development and management of hydropower projects at the basin level. Sever-al tools and mechanisms in the area of, for example, basin planning, dam operation or cost sharing can be applied to prevent imbalances and conflicts on the national or regional level. The lessons learnt are based on a comparative assessment of mechanisms and tools applied in cooperative hydropower development and management in five case studies: the Manantali Dam (Senegal, Mali, and Mauritania), the Itaipu Dam (Paraguay/Brazil),the Columbia River Project (USA/Canada), the Kariba Dam (Zambia/Zimbabwe), and the Kosi Dam (Nepal/India).

The report is structured as follows: the background section gives an overview of potential and existing mechanisms and approaches to cooperative hydropower management, including legal and institutional frameworks, joint basin planning, dam operation, cost and benefit sharing as well as impact mitigation measures. In the following section, case studies of five jointly managed transboundary hydropower projects provide details on the respective cooperation background, the hydropower project's infrastructure and organisational setup, the applied management mechanisms, as well as the related technical and political challenges. Subsequently, the tools applied in the case studiesare briefly summarizedin a comparative overview.A concluding chapter draws lessons for the MRC. The Annex provides informative fact sheets, one for each case study and one summarizing the lessons learnt.

2 Background

All sectors of a society depend on water. Water resources thus play an important role in promoting socioeconomic development at the local as well as the regional level. In order to ensure that water resources development serves economic, social, ecological and political objectives, an Integrated Water Resources Management (IWRM) approach is essential. IWRM involves “the coordinated development and management of water, land, and related resources in a way that maximizes economic and social welfare without compromising the sustainability of vital ecosystems” (Global Water Partnership 2000). The MRC has long been committed to IWRM, as is expressed, for example, in its IWRM-based Basin Development Strategy 2011-2015.

In the context of hydropower an integrated approach implies that development and management decisions are based on basin-wide assessments and strategies. In transboundary basins like the Mekong this requires a high level of cooperation between the riparian states.Cooperation should be based on equal participation and decision-making power between all parties. Taking these aspects into account transboundary cooperation in hydropower development and management can significantly increase project benefits. It allows for the more efficient location and operation of infrastructure. Sharing of project related costs and benefits can generate win-win situations, which would not have been possible unilaterally. Cooperation between riparian countriesis also necessary to effectively mitigate social and environmental impacts that regularly come along with large infrastructure projects.

A range of water resources development opportunities exist in most transboundary basins. A first step in making use of these is to identify the shared benefits, water-related risks and/or objectives as well as probable barriers. Secondly, governance structures and mechanisms to jointly develop and manage transboundary hydropower and/or multipurpose schemes should be established. The following sections on legal and institutional frameworks, mechanisms for hydropower planning and operation, cost and benefit sharing as well as impact mitigation demonstrate different possibilities for the design of cooperative mechanisms.

2.1 Legal frameworks

Different kinds of laws and agreements can form the framework for cooperation in hydropower projects in transboundary basins, ranging from general framework conventions to project-specific agreements. On the international level the 1997 *UN Convention on the Law of the Non-Navigational Uses of International Watercourses* provides a set of guiding principles for cooperation between watercourse states on the use, management and protection of international watercourses, and therefore also for the development of joint hydropower projects. Stipulated principles include ‘do no harm’, ‘equitable utilization’, ‘prior notification’ and ‘protection and preservation of ecosystems’, which can be helpful in guiding cooperation and in preventing potential conflicts if respected by the co-riparians. However, while these principles are well accepted internationally, the UN Convention has not been ratified by the required number of countries and is thus not in force. While the *recommendations of the World Commission on Dams* (WCD 2000) and of the *International Hydropower Association* (IHA 2004) provide more specific guidelines for developing sustainable hydropower projects, they are of voluntary character and thus not enforceable.

Legally binding norms only exist on the regional level:Binding framework agreements include, for example, the *United Nations Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes*, or the *Revised Protocol on Shared Watercourses in the Southern African Development Community* (SADC Water Protocol). While both treaties are rather general in nature, in the Zambezi basin, for instance, in the absence of a basin-wide agreement, the SADC water protocol forms the framework for cooperation on hydropower management.

Where basin-wide, or at least multilateral agreements on transboundary water resources management exist, these usually can also provide the base for cooperation in hydropower development and management, as for example the agreement between Senegal, Mali and Mauretania on the Senegal River[1], or between Uzbekistan, Kazakhstan, Tajikistan and Kyrgyzstan with regard to the resources of the Syr Darya Basin[2]. Where no multi-national agreements exist – or in addition to these – bilateral treaties have often been concluded to regulate cooperation in hydropower development and management. Such bilateral treaties were for instance signed between Brazil and Paraguay, Nepal and India, Argentina and Uruguay, or Zambia and Zimbabwe, to name just a few[3]. In cases of advanced cooperation in hydropower management, such multi- or bilateral agreements are sometimes further amended or specified in protocols or By-Laws regulating detailed aspects of management and operation (for examples see below on the Columbia and Senegal River cooperation).

2.2 Organisational setups

Riparian countries have developed diverse institutional structures and organisational settings for joint hydropower development and management, depending on the main hydropower concerns to be tackled, existing cooperation and riparian relationships in the basin. Existing multi- or bilateral institutions can provide a suitable frame for planning and developing joint hydropower projects. In the case of the Senegal, the river basin organisation OMVS (Organisation pour la mise en valeur du Fleuve Sénégal) is mandated to develop the entire Senegal River and its tributaries with regard to hydropower generation, irrigation and navigation. Likewise, the International Joint Commission between Canada and the USA provided the initial framework for the joint planning of dams on the Columbia River.

In addition or instead of river basin organisations, project-specific institutions are regularly established for the management of co-owned hydropower projects.These can take the legal form of a company owned by the riparian states or the form of a bilateral authority,such as the Zambezi River Authority, which is responsible for operating and managing the Kariba Dam.In the case of the Senegal River, for example,the public company SOGEM (Société de Gestion de l'Energie de Manantali) was created as a subordinate body to the OMVS with responsibility for the operation and management of the Manantali Dam. In absence of a ba-

[1] Convention portant création de l'organisation pour la mise en valeur du Fleuve Sénégal' (1972) and 'clé de repartition' (1985).

[2] 'Agreement between the government of the Republic of Kazakhstan, the government of the Kyrgyz Republic and the government of the Republic of Uzbekistan on the use of water and energy resources of the Sry Darya Basin' (1998) and 'Agreement between the governments of the Republic of Kazakhstan, the Kyrgyz Republic, and the Republic of Uzbekistan on joint and complex use water and energy resources of the Naryn Syr Darya cascade reservoirs' (1998).

[3] 'Treaty between the Federative Republic of Brazil and the Republic of Paraguay concerning the hydroelectric utilization of the water resources of the Parana River owned in condominium by the two countries, from and including the Salto Grande de Sete Quedas' (Paraná, 1973); 'Agreement between the government of India and the government of Nepal on the Kosi project' (Kosi, 1954); 'Treaty between Uruguay and Argentina concerning the Rio de la Plata and the corresponding maritime boundary' (Paraná, 1973); 'Agreement between the Republic of Zimbabwe and the Republic of Zambia (Zambezi, 1987); (Oregon State University Department of Geosciences/Northwest Alliance for Computational Science and Engineering, without date).

sin organisation for the Parana River, Brazil and Paraguay created the co-owned company Itaipu Binacional responsible for the operation and management of the Itaipu Dam).In all three examples, ministerial level representatives of the riparian states are present in the governing or supervising bodies. For electricity generation and distribution, in all three cases the transboundary entities closely cooperate with national utilities through different organisational setups.

The Nile Equatorial Lakes Subsidiary Action Program (NELSAP) of the Nile Basin Initiative is envisaging a similar approach for the Regional Rusumo Falls Hydroelectric Project under joint development by Burundi, Rwanda and Tanzania. The hydropower project is intended to be implemented through a publicly financed, privately managed mechanism. The company will be co-owned by the three governments to oversee the implementation and operation of the project. Although its shareholders will be the three governments, it is intended that the organisation will operate at arm's length and to all intents and purposes as a private company. Until the enterprise is established NELSAP will act as the implementing agency (NELSAP without date-a,b; Infrastructure Consortium for Africa without date).

A different approach was taken for management of the dams under the Columbia River Treaty, which are not co-owned by the riparian countries but either by Canada or the USA. In this case, no additional organisation was set up, but two national entities, which are represented by federal or state-level agencies, coordinate the operation and management of the multipurpose dams through Engineering, Operating and HydroMet Committees, respectively.

2.3 Cost and benefit-sharing mechanisms

Some of the most common mechanisms applied in the joint development and management of transboundary hydropower projects are mechanisms for sharing the accruing costs and benefits. Through the sharing of costs and benefits, win-win situations can be created and additional advantages can be generated that could not be achieved if each riparian acted unilaterally. Concepts for cost and benefit sharing can thus help to provide incentives for transboundary cooperation in hydropower development and management. Different approaches can be applied to determine how costs and benefits shall be shared, depending on the project context (e.g. the hydro-political constellation, project purpose, interests of the stakeholders, environmental and social issues) and the governance level (from international to local) on which costs/benefits are to be shared. Moreover, costs and benefits generated in various water-related areas (including hydropower, irrigation, navigation, fisheries, water-sharing rights and flood prevention), but also in non-water areas (e.g. trading conditions, border controls, infrastructure and indirect economic benefits), can be included in the basket of benefits to be shared. Multi-purpose dam projects that combine hydropower with other goals provide increased opportunities for generating benefits and thus incentives for cooperation (for a more detailed discussion of benefit-sharing in dam projects on shared rivers see Hensengerth et al. 2012).

One option is to share the benefits and costs equally among the riparian countries in monetary or non-monetary terms (e.g. through royalties, direct compensation payments, or supply of power or water). This approach is applied, for example, at the Itaipu Dam, where Brazil and Paraguay each have the right to 50% of the electricity produced by the co-owned company Itaipu Binacional. However, since Paraguay does not use its full share, Brazil has a priority right to buy this unused electricity from Paraguay.

Another possibility is to share the costs of jointly owned infrastructure according to the benefits that each partner generates respectively. The co-owners of the Kariba Dam, Zambia and Zimbabwe, agreed to share the costs of the operation and maintenance of the dam accord-

ing to the amount of water used by each riparian for electricity generation in the two national power houses. In the case of the Senegal river, an advanced approach was taken: a calculation of anticipated benefits in irrigation, energy and navigation for each riparian is used to determine the allocation of investment and operating costs for structures authorized by the OMVS.

Compensation transfers (monetary or non-monetary) between riparian countries are also often chosen as a mechanism for sharing the costs of a joint hydropower project. Compensation is, for instance, paid by the main beneficiary for the damages and losses (e.g. energy, land) suffered by other riparians; for costs only one party has to bear (e.g. investment or operation costs), or for benefits created downstream of a dam. The focus of compensation payments at the Columbia River, for instance, is on downstream benefitsthat are created upstream in Canada. Thus, the downstream USA compensates upstream Canada for the benefits in regard to flood protection and increased energy production that result from dams built in Canada. Canada in turn was/is responsible for the construction and operation of three dams. India compensated Nepal for the damages due to inundation resulting from the Kosi Project, for used Nepalese materials and for leased Nepalese territory.

2.4 Mechanisms for monitoring and mitigation of social and environmental impacts

In most cases hydropower schemes not only produce benefits but also serious negative impacts. These can occur on the national or transboundary level and are mainly of a social and/or environmental character. Joint mechanisms implemented from the start of a cooperative hydropower project can help to prevent and mitigate adverse effects. They can take the form of action programmes or even specified (sub-)agencies of river basin organisations or other institutions responsible for hydropower management. The involvement and participation of affected communities can further play an important role in identifying negative social and environmental effects as well as appropriate counter measures. A first step to effective mitigation is a thorough assessment of impacts, such as done in transboundary Environmental Impact Assessments (EIA), Social Impact Assessments (SIA), or Strategic Environmental Assessments (SEA). Based on such knowledge, specific mitigation measures can be designed.

Common approaches toalleviateenvironmental impacts include establishing environmental flow regimes, providing fish hatcheries/passes/ladders, afforestation measures for sedimentation control, etc. Measures to mitigate impacts on downstream fisheries are, for instance implemented in the Columbia and Parana basins: the Columbia riparians frequently coordinate reservoir levels and river flows to create favourable conditions for fish spawning and migration, and Itaipu Binacional's environmental programme included construction of a fish spawning channel to compensate for the loss of spawning habitat through dam building. Negative social effects can be reduced through mechanisms that help to avoid adverse impacts as well as through the sharing of project benefits with affected communities. Applied measures include comprehensive resettlement programmes, grievance procedures, compensations for lost assets, creating new income opportunities, electrification and social infrastructure programmes, issuing of fishing rights, etc. On the Senegal River, social impacts were mitigated by providing benefits for the local population inside and outside the Manantali Dam area through the electrification of the Manantali resettlement villages and villages located near the basin, as well as income generation activities for poverty reduction supported by micro subsidies. In the Zambezi basin, loss of income due to reduced fish stock downstream of the dam could partly be balanced by establishing fisheries at the reservoir.

To ensure that impact mitigation measures are effective, continuous monitoring of social and environmental impacts should take place. This allows assessing implemented mitigation measures andadapting/developing joint actions or policies.For this reason, the OMVS, for exampleset-up the Environmental Observatory aimed at providing accurate environmental data in an environmental information system.

As the environmental and social contexts of hydropower projects change over time, mechanisms that allow for flexibility have proven successful, such as agreements that allow the concerned parties to react to changes or new requirements by adapting previously agreed upon regulations. This approach has been taken, for example, by Canada and the USA; the main operating plans for the dams of the Columbia River Treaty can be amended by so-called Supplemental Operating Agreements during the operational year in order to accommodate, for instance, current breeding requirements for certain fish species or recreational water-level requirements.

Last but not least, social and environmental mitigation measures need continuous financing. One option for this are national or transboundary trusts or funds financed (completely or partly) by project beneficiaries or from project benefits. Brazil, for instance, invests the royalties it receives from Itaipu Binacional in social and environmental mitigation measures. The use of revenues from energy plants, including hydropower, is strictly regulated by the Brazilian Constitution of 1988 and related laws. The existing revenue allocation key ensures that areas most affected by the project receive the biggest share of the revenues. In addition, participatory mechanisms ensure that local communities have adequate opportunities to influence the use of the revenues. The Canadian Columbia Basin Trust (CBT) was founded in 1995 to compensate people affected for social and environmental impacts in the basin. The province of British Columbia endowed the trust funds from the province general revenues. Local communities are part of the trust and participate in decision making processes. The funds have been used for instance to build power stations on existing reservoirs to promote economic development in the region, while the revenues of these projects are reinvested for instance in environment, social and economic development projects.

3 Case Studies

3.1 Senegal River Basin – Manantali Dam

3.1.1 Background

The Senegal River has its source at Bafoulabe in Mali in the Sahel region, where the Bakoye River and the Bafing River meet after having left the water-rich areas of Guinea and Mali. Upon reaching the three-country border point of Mali, Mauritania and Senegal, the Senegal forms the border between Mauritania and Senegal, before flowing into the Atlantic Ocean at Saint-Louis. Water in the basin is used for recessional (Mauritania and Senegal) and rain-fed (Guinea and Mali) agriculture, irrigation, fishing, drinking water and hydropower generation.

Source: World Water Assessment Programme 2003 (map prepared by AFDEC).

The Middle Senegal Valley in Senegal and Mauritania was traditionally characterized by wetlands that depended on cyclical floods following heavy rains in Guinea. The floods sustained a large population of farmers, herders and fishers. Following the Sahel drought (1968-1974), village-based irrigated rice plots were introduced to alleviate the food crisis (Horowitz/Salem-Murdock 1993).

3.1.2 The regulatory and organisational framework for river basin management

Attempts to develop the Senegal River date back to French colonial times. In 1963, after independence from France, the four riparian countries formed the Comité inter-états pour l'aménagement du Bassin du Fleuve Sénégal (Intergovernmental Committee for the Development of the Senegal River Basin), based on the Convention relative a l'aménagement general du Bassin du Fleuve Sénégal. The Convention declared the Senegal to be an international river. At least in theory, this forgoes the concept of absolute sovereignty and acknowledges limited sovereignty (Alam et al. 2009).

After several failed attempts to formalize cooperation, Senegal, Mauritania and Mali founded the Organisation pour la mise en valeur du Fleuve Sénégal (OMVS) in 1972, under the Convention portant création de l'organisation pour la mise en valeur du Fleuve Sénégal. Guinea did not participate due to political difficulties internally and within the region but joined the OMVS in 2006. The OMVS was thus founded during the Sahel drought. During the drought agricultural production shrank from 130,000 hectares to 15,000 hectares in 1973. This resulted in extreme poverty and large-scale emigration into cities. Mauritania and Senegal therefore desired a more regular flow downstream from Bakel to enable irrigation. In addition, landlocked Mali's dependence on the ocean port of Saint-Louis in Senegal and on Senegal's railway network to export its raw materials gave it an interest in developing navigation (Parnall/Utton 1976; Newton without date). Interests were thus complementary.

However, the countries faced limited financial capabilities, limited manpower resources, and undeveloped administrative structures for river development (Parnall/Utton 1976). River development works were thus dependent on international donor financing and on collaboration between the riparian states under the framework of the OMVS.

Observers called the OMVS "the first international river basin authority with an executive capability" (Parnall/Utton 1976: 248). It was not limited to a specific issue (e.g. navigation only), competence (e.g. a mandate limited to an advisory role), or geographical scope (e.g. while there is a coordinating committee, the management of the river works are carried out by the member countries within their sovereign territories). The OMVS had a broad mandate to develop the entire stretch of the Senegal River and its tributaries in relation to hydropower generation, navigation, and irrigation (OMVS 1972a, b).

The OMVS has three principal bodies (Yu 2008): (1) The Conference of Heads of State and Government is the apex body. Its decisions must be taken unanimously and are binding for the member governments. (2) The Council of Ministers decides on general policy for the river's development. Chairmanship is held in succession by the three countries, and ministers are typically from water-related national ministries. The Council "sets the budget, defines and prioritizes projects […], and determines the contribution of each member state for financing operations, research, and administration. The Council has the authority to obtain financing for projects." (3) The High Commission is the executive branch in charge of implementing Council decisions and regulating and monitoring river works. The Commission also "receives proposals for projects and water uses which are sent to the Permanent Water Commission for evaluation and recommendation." Each organizational body of the OMVS is staffed according to the principle of national parity, i.e. with equal numbers of staff from each member country (KfW 2008: 10).

At its first meeting in 1972, the Council of Ministers decided to realize the following structures:

- An upstream dam at Manantali for flow regulation, hydropower generation of 800Gwh annually, and double-crop irrigation of 255,000 hectares.

- A delta dam at Diama to fight salt intrusion, create irrigation potential for 42,000 hectares in the Delta and an additional 78,000 hectares when operated in combination with Manantali. This would increase the total irrigated area to 375,000 hectares.
- A maritime port at Saint-Louis, Senegal, and a river port at Kayes, Mali (Parnall/Utton 1976; LeMarquand 1990; AfDB 1998).

The structures would be the joint property of the member states, they would be administered by "special interstate or mixed national interstate agencies" (Parnall/Utton 1976).
The members formulated definitions and obligations for the jointly owned structures and the financing modalities in the 1978 Convention on the Legal Status of the Jointly-Owned Structures, and in the 1982 Convention on the Financing of the Jointly-Owned Structures. The two conventions contain the following arrangements:

- "All structures are the joint, indivisible property of the member states throughout their life."
- "Each co-owner state has an individual right to an indivisible share and a collective right to the use and administration of the joint property."
- "The investment costs and operating expenses are distributed between the co-owner states on the basis of benefits each co-owner draws from exploitation of the structures."
- "Each co-owner state guarantees the repayment of loans extended to the OMVS for the construction of the structures."
- "Two entities are established to manage the jointly-owned structures for the OMVS" (Yu 2008: 15-16). The two structures would later be the Société de Gestion de l'Energie de Manantali (SOGEM) for the operation of Manantali, and the Société de Gestion et d'Exploitation de Diama for the operation of the Diama Dam (SOGED).

In 2002, the OMVS countries signed a Water Charter, which laid out mechanisms for reviewing new projects, environmental protection mechanisms (including environmental action plans), and rules for stakeholder participation, including farmers, fishermens' associations and NGOs, and the OMVS national coordinators. This was formalized in the setting up of the multi-stakeholder Permanent Water Commission. The Commission is tasked with determining water allocation among usage sectors. It "advises and reports directly to the Council" (Yu 2008: 16-17; OMVS 2002).

3.1.3 The Manantali Dam

The Manantali Dam (200 MW), located at the Bafing River in Mali 90km upstream from Bafoulabe, is part of the integrated development strategy for the basin. The dam has a height of 65m and a reservoir of 477km². It necessitated the resettlement of 10,000 people (KfW 2008).
The dam was built in 1988, but without power facilities. Power facilities and transmission lines were built only with the donor-financed Regional Hydropower Development Project (RHDP), implemented between 1998 and 2003. Manantali came online in 2001 when it began to supply power to Mali. Senegal and Mauritania connected in 2002. The dam has been working at full capacity since 2003. The long gap between 1988 and 2001 was due to the conflictive relationship between Senegal and Mauritania following the 1989 border dispute (Yu 2008; Newton without date; Skinner et al. 2009; World Bank 2006).

3.1.4 Institutional setup and mechanisms for dam/hydropower management

As all structures authorized by the OMVS are jointly owned and managed by all members, so is Manantali. SOGEM was created by the RHDP to operate the power facilities of Manantali. Each member country owns 33% of SOGEM. The management of energy production

has been contracted to Eskom Energy Manantali (EEM), a subsidiary of the South African utility Eskom. The concession period was initially for 15 years, but EEM decided to terminate the concession by October 2011, citing "contractual difficulties" (ESKOM 2011: 288). SOGEM must therefore find a new contractor (ibid.). One of the problems that EEM faced was the bad payment behaviour of electricity customers, resulting in a continued underfunding of SOGEM (KfW 2008). The contracting out of energy production and transmission to a private operator conformed with donor priorities of private sector participation. EEM operated and maintained the production and transmission facilities up to the point where energy transmission is handed over to the national utilities of Mali, Senegal and Mauritania. EEM was also in charge of collecting energy use fees. EEM transferred tariff revenues to SOGEM, minus management costs. However, non-payment of bills made government subsidies for SOGEM necessary. SOGEM used the income to maintain the dam structure, service its debt, and endow the Fonds de Risque Hydraulique. The purpose of the fund is to ensure the financial security of SOGEM in case a low water table in the reservoir does not allow for sufficient energy production (KfW 2008; World Bank 2006; www.sogem-omvs.org).

3.1.5 Mechanisms for cost and benefit sharing

Importantly, the 1963 recognition of the Senegal as an international river meant that member states did not consider water allocation to be the key to peaceful exploitation, but moved directly to the sharing of costs and benefits from joint management of the river. This was formalized in the clé de repartition, which was adopted by the Council of Ministers in 1985.
The origin of the clé dates back to the year 1977 when the Council of Ministers asked Utah State University to develop a methodology for the allocation of costs and benefits for the joint operation of the Manantali and Diama Dams in the areas of hydropower, irrigation and navigation (Yu 2008. For the technical details in calculating the key see Yu 2008: 17-18).
The clé determines the share of irrigation, navigation and hydropower benefits each member country receives based on each country's needs and capacity for exploitation of the benefit. Based on this share, members are financially obliged to guarantee funding. The cost allocation by sector was 22.37% for irrigation, 30.78% for energy and 46.85% for navigation. The further allocation was as follows (Yu 2008):

Benefit and cost allocation	Mauritania	Mali	Senegal
Irrigation potential, based on the joint operation of Diama and Manantali	31%	11%	58%
Energy generated from Manantali	15%	52%	33%
Navigation potential generated from Manantali	12%	82%	6%
Total cost allocation by country	22.6%	35.3%	42.1%

Donor-funding was contingent on adoption of the clé (Yu 2008). The members would jointly guarantee their financial obligations incurred through the projects (Parnall/Utton 1976). Owing to a lack of financial capabilities, the OMVS became funded by donor loans. Therefore, members effectively guaranteed the repayment of the loans.

3.1.6 Mitigation mechanisms for environmental and social impacts

The triple goal (irrigation, energy and navigation) of the OMVS was based on the complete cessation of natural floods. When the Manantali reservoir was filled, the traditional pattern

whereby farmers and herders would follow each other in the use of the flooded plains was destroyed, and both groups competed for the land and water, sometimes violently. In the absence of access of many valley residents to irrigated fields, many became dependent on remittances from migrant workers to buy food (Horowitz/Salem-Murdock 1993; LeMarquand 1990; AfDB 1998).

The creation of permanent water levels in the reservoir and for irrigation along the river led to the spread of diarrhoea, schistosomiasis, malaria, concentrated industrial pollution, reduction in pastureland, degradation of fisheries, increased soil salinity, and riverbank erosion (Newton without date; KfW 2008; IUCN without date). The environmental effects were recognized in an EIA study conducted by USAID in 1977-1980.

In terms of resettlement and compensation, 30 villages, 250km of rural roads connecting villages to main roads, 4500 new houses, 148 wells and infrastructure (schools, hospitals, and storage houses) were built. During the transition period, food aid was also provided. Compensation was paid in the amount of 120 million FCFA (Franc de la Coopération Financière en Afrique Centrale, 1986/87). Total resettlement costs amounted to US$27 million, provided by USAID, UNDP and the government of Mali (KfW 2008).Furthermore, benefits for the local population inside and outside the Manantali area included: electrification of the Manantali resettlement villages; rural electrification for main villages (ten per country) that are located near the basin; and income generation activities for poverty reduction “supported by micro subsidies” (Skinner et al. 2009: 16).

Following the impounding of the Manantali reservoir, short-term measures were implemented in order to alleviate the environmental and health effects, including limnological studies, and the creation of a nature reserve by Mali at the Bafing River (KfW 2008).To make up for the reduction of fisheries in the river, a fishery was created in the Manantali reservoir. The reservoir is now the third largest source of fish in the basin (KfW 2008; IUCN without date).

In addition, to facilitate the transition from flood-recessional to irrigated agriculture, it was suggested to alter the management of Manantali to allow artificial floods during 1988-1992. The artificial floods should be created when floods would have occurred naturally. When the OMVS first did this in 1989, artificial floods were timed so badly that they wiped out crops.

Beyond these measures, the institutionalization of long-term mitigation only began in 1998 under the donor-funded Environmental Impact Mitigation and Monitoring Programme (PASIE, Programme d’Atténuation et de Suivi des Impacts sur l’Environnement), funded as part of RHDP. PASIE was the condition set by donors for the continued funding of the OMVS.In 2002, PASIE set up an Environmental Observatory under the High Commission[4] and instituted a Health Plan with the aim to provide accurate data on the environmental and social situation in the basin and to carry out mitigation measures (N’Diaye et al. 2007). PASIE established a reservoir management plan which included the permanent continuation of artificial floods, rural electrification and environmental and social management plans (Yu 2008; IUCN without date; Newborne 2010).

In terms of practical impact for the project-affected population in the Senegal valley, PASIE had a number of successful outcomes: the institutionalization of one artificial flood annually enabled farmers to continue small-holder recessional agriculture beyond the initially envisaged transitional period of 1988-1992. This was the more important as farmers preferred recessional agriculture to the market-oriented and financially risky irrigated agriculture, particularly when the promise of the expansion of irrigation facilities slowed and the negative consequences of the dam became apparent. The artificial floods had the additional function

[4] In 2010, the Environmental Observatory was integrated into the newly formed Direction de l‘Environnement et du Développement Durable (http://www.omvs.org/fr/gestion/observatoire.php).

to “preserve the ecological equilibrium in the valley” (Yu 2008: 20-21). In 2002, environmental flows were prescribed in the Water Charter, which was ratified by all member states. The Charter explicitly mentions that the use of water resources must take into account the “needs for agriculture, the breeding, sylviculture, pisciculture, fishing, fauna, the flora and the environment” (OMVS 2002: Article 8). The Water Charter is a direct outcome of PASIE (Newborne 2010).

In terms of institutional change, the Environmental Observatory set up a multi-tiered multi-stakeholder structure of regional, national and local level committees. In detail, Local Coordination Committees (Comités Locaux de Coordination) were created that include “communities, user associations, producers organisations and cooperatives [farmers, fishers], grassroots NGOs and representatives of local administrations” (Newborne 2010: 69). The Local Coordination Committees consult with National Coordination Committees, which were set up in each member state and include members of ministries, professional bodies and national NGOs. Consultations between both types of committees ideally take place before the high-level meetings of the Permanent Water Commission (ibid; N’Diaye et al. 2007). While especially the local committees had difficulties communicating with government offices and suffered from financial and human resources limitations, particularly in the initial stages of the Project (Newborne 2010), the proliferation of local committees in all four basin countries can be seen as a success of the project. The World Bank (2009: xii) argues that through PASIE the “foundation of an institutional framework for effective transboundary communication and participation emerged” which introduced ”effective local stakeholder participation and elements of decentralized management in the planning and decision-making process for regional water resources management for the first time.”

3.1.7 Conclusions

To date, management of the Senegal River suffers from two on-going issues: conflicts of interest between regional/international, national and local actors; and between the peasantry that prefers recessional agriculture and the state’s interest in irrigation (N’Diaye 2007). Nevertheless,the example of the OMVS shows overall that regional cooperation provides benefits and advantagesover unilateral action. Problems were caused not by the decision to engage in basin-wide hydropower cooperation, but by the lack of efficient and effective implementation, especially with regard toenvironmental and social mitigation measures.

In detail, the following conclusions can be drawn from the example of the OMVS.

- **Expected mutual benefits served as a motivator for transboundary cooperation:**Riparian countries started to cooperate because of a common perceived need for basin-wide cooperation, not because they were in conflict with each other. The OMVS was created against the backdrop of countries’ plans to exploit the water resources of the Senegal. The immediate trigger was the Sahel drought. As a result, countries came together to form a river basin organisation that would be able to create food security and sustained economic development, including access to cost-efficient electricity.
- **Co-ownership and cost sharing provided the basis for an innovative approach to fair sharing of benefits.**The riparians acknowledgedthat they have limited sovereignty over the water resources of the international Senegal River. Furthermore, they adopted the principle of co-ownership of the dams and all other infrastructure built within the remits of the OMVS, and the allocation of costs based on the projected usage of the benefits. As a result, the member countries perceived that the OMVS regime is based on an equitable and fair apportioning of costs and benefits. This benefit sharing approach to transboundary cooperation was – and still is –innovative.

- **Cooperation benefits outweigh occasional conflict on specific issues.**The cooperative arrangement of the OMVS was a political success. It catered to the needs of the Senegal countries, and the distribution of costs and benefits embodies these needs. Nevertheless, conflicts could not entirely be avoided: the 1989 border conflict between Mauritania and Senegal, the 1999 conflicts between Malian herders and Mauritanian horsemen over a watering hole, and the 2001 dispute between Senegal and Mauritania over the Fossil Valley Project are all examples of conflicts which erupted. Still, however, the advantages derived from the OMVS outweigh the conflicts.
- **The multiple goals (irrigation, hydropower and navigation) of the dam projects could not be achieved due to financial constraints, implementation deficits, and bad planning**. Among the three goals, only the energy component reached satisfactory results as regards the provision of affordable and reliable electricity, albeit with major delays. SOGEM and EEM have also run up debts, as electricity bills are not paid on time or are not paid at all by the national utilities who bought the energy from EEM during EEM's involvement in the project. As for navigation, the goal of year-round navigation was never realized because of high investment costs, even though Diama Dam was built with a ship lock. The irrigation goal was never realized, with only 130,000 hectares developed, partly because the economic relevance of irrigated rice production was overestimated. (Yu 2008; World Bank 2006; KfW 2008; Parnall/Utton 1976; Horowitz/Salem-Murdock 1993).
- **Environmental impact mitigation measures that depend on donor funding risk being unsustainable in the long term**. All environmental impact mitigation measures taken by the OMVS were mandated by donors and their adoption was made contingent on continued funding. Due to its donor-led structure and the incomplete democratization processes, particularly in Mauritania, the effectiveness of the multi-stakeholder structure institutionalised by the Environmental Observatoryis also questionable without donor support and monitoring. This situation makes environmental mitigation measures strongly dependent on continued donor involvement and the OMVS dependent on continued donor funding.
- **Cultural importance as well as economic value of flood recessional agriculture should not be underestimated.** The resistance of local farmers to turn to irrigated agriculture led to theOMVS institutionalising artificial floods beyond the initially planned adjustment period from recessional agriculture to irrigated agriculture during 1988-1992. The operation of Manantali must now take into account the diverging water needs of irrigation agriculture, traditional recessional agriculture, and hydropower generation.

3.2 Parana River Basin – Itaipu Dam

3.2.1 Background

The Parana River originates in Brazil through the confluence of the Paranaiba and Grande Rivers. Upon flowing southwards, it forms the border between Brazil and Paraguay. Further downstream, the Parana meets the Iguazu River at the Iguazu Falls and forms the border between Paraguay and Argentina. The Parana then meets the Paraguay River, after which it continues through Argentina. Upon reaching the border of Uruguay, the Parana merges with the Uruguay River to form the Rio de la Plata, which then empties into the Atlantic Ocean. The Parana's waters are used for fisheries, both subsistence and commercial, navigation including deep-water ports, and hydroelectric power generation. The Parana River forms part of the much larger Rio de la Plata Basin, covering Brazil, Paraguay, Argentina, Uruguay and Bolivia.

Source: World Water Assessment Programme 2009, reprinted in Flinker 2012.

3.2.2 The regulatory and organisational framework for river basin management

There is no basin management plan for the Parana River alone. Management extends to the entire Rio de la Plata basin, covering Brazil, Paraguay, Argentina, Uruguay and Bolivia.

However, the existing legal and institutional framework for basin-wide cooperation is of limited effectiveness (this paragraph follows del Castillo Laborde 2008 274-275). In 1969 all five basin states signed the La Plata Basin Treaty. The institutionalization of basin-wide management was conducted against the backdrop of the creation of the Organization of American States (OAS) in 1960, which provided an institutional backing for development initiatives of member states, including a regional branch of the Economic and Social Council of the United Nations for Latin America to extend technical assistance, and the Inter-American Development Bank for financial assistance. Following the suggestion of Brazil to convene a Panamerican Conference on the rights and duties of riparian states, the OAS drafted a Convention on the industrial and agricultural utilization of international rivers and lakes in 1965, but it was never adopted by the Conference.

In 1966, Argentina asked the Inter-American Development Bank to conduct a study of the basin's water resources. As part of this development, all La Plata Basin countries met in 1967 and established the Coordinating Intergovernmental Committee as a permanent entity tasked to "assist countries in the joint and comprehensive study of the La Plata Basin and of outlining a programme of multinational, bi-national and national works" (del Castillo Laborde 2008: 275). The Committee was also to produce a treaty to formalize institutionalization of the basin. As a result, all basin countries signed the La Plata Basin Treaty in 1969, with the Committee as its operational body and the Foreign Affairs Ministers Meeting as its highest decision-making body.

Del Castillo Laborde (2008: 275-276) calls the resolutions by the Foreign Ministers Meeting "too general" and "with limited implementation at the national level". There is no duty for states to inform the Coordinating Intergovernmental Committee of any projects undertaken, and there are no provisions for prior consultation. Articles V and VI of the La Plata Basin Treaty specifically state that it does not prevent member states from pursuing bilateral or multilateral agreements or national projects within a member's sovereign territory. The purpose of the Treaty is thus not water management, and the treaty organisations are not planning and executing bodies. The structure established by the 1969 Treaty was conceived as a negotiating forum so that members would not block projects or disputes would not arise. The Treaty purposefully did not create constraints on member states, and the Foreign Ministers Meeting was not a substitute for bilateral negotiations (del Castillo Laborde 2008). Rather, projects had to be approved, planned and managed by each country and the respective national legal system (Wolf/Newton without date). This was the case for the Itaipu Treaty.

According to Wolf and Newton (without date), there are around 130 dams on the Parana River alone. A considerable number of these, however, are small dams. According to a Senior Economic Advisor at the Brazilian Ministry of Energy and Mines, there are the following large dams on the Brazilian stretch of the Parana: Itaipu (14,000 MW), Ilha Solteira (3,444 MW), Engineer Souza Dias, formerly known as Jupia (1,551 MW), and Engineer Sergio Motta, formerly Porto Primavera (1,540 MW) (personal communication, 30 April 2012). The most well-known project further downstream is the Yacyreta Dam on the border between Paraguay and Argentina.

3.2.3 The Itaipu Dam

The Itaipu Dam is located on the border between Paraguay and Brazil where the Parana River forms the border between both countries. Itaipu became operational in 1984, when the first generation unit began to produce electricity. A total of 18 units were installed until 1991. Two further units were installed in 2006 and 2007, reaching an installed capacity of 14,000 MW. Itaipu flooded an area of 1,350km². The Guaira Falls were submerged and the Guaira Falls National Park closed; 65,000 people were displaced.

3.2.4 Institutional setup and mechanisms for dam/hydropower management

Bilateral negotiations on hydropower generation date back to the 1966 Act of Iguazu between Brazil and Paraguay. Negotiations were acrimonious as both countries claimed possession of the Guaira Falls. In 1964, Brazil occupied the area around the falls, which was regarded as an act of aggression by Paraguay (Nickson 1981). Nevertheless, a change in Paraguayan foreign policy eventually led to the conclusion of the Act of Iguazu. The Act stipulated that both countries would share the energy produced at the Guaira Falls equally. The Act "constituted a diplomatic triumph for Brazil since it signified an implicit relinquishment by Paraguay of its former claim to sole possession of the Guaira Falls" (ibid: 21). In return, Brazil would withdraw its troops, and Paraguay agreed to lift bans on land purchases in its agriculturally valuable Eastern Border Region, which had already seen several decades of Brazilian immigration, albeit under heavy restrictions (ibid.).

The Act of Iguazu provided for detailed studies of the hydraulic resources of the Parana, and it stipulated that the power to be produced would be divided equally between both countries. Each country has the right to acquire, at fair prices, the unused energy of the other party for its own consumption (Ventura Filho 1999).

The Itaipu Treaty of 1973 created a bi-national entity, Itaipu Binacional, founded in 1974 and co-owned by Brazil and Paraguay. Itaipu Binacional was tasked with building and operating the Itaipu Dam as project owner (Egre 2007). The Board of Directors of twelve members is appointed in equal shares by both governments through their national utilities, Centrais Eletricas Brasileiras S.A. (Eletrobras) of Brazil and Administracion Nacional de Electricidad of Paraguay (Ventura Filho 1999; Itaipu Binacional without date-a).

Itaipu "is not associated with the Plata Basin Treaty organs in data exchange or in other programmes" (del Castillo Laborde 2008: 279). However, within Brazil, all energy generation and transmission facilities are centrally coordinated by the Operator of the National Electricity System (ONS) under the National Agency for Electricity (ANEEL). This means that all storage levels for reservoir dams can be optimized simultaneously. ONS is also in charge of Itaipu (personal communication with a Senior Economic Advisor at the Brazilian Ministry of Mines and Energy, 30 April 2012). This means that at least on the Brazilian stretch of the Parana, there is institutionalized control over the flow of the Parana.

The 1973 Itaipu Treaty led to conflicts with Argentina, which were resolved in the 1979 Tripartite Agreement on Corpus and Itaipu, which established the allowed water levels and changes produced by the upstream reservoirs (Flinker 2012). Low water levels would have threatened Argentinian plans for hydropower production, such as at the Yacyreta Dam downstream from Itaipu. When the Itaipu reservoir started to be filled in 1982, Itaipu Binacional had to comply with the downstream flow requirements set out in the 1979 treaty (Ventura Filho 1999).

3.2.5 Mechanisms for cost and benefit sharing

The construction costs for Itaipu were paid by loans, with the Brazilian government acting as guarantor and repayment coming from energy sales. In addition, the Itaipu Treaty confirmed the right of each party to purchase unused electricity from each other. Under the Treaty, the parties are not allowed to sell the energy to third parties. While Paraguay uses only roughly 5-10% of the electricity from Itaipu, Brazil consumes around 90-95% (BBC 2009a, b). Paraguay has thus been selling its unused share of the generated electricity to Brazil for a fixed price to the state-owned utility Eletrobras. In addition, Brazil pays Paraguay an annual lump sum in compensation for the use of Paraguay's share of the hydraulic resource.

The energy sales arrangement had long been perceived as unfair by Paraguay which claims that Eletrobras buys the energy comparatively cheaply and sells it with high profit margins in Brazil. However, the claims are refuted by the Brazilian side: the energy from Itaipu is valued in US Dollars, and the price therefore depends on the exchange rate. The energy from Itaipu is also expensive and was particularly so in the 1980s and early 1990s. Nevertheless, Brazil has been buying the energy, including the part that Paraguay does not consume, also at times when there was insufficient demand for this energy. Moreover, partly because of these factors, Eletrobras does not gain profits from the energy sales within Brazil. Furthermore, because Brazil consumes the bulk of the electricity, Brazil is the major contributor to Itaipu's revenue (Instituto Acende Brasil 2010: 19; personal communication with a Senior Economic Advisor at the Brazilian Ministry of Mines and Energy, 30 April 2012).
While the energy sales must continue under the Itaipu Treaty until the expiration of the Treaty in 2023, the Treaty does not prevent the parties from renegotiating the details. In 2009, after years of stalling, Brazil agreed to a re-negotiated agreement: Brazil's annual compensation payments were tripled from $120 million to $360 million, and the Brazilian government agreed to study whether Paraguay should be allowed to sell the unused electricity directly to the Brazilian market (BBC 2009a, b). The latter provision is still being studied (personal communication with a Senior Economic Advisor at the Brazilian Ministry of Mines and Energy, 30 April 2012).
In addition, under the 1973 treaty Itaipu Binacional pays monthly royalties (payment begun when the dam became operational in 1984) for the use of the hydraulic resource to the governments of Paraguay and Brazil. Royalties are paid in US dollars and are kept constant, taking into account the inflation of the dollar. In the submission to the World Commission on Dams in 1999, Itaipu Binacional stated a monthly sum of US$13 million that it paid to each country (Egre 2007; Ventura Filho 1999).Between 1985 and 2008, Itaipu Binacional paid a combined total of US$6.5 billion to both governments. In 2008 alone, the company paid US$218.9 million to each country.

While in Paraguay all royalties are paid to the national treasury and from there are distributed "according to government priorities" (Egre et al 2002: 35), in Brazil royalties are further shared on a domestic level. According to the Law 8001, passed in 1990, electric utilities have to pay financial compensation from the exploitation of water resources. The royalties thus go to the national treasury and from there are redistributed to states, federal districts, federal administrations and municipalities. The Brazilian government has to pass on the funds within ten days after the payment made by Itaipu Binacional (Itaipu Binacional 2007, 2008). The domestic allocation key was defined in the 1991 Federal Decree No. 1, also known as the Royalties Law. (Ventura Filho 1999; Egre et al 2002; Egre 2007; da Costa 2010):

- 45% to the affected states;
- 45% to the municipalities, which receive royalties as a proportion of the impounded land;
- 8% to the Federal Electricity Regulatory Agency;
- 2% to the Ministry of Science and Technology

For Itaipu, this key results in the following allocation:

- 10% to the federal government;
- 38.06% to the State of Parana, and 0.76% to the State of Mato Grosso del Sul, both of which are affected by the Itaipu reservoir;

- 6.29% to states affected by upstream reservoirs[5];
- 38.25% to municipalities affected by the Itaipu reservoir;
- 6.64% to municipalities affected by upstream reservoirs

The domestic revenue allocation key ensures that areas most affected by the project also receive the most royalties. Some of the directly affected municipalities depend on the royalties for their budget revenue. (Egre et al 2002. For more details on the arrangements in Brazil see Egre 2007: 24-27).Importantly, the Brazilian legislation on domestic revenue sharing of the royalties does not affect the provisions of the bilateral Itaipu Treaty or the obligations of Itaipu Binacional (Ventura Filho 1999). It is therefore a domestic arrangement independent of the bilateral agreements.

3.2.6 Mitigation mechanisms for environmental and social impacts

Mitigation for Itaipu can roughly be divided into the pre- and post-democratisation periods. In the 1970s and 1980s, the authoritarian regimes of Paraguay and Brazil had no participatory mechanisms in place. The impounding of the reservoir necessitated the resettlement of 40,000 people on the Brazilian and 25,000 people on the Paraguayan side. Resettlement was carried out in coordination between Itaipu Binacional and government officials, and Itaipu Binacional paid compensation costs for land acquisition in the amount of US$190 million (Ventura Filho 1999). However, compensation was overall insufficient to enable farmers to purchase new plots, and some displaced people did not receive any compensation, resulting in landlessness or marginal holdings and widespread poverty (McDonald 1993; Feldmann 1999; Kohlhepp 1987; Association of Island Dwellers Impacted by the Ilha Grande National Park without date). At the time of construction, Brazil and Paraguay also had no relevant environmental legislation in place. However, some wildlife rescue measures were implemented.

Since the turn to democracy, the royalties paid by Itaipu Binacional to Brazil and Paraguay have played a major role in social and environmental mitigation measures, at least in Brazil. In addition, Itaipu Binacional has its own environmental and social mitigation and outreach programmes. In 2005, both governments signed an agreement that social and environmental protection mechanisms should be a permanent part of Itaipu Binacional's activities.In 2005, Itaipu Binacional spent US$18 million on outreach and environmental activities in both countries, with the same amount invested in 2006. (Itaipu Binacional without date-b and c; Fernandez et al 2007; Agostinho/Gomes without date; Ventura Filho 1999).

Itaipu Binacional implements its mitigation and outreach programmes in the reservoir area and beyond in adjoining parts of the Parana Basin, an area defined as the Basin of Parana III. The widening of mitigation from the reservoir to Parana III began in 2003 with the start of the Cultivating Good Water programme (the following account is based on the Sustainability Reports compiled by Itaipu Binacional (Itaipu Binacional 2006, 2007, 2008, 2009, 2010). The programme includes sedimentation and erosion control, improving agricultural productivity, protecting biodiversity and ciliary vegetation, fish production and water quality control.

In terms of environmental protection, Itaipu Binacional's programmes include:

- Water quality monitoring: First started in 1983 by monitoring the reservoir and the main effluents, it was widened in 2005 to some of the micro-basins in the Parana III basin that

[5]The reason why Itaipu pays compensation for upstream reservoirs is that it benefits from the regularization caused by these reservoirs (personal communication with a Senior Economic Advisor at the Brazilian Ministry of Energy and Mines, 29 May 2012).

supply the reservoir and includes monitoring stations and sample collection points. Since 2006, Itaipu Binacional involves volunteers from the communities in the reservoir area in water quality control. Partner institutions in water quality programmes include the UN Food and Agriculture Organization (FAO) and UNESCO.

- Biodiversity: Itaipu Binacional has begun creating the Upper Parana Trinational Atlantic Forest Biodiversity Corridor (of which the Itaipu Binacional-run Santa Maria Biodiversity Corridor forms a part). On the reservoir's left bank, Itaipu Binacional maintains 34,000ha of protected areas, including a protection belt around the reservoir, in cooperation with surrounding municipalities and state supervision departments. Environmental research has been partly carried out in the Itaipu Environmental Laboratory since 1991, which provides research services for the Bela Vista Biological Refuge where there is also a wild animal nursery. Other sanctuaries maintained by the company are the Santa Helena Biological Sanctuary, and the Maracaju Bi-national Biological Sanctuary, which is jointly maintained by both governments. The company also replants indigenous tree species, has created a forest nursery, and runs programmes to advance knowledge on regional medicinal plants.
- Fishing: Before damming took place, 113 fish species were catalogued in the Parana River. The 2008 Sustainability Report states that currently 169 fish species are registered as living in the reservoir, meaning that an increase took place in the overall volume of species [note: it does not say if some species disappeared after damming]. To enable migration, a 10km-long fish spawning channel has been in operation since 2003, following extensive studies of the feasibility of fish passes for Itaipu (for the study period see Fernandez et al 2004, 2007). As regards reservoir fisheries, a fish germplasm bank was introduced, the number of fishing areas in the reservoir expanded, fishing rights allocated, and aquaculture (net-tanks) provided, including juvenile fish to stock the tanks. Aquaculture was introduced as an additional source of income for fishing communities. This is important as incomes can be precariously low during spawning season when fishing is forbidden over a 4-month period. Extractive fishing is overseen by Itaipu Binacional in cooperation with the State University of Maringa.

In terms of social engagement, the programmes include:

- Agriculture: Communities are trained in organic agriculture, soil conservation methods, and alternative sources of income such as beekeeping.
- Education and professional development: Itaipu Binacional has also funded professional qualification courses and alphabetization campaigns in cooperation with state and municipal education authorities and banks. Professional skill courses are also provided to Village C, a place where former Itaipu construction site workers and their families live.
- Rehabilitation programmes for Indian communities: Itaipu Binacional has provided assistance in food, housing and agricultural production (such as the provision of seeds) as rehabilitation measures to Indian communities in the reservoir area that have lived in impoverished conditions since their resettlement. Professional skill courses are also provided to Village C, a place where former construction site workers and their families live. Tourism promotion is another alternative source of local income promoted by Itaipu Binacional.
- Since 2003, Itaipu Binacional has also funded essential health services in the three-country border area of Brazil, Paraguay and Argentina, including a hospital and disease prevention programmes, in collaboration with health authorities from all three countries (Itaipu Binacional 2006, 2007, 2008, 2009, 2010).

Itaipu's large budget for environmental and social mitigation measures is owing to two facts: first, Itaipu is run under a cost of service energy tariff. This means that consumers need to pay for all of Itaipu Binacional's expenses. The higher the expenses, the higher the energy costs from Itaipu. Itaipu Binacional therefore has no incentive to operate economically. Second, the 1973 Itaipu Treaty stipulates that Itaipu Binacional needs to spent equal amounts for social and environmental monitoring programmes in both countries. For example, if spending for the Paraguayan side increases, spending on the Brazilian side must equally increase. Due to Paraguayan pressures for higher spending on the Paraguayan side, Itaipu Binacional commands large sums for social and environmental monitoring programmes (personal communication with a Senior Economic Advisor at the Brazilian Ministry of Energy and Mines, 30 April 2012).

3.2.7 Conclusions

The work that Itaipu Binacional invests in social and environmental mitigation measures shows two important aspects of hydropower management: first, cooperation in hydropower projects should not be limited to short-term compensation measures, but encompass long-term plans for joint management, mitigation and benefit-sharing;second,hydropower developers and operators themselves, such as Itaipu Binacional, can play an important role inthe governance network responsible for hydropower management.
In detail, the following conclusions can be drawn from the Itaipu case:

- **Basin-wide agreements can provide a supportive framework for bilateral hydropower projects**. Although the creation of the La Plata Basin Treaty did not impose on member states any limitations regarding the scope of their work, the function of the treaty as an umbrella treaty for bi- and multilateral river works provided a continuous forum and reference point for member states to resolve disputes. There has been altogether peaceful exploitation of the basin's water resource by the five riparians. The treaty can therefore be regarded as a diplomatic success.
- **Arrangements with affected states that are not directly involved inthe project can be of additional value for regional hydropower coordination.** The need to coordinate water management between countries along the Parana became necessary as Itaipu threatened the operation of Yacyreta. The tripartite treaty with Argentina stipulates water levels, which means that all upstream dams must be operated in a way that conforms to the treaty. This would also ensure a minimum downstream flow for hydropower stations there, such as Yacyreta. As a result, although there is no basin-wide organisation for the Parana River, there is some coordination between Brazil, Paraguay and Argentina.It is noteworthy that at least inside Brazil, a coordinated management of dams exists: ONS has the ability to centrally optimize water levels in the basin for electricity production.
- **International cost sharing and compensation agreements need to be flexible to accommodate emerging developments**. Since the bilateral Itaipu Treaty does not stipulate the details on energy sales and compensation payments, bilateral conflicts between Brazil and Paraguay over the arrangements could be solved through re-negotiation. This allowed continuing fruitfull cooperation.
- **Domestic benefit-sharing arrangements as well as continuous programmes run by dam operators can help mitigating social and environmental impacts in the long-term**. Brazil's participatory and revenue sharing practices after 1988 improved the social aspects of the dam in particular, including reservoir fisheries management and local income. While Itaipu Binacional remains unaffected by this, corporate social responsibility practices have improved over time, includingextensive environmental and social mitigation programmes. Both governments have also acknowledged that social and environmental

monitoring must be a constant part of Itaipu Binacional’s operations. This should ensure a large enough budget to implement such programmes also in the future.

3.3 Columbia River Basin – Columbia River Project

3.3.1 Background

The Columbia River rises in the Rocky Mountains of British Columbia, Canada, flowing first northwest then southwards through multiple U.S. states before emptying into the Pacific Ocean. The basin area has a size of about 668,400 km². The two riparian countries Canada (101,900 km²) and the USA (566,500 km²) are both in an up- and downstream position (UNEP without date). The river,with its major tributaries Snake River, Willamette River, Kootenay River and Pend Oreille River,is the fourth-largest river (by annual discharge of 7300 m³/s) in North America. Due to its relatively steep gradient it offers a significant potential for the generation of hydropower, which has been used for decades. As a result, the basin is the most hydroelectrically developed river system in the world, with more than 130 large mainstream and tributary dams (as of 2010) (Ferguson et al. 2010; Hyde 2011; Yu 2008).

Source: Hyde, 2011.

3.3.2 The regulatory and organisational framework for river basin management

In 1909 the Boundary Waters Treaty between Canada and the USA was signed. It provides principles and mechanisms to resolve and prevent disputes regarding transboundary water

resources of the two countries. The International Joint Commission (IJC), which is composed of 3 commissioners from each country, was formed under this Treaty.
Canada and the USA were both interested in the hydropower potential of the Columbia River and therefore asked the IJC to investigate the development of the water resources of basin in 1944. However, the pressure for tapping further sources of energy in the USA was higher than in Canada, because the energy demand had increased considerably during the Second World War. During the Great Depression, the USA had also already started the construction of federal hydropower projects for economic development.
Thus, the IJC established the International Columbia River Engineering Board, which conducted the needed studies in the following 15 years. During this period the disastrous flood of 1948, which caused damages and several deaths in both countries, influenced and accelerated the on-going discussions. In the 1950s the USA updated its master resource plan for the development on the Columbia River. The latter and the IJC studies recommended the development of upriver storage on the main river and its tributaries to address flooding and growing energy demands.
The IJC study had elaborated the principles of determining and apportioning benefits from the cooperative use of storage. Guided by these principles, formal negotiations resulted in 1961 in the Columbia River Treaty (CRT), an international agreement for the cooperative development of water resources regulation in the upper Columbia River (for details see below). A range of treaties, conventions and agreements regarding transboundary rivers other than the Columbia and dealing with e.g. water quality or toxics have further been signed by Canada and the USA (Hyde 2011; Yu 2008; Ketchum/Barroso 2011).

3.3.3 The Columbia River Treaty dams

To provide the needed reservoir storage for power generation and flood control, four dams were constructed under the CRT: three in Canada (Duncan Dam 1968, Keenleyside/Arrow Dam 1969, Mica Dam 1973) and one in the USA (Libby Dam 1973).
The Libby Dam is built on USA territory but its reservoir extends into Canada. Completed in 1975, the dam spans the Kootenay River with a length of 931m and a height of 112m. 1.4km³ of the total 6.3km³-large reservoir, named Lake Koocanusa, is in Canada. The powerhouse contains five turbines and is capable of generating 600 MW. At full capacity, the dam can pass over 4,500 m³/s of water (Muckleston 2003; Hyde 2011; Yu 2008).
The Mica Dam on the Columbia River has four generating units with a combined maximum capacity of 1,805 megawatts (MW). Two new units are planned that will generate approximately 1,000 MW. The reservoir has a size of 8.63 km³ (B.C.-Hydro without date). Keenleyside Dam (originally known as the Arrow Dam) is located downstream of the Mica Dam and has a reservoir of 8.76 km³. In 2002 an 185MW powerhouse was added; owned by the Columbia Power Corporation. Prior to that, the dam was used for storage only. Duncan Dam was also built as a storage facility on the Duncan River without power generation facilities. Duncan and Libby Dam together ensure operational water levels for the Kootenay Canal and Corra Linn Dam projects further downstream on Canadian territory (BC-Hydro without date; CBT without date-a).
In terms of environmental and social impacts around 2,300 people were displaced due to the CRT dams and about 60,000ha of high-value land was flooded (Egre 2007).None of the dams have fish passage facilities because the passage of anadromous fish had already been blocked by the construction of downstream U.S. Grand Coulee Dam in 1941, which led to a decimated fish population in the river.

3.3.4 Institutional setup and mechanisms for dam/hydropower management

The CRT negotiation process was marked by national differences: Canada was mainly afraid to lose sovereignty of its natural resources while the USA was worried that Canada could divert water out of the basin if no agreement could be achieved. Besides, disputes arose on the Canadian side between the Canadian federal and provincial governments, resulting in a four-year postponement of the CRT implementation. In Canada the provinces have sovereignty over natural resources in their territory, which led to many debates in British Columbia regarding the location of the dams and the trade-offs.

Thefinally adopted treaty included the construction of three dams in Canada and one dam in the USA. Main purpose of the three Canadian dams (Arrow, Mica, and Duncan) is to raise the storage capacity in Canada and to increase the power generation outcome in the USA. Canada is allowed to operate its individual projects with substantial flexibility as long as the net flow requirement at the border of the USA is met. The USA also received permission to build the Libby Dam, whose reservoir extends into Canada. The CRT further established Canada's right to certain U.S. downstream power benefits, i.e. to some of the power that can be generated in the USA as a result of the additional storage regulation provided by Canada(see below for more details on the benefit sharing arrangements).In addition, the CRT lays down provisions for flood control which obligate Canada to provide assured annual water storage at the three CRT reservoirs, as well as additional 'Called Upon' flood control during periods of very high flows (Columbia River Treaty 1964).

In the frame of the CRT two Entities were designated that are in charge of implementing the treaty. The U.S. Entity consists of representatives of Bonneville Power Administration (BPA), which is a federal power marketing entity that markets the generated power from the Libby and several other dams. The North Pacific Division of U.S. Army Corps of Engineers (USACE) is the other part of U.S. Entity. It directs and coordinates reservoir operations in most of the Columbia River system, also regarding the Libby Dam. The British Columbia Hydro and Power Authority (B.C. Hydro) is the Canadian Entity. The duties of the Entities include: coordination of plans and exchange of information; periodic calculation of compensations and benefits; establishment and operation of a hydro-meteorological system; preparation of hydroelectric operating plans and flood control operating plans for the Canadian storage; etc. The Entities have established Coordinators, Secretaries, an Operating Committee, and a Hydro-Meteorological Committee to perform most of the CRT activities (Hyde 2011). Furthermore, a Permanent Engineering Board was set up by the Entities, consisting of personnel from each country by equal share, which are responsible for collecting statistics, ensuring that the objectives of the treaty are met, assisting in settling differences that may arise between the Entities, and creating annual reports of the results achieved.

Under the treaty, two operation plans were introduced that are jointly prepared by the Entities: The Assured Operating Plan (AOP) is developed for a six-year period to guide flood control and power generation operations. The Detailed Operating Plan (DOP) is prepared annually and updates the AOP by using updated reservoir-level information. Moreover, the DOP goes beyond flood and power objectives to address other requirements regarding for example fisheries and recreation (Yu 2008).

Each Entity is authorized to make maintenance curtailments, but must give notice to the other Entity of the reason for the maintenance and the probable duration (except in the case of emergency maintenance). Both countries can cancel the CRT after 60 years, i.e. in 2024. However, cancellation must be communicated 10 years in advance. Thus, both countries are currently studying post-2024 treaty issues to decide on the continuation, amendment or termination of the CRT.

Apart from this, the CRT stipulates that certain terms of the CRT will continue on during the useful life of the dams, even if the treaty is terminated. This includes the 'Called Upon' flood control provisions, Libby Dam coordination obligations, and Kootenay River diversion rights. As part of the 'Called Upon' flood control provisions, Canada must provide flood control operation for the USA as long as a need and relevant dams exist. In return the USA must meet any attendant operating costs and resulting economic losses. If the CRT is terminated, the Mica, Duncan, Arrow, and Libby Dams will be subject to the Boundary Waters Treaty (UNDP-GEF 2011;Columbia River Treaty 1964; USACE/BPA 2009; Yu 2008).

3.3.5 Mechanisms for cost and benefit sharing

As agreed in the CRT the USA is required to pay Canada one-half of the estimated increase in U.S. downstream power benefits (in terms of energy and capacity)that result directly from the operation of the Canadian CRT dams (the Canadian Entitlement). The Canadian Entitlement is determined in advance based on 30-year simulation studies undertaken as part of the AOP (Ketchum/Barroso 2006, for details on the calculation of the Canadian Entitlement see also Hyde 2011: 9-10). For the period of the first 30 years Canada sold this Entitlement for US$254 million to a consortium of U.S. utilities because the energy was not needed in British Columbia at that time. Since the agreement expired in 2003 the power is delivered directly to the Province of British Columbia at the border on a daily schedule (USACE/BPA 2009; Yu 2008; Hyde 2011). According to the Columbia Basin Trust, the Canadian Entitlement is worth approximately US$150 - 300 million annually (CBT without date-e).
It was also agreed uponin the CRT that the USA would make a monetary for one-half of the value of the estimated future flood damages prevented in the USA during the first 60 years of the treaty. Instead of receiving an annual payment for the flood control benefits, Canada chose to get a lump sum payment in 1964 (in total US$64.4 million). In return Canada was indebted to construct and operate the CRT treaty dams Mica, Arrow and Duncan. Regarding the reservoir of the Libby Dam, the USA reimbursed the costs for resettlement and relocation of transport infrastructure in Canada. The USA also has to pay compensation for the operation costs which will result in the event of a claim from the negotiated 'Called Upon' provision(USACE/BPA 2009; Yu 2008; Hyde 2011).

3.3.6 Mitigation mechanisms for environmental and social impacts

Environmental and social concerns came up as a result of the constructed dams and were increasingly discussed and demanded by the public. Issues raised included fish decimation and the need for fish passage, recreational water-level requirements, wildlife and vegetation issues, and heritage site protection. In reaction, the Entities agreed upon changes in dam operation in several Supplemental Operating Agreements (SOAs). SOAs enable both countries to gain additional benefits during the operating year by negotiating trade-offs in dam operation (e.g. harmonised storage releases, compensation payments for power benefit losses, water transfer between reservoirs). Changes regarding fishery and recreational requirements can also be incorporated in the DOPs, but only to a little extent. All agreements and proposed changes to the operating parameters are based on datafrom continuous flow monitoring and studies, which the two entities frequently undertake to evaluate impacts on reservoir level and generation regimes (Ketchum/Barroso 2006)
The SOAs address mostly fishery and recreational objectives, as does the most important SOA, the Non-Power Uses Agreement (NPUA) that has been signed by the Entities every year since 1993. Under the NPUA storage releases are adapted to reduce dewatering and the mortality of spawn of specific fish species in Canada as well as to increase the survival

rate of young salmon downstream in the USA. Compensation is strictly “fish benefits for fish benefits” (Email correspondence with Kelvin Ketchum, Chair of Canadian Section, Columbia River Treaty Operating Committee, 01 June 2012). The NPUA thus enables Canada as well as the USA to meet national fisheries goals and to comply with national conservation legislation.

Another important arrangement is the Libby Coordination Agreement. This agreement recognized that certain operation patterns for Libby Dam are necessary to meet the U.S. Endangered Species Act (for protecting sturgeon, trout, salmon), and created several procedures to mitigate adverse impacts in Canada. The USA has to compensate Canada for potential lost power benefits due to the measures. (UNDP/GEF 2011; Hyde 2011; Ketchum/Barroso 2006).

In the beginning of the 1990s the pressure from Canadian civil society rose, which demanded to profit from the Canadian CRT benefits. Thus, the Canadian Columbia Trust (CBT) was set up in 1995 to compensate people affected in the basin for social and environmental impacts. The Province of British Columbia endowed the trust with CAN$295 million over a 5 year period. Additionally the CBT received an annual operational endowment of CAN$2 million for 16 years from the province. These funds were not directly related to the Canadian Entitlementbut came from the province’s general revenues.The local communities were actively involved in the creation of the trust and are also directly involved for example in the form of consultative committees or in choosing trust projects.

The CBT funds have been used for instance to build power stations on existing reservoirs to promote economic development in the region. Revenues from these projects are reinvested in the areas of environment, economic development, social, education and training, youth initiatives, arts, culture and heritage in the basin region (Egre 2007; CBT without date-c). The CBT is also involved in monitoring environmental and social effects. The Waneta Expansion Project Socio-Economic Monitor for the Wanted Dam, for example, aims to ensure thatthe project’s impacts on local communities are documented and published. Indicators such as employment, wage income, expenditures, economic development, traffic, health and safety, housing, population, recreation and community services are monitored in cooperation with a community impact management committee (CBT without date-d). Local communities can also get involved in watershed groups, which collect water quality data according to a common monitoring protocol established within the framework of the Columbia Basin Water Quality Monitoring Project (CBT without date-b).

In the USA national programmes addressing the environmental impacts of dams are not directly connected to the CRT dams, but address the entire Columbia River Basin on U.S. territory. For example a fish and wildlife program was developed by the Northwest Power and Conservation Council in 2005 and funded by the BPA. Itaims to guarantee adequate and reliable energy at the lowest economic and environmental cost (Northwest Power and Conservation Council without date). Furthermore, the Washington Department of Ecology set up the Columbia River Program for “coordinating and promoting effective protection and restoration of fish, wildlife and their habitat in the Columbia River Basin” in 2006 (www.cbfwa.org;www.ecy.wa.gov).

3.3.7 Conclusions

The coordinated development and management of dams in the Columbia River basin enabled both countries to implement their national development strategies and generate significant benefits,which they would not have been able to achieve through unilateral action. For instance, Canada profits from the generated energy, flood control, and the compensa-

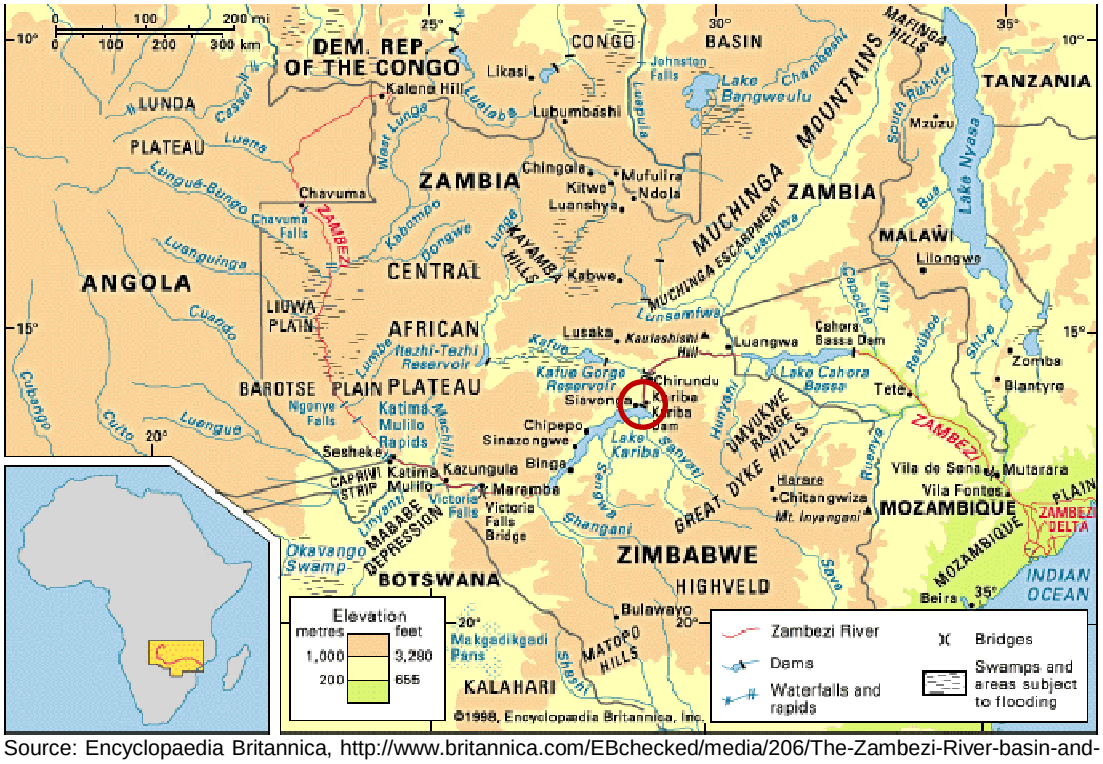
tions paid by the USA. The latter also benefits from flood control, the reliable capacity of power plants, greater operational flexibility and increased energy generation. In conclusion:

- **Reliable transboundary cooperation mechanisms and flexible operation plans facilitate transparent and efficient operation of dams.** The mechanisms for joint planning and coordinated operation of dams under the CRT include six year Assured Operation Plans, yearly Detailed Operation Plans and Supplemental Operating Agreements that can be adopted from time to time. This framework provides for planning reliability with regards to power generation and flood control on the one hand, and flexibility to generate additional benefits, including environmental and recreational, on the other. The two national entities responsible for implementing the Agreement conduct joint studies to decide on operating plans and hold weekly conference calls to discuss the upcoming week's CRT storage discharge. These coordination mechanisms have helped establish trust-based and transparent cooperation. This becomes evident, for example, in the fact that mitigation measures and changes to operating rules could be accommodated without arduous negotiations. In several cases, these changes allowed riparian countries to comply with their national policies, e.g. for fish protection.
- **Continuous compensation payments provide a suitable mechanism for reimbursing each participating party according to costs borne.**The CRT lays down that downstream benefits, and through this also the cost for the construction and operation of the Canadian dams, are explicitly shared between riparians. This does not only refer to the Canadian Entitlement to downstream power benefits but also to compensation payments for power losses resulting from dam operation according to frequently agreed SOAs as well as from dam operation to meet called upon flood control. Long term benefit sharing agreements, however, risk becoming unfair with changing conditions. The benefit sharing under the CRT became unequal since the Entitlement sale expired in 2003, because Canada's Entitlement today is much larger than was expected in 1964, whereas the U.S. power benefits decreased due to the operation of U.S. dams for fishery objectives instead of an optimum power outcome (Hyde 2011).
- **Local benefit-sharing mechanisms and participatory programmes can support mitigation of social and environmental effects.** At the time of CRT negotiation, there was relatively little concern about environmental and social issues. However, increasing public awareness and pressure has required both countries to react. While the SOAs provide a framework for coordinated implementation measures, national programmes play an important role in monitoring and mitigating social and environmental effects in the Columbia basin. In Canada, the Columbia Basin Trust provides for localsharing of benefits and participatory monitoring of social and environmental effects, in the USA the Northwest Power and Conservation Council promotes inclusion of environmental issues in hydropower management. However, these national programmes were established decades after the dams and thus could not prevent negative effects.

3.4 Zambezi River Basin – Kariba Dam

3.4.1 Background

The Zambezi River flows from its source in the Kalene Hills in Zambia through Angola, Namibia, Botswana, Zimbabwe, Malawi, and Tanzania and empties into the Indian Ocean in Mozambique. The waters of the Zambezi are used for agriculture, fishing, cattle grazing, industrial development, navigation and hydropower. Hydropower is generated at the mainstream at Kariba and Cahora Bassa, as well as on tributaries, particularly at the Itezhi-Tezhi and Kafue Dams on the Kafue River in Zambia and the Kamuzu Barrage on the Shire River. In 2010, Mozambique authorized construction of the Mphanda Nkuwa Dam on the Zambezi, located 60km downstream from Cahora Bassa (Agencia de Informacao de Mocambique 2010).



Source: Encyclopaedia Britannica, http://www.britannica.com/EBchecked/media/206/The-Zambezi-River-basin-and-its-drainage-network.

There are two institutions that bear relevance for this case study: the bilateral Zambezi River Authority owned by the governments of Zambia and Zimbabwe, which manages Kariba Dam; and the Interim Secretariat for the Zambezi Watercourse Commission that oversees Zambezi-wide water management. As will be explained below, the Zambezi River Authority operates independently of the Interim Secretariat

3.4.2 The regulatory and organisational framework for river basin management

The Kariba Dam is managed by the bilateral Zambezi River Authority, which was established in 1987 as successor of the Central African Power Corporation that had managed Kariba since 1963 (details see below). The bilateral management of Kariba therefore long predates

the effort to establish a basin-wide Zambezi River organisation. This effort started in 1987 with the inauguration of the Zambezi Action Plan (ZACPLAN). ZACPLAN was largely a donor-driven initiative and guided by United Nations Environment Programme (UNEP). The riparians adopted ZACPLAN in 1987, upon which it was also adopted by SADC. However, due to a lack of political will, implementation was sluggish, with the lack of funding and leadership as the twin causes. ZACPLAN comprises 19 projects (ZACPLAN projects, or ZACPROs), which were supposed to be finished by 1996. Yet, by then none of the projects had been completed (Shela 2000). Of the 19 projects, ZACPRO 6 was designed to develop an integrated water management plan for the Zambezi River (ZRA without date-b; Tumbare 1999).

In detail, ZACPRO 6 aimed at setting up a Zambezi Watercourse Commission (ZAMCOM), a water resources management system (including models and joint planning guidelines), and a basin-wide IWRM strategy. Assistance for ZACPRO 6 came from the Swedish International Development Cooperation Agency (SIDA), the Norwegian Agency for Development Cooperation (NORAD) and the Danish International Development Agency (DANIDA) (ZRA without date-c). Phase II of ZACPRO 6, executed by the Zambezi River Authority (ZRA) on behalf of SADC, started in 2001. It focussed on the establishment of an Interim ZAMCOM Secretariat.

In 1995, the SADC states adopted the 1995 Protocol on Shared Watercourse Systems (henceforth: SADC Water Protocol), which was the result of ZACPRO 2 (Development of Regional Legislation for the Zambezi River Basin). Institutionally, ZACPLAN is implemented by the SADC Water Division (Shela 2000). The SADC Water Protocol also guided the implementation of ZACPRO 6 (Tumbare 1999). Apart from the SADC Water Protocol, all riparians are also members of the 2008 Zambezi River Basin Integrated Water Resources Management Strategy and Plan (SADC 2011).

In 2004, seven of the eight riparian countries signed the ZAMCOM agreement with the provision that it would enter into force when two-thirds of the riparian states have ratified the agreement through their parliaments (Turton 2008). It was only in May 2011 that the Interim ZAMCOM Secretariat was established to begin the institutional build-up for ZAMCOM. Until then, the SADC Water Protocol functioned as a “surrogate basin-wide agreement” (ibid: 60). Of the countries in the Zambezi Basin, Malawi has signed but not ratified the ZAMCOM agreement, and Zambia has neither signed nor ratified it (interview with Anthony Turton, 24 May 2012).

The one-year-old Interim ZAMCOM Secretariat means that the Zambezi River Basin does not yet have a functioning basin-wide management organisation. Despite the 24-year history of attempts to establish ZAMCOM, hydropower projects are still operated as individual projects with no coordination between them (SADC 2011). In addition, dams, whether for hydropower or other uses, are operated to fulfil their primary function but “do not generally incorporate the environmental and social needs downstream and upstream” (ibid: 2). There is also no basin-wide flow forecasting system, which is essential to achieve coordinated management of all basin dams. Flow forecasting has so far been on a national or bilateral basis for the purpose of operating single projects (ibid: 6). Furthermore, riparian water policies “are not harmonized” with each other or with the SADC water protocol, policies and strategies, or the ZAMCOM agreement. There is also a “[l]ack of trust and confidence” (ibid: 8).

In addition to the SADC Water Protocol and the now established Interim ZAMCOM Secretariat, there are many bi- and multilateral agreements between riparian states of the Zambezi, the oldest being the agreement that established the ZRA between Zambia and Zimbabwe for the management of the Kariba Dam (Turton 2008).

3.4.3 The Kariba Dam

The decision to build Kariba was made by the Central African Federation, composed of the British Colonies of Northern Rhodesia and Nyasaland, and self-governing Southern Rhodesia. While Northern Rhodesia favoured a dam at Kafue Gorge on the Kafue River as it was a cheaper option and closer to the Copperbelt (it would also be a national option following independence), Southern Rhodesia favoured the location of Kariba at the border between both territories on account of its larger energy generating capacity. The purpose of Kariba was to produce energy for the copper mines in Northern Rhodesia and for the industrial urban centres in Southern Rhodesia. The federal government eventually decided to build Kariba on the Zambezi mainstreamat the Kariba Gorge, and thus on the border between Zambia and Zimbabwe(for a detailed history see Scudder 2005).

The dam has a height of 128m. Lake Kariba, its reservoir,has a surface area of 5,400km² and a volume of 180km^3. The Kariba dam was financed by a number of actors; according to Scudder (2005), the World Bank contributed a loan of GB£28.6 million, mining companies and Barclays and Standard Banks contributed GB£28 million, and the Commonwealth Development Corporation GB£15 million.The first stage of the dam including the southern power house was constructed between 1955 and 1959. The south station belonging to Zimbabwe has been in operation since 1960 and has six generators of 125 MW capacity each. The north station belonging to Zambia has been in operation since 1976, and has four generators of 180 MW each. The total generating capacity is thus 470 MW (ZRA without date-a).

Construction of the dam and filling of the reservoir necessitated the resettlement of 57,000 people and caused a decline in fisheries as well as agricultural and grazing resources downstream. In addition, the expansion of tsetse flies parallel to the expansion of the reservoir could only be met with extensive spraying efforts.

3.4.4 Institutional setup and mechanisms for dam/hydropower management

The authority to build and manage Kariba was handed to a newly established Federal Power Board in 1955. In the 1960s, the Central African Federation broke apart with the independence of Nyasaland as Malawi in 1963, Northern Rhodesia as Zambia in 1964, and the illegally declared independence of Southern Rhodesia as Rhodesia (Rhodesia would become legally independent in 1980 as Zimbabwe). Following the break-up of the Federation, the United Kingdom established CAPCO in 1963 “to take over the functions, staff and assets of the Federal Power Board and a Higher Authority for Power to approve major policy decisions” (Scudder 2005. 7; Agreement Relating to the Central African Power Corporation 1963).

The history of Kariba is bedevilled by the competition and distrust between Zambia and Zimbabwe. In particular: In Zambia, the authorities believed that the Kariba project was yielding more benefits to Zimbabwe. When the northern bank power stations were completed in 1975, Zambia’s demand for power had stagnated while Rhodesia’s power demand soared. Because CAPCO bought electricity at cost, including that generated in Zambia with funds independent of CAPCO’s, profit from Zambia’s major energy investments went to an organisation that not only allocated significantly more joint revenue for extending the transmission system in Zimbabwe than in Zambia, but also sold more electricity to Zimbabwe from joint facilities due to that country’s higher growth rate during the 1980s.

Such problems led to CAPCO being replaced in 1988 by the ZRA with a more restricted mandate. Though still responsible for running the Kariba facilities and for planning and im-

plementing additional dams on the Zambezi, the distribution of power as well as budgetary authority had been handed over to the appropriate ministries in the two countries (Scudder 2005: 7).
The ZRA was founded by “two identical Zambezi River Authority Acts of parliament in 1987, one for Zambia and the other for Zimbabwe” (Shela 2000. 74). It is governed by a Council of Ministers and a Board of Directors, which are staffed by ministers and permanent secretaries from the Ministries of Energy and Finance. The 1999 Zambezi River Authority Amendment Act provided for the recruitment of more Zambians to junior-level positions in the ZRA Operational Station at Kariba in order to equalise the dominance of Zimbabweans in junior-level positions (Mukosa/Mwiinga 2008).The Zambezi River Authority is therefore left with the responsibility of operating and maintaining the dam structure as well as with studying new potential dam sites (ZRA without date-a). The power stations are operated by the national utilities of Zambia (north bank power station) and Zimbabwe (south bank power station).

3.4.5 Mechanisms for cost and benefit sharing

When the ZRA was founded, the funding arrangement was that both governments would contribute equal amounts through their national utilities, the Zimbabwe Electricity Supply Authority and the Zambia Electricity Supply Corporation (ZESCO). The arrangement was later altered to even out perceived imbalances where “one country would utilise more water to generate power than the other but still contribute equal amounts to the operations of ZRA” (Mukosa/Mwiinga 2008: 3). Furthermore, the utilities felt that they did not have to pay their bills where there are no deliverables attached. As a consequence, the Council of Ministers created a tariff structure that “takes into account the quantity of water used by the respective Utilities to generate electricity” (ibid.). Payments to the ZRA are therefore based on the volume of water used for energy generation, which is “easier than to have to convert energy to its water equivalent” (ibid.). The tariff structure and the water allocation regulation were laid down in the 1999 Zambezi River Authority Amendment Act and the 1999 Zambezi River Authority (Water Tariff) By-laws (Statutory Instruments No. 302 and 109 of 1999, respectively) (ibid).
As a result, the ZRA installed flow metres at Kariba “to measure the actual quantities flowing through the turbines” (ibid: 4). The tariff structure allowed the ZRA to allocate an equal amount of water from the Kariba Reservoir (based on the flow/energy forecasts) to each utility for each ensuing year and charges a tariff on the actual amounts used. The By-laws also provide for incentives for efficient utilisation and penalties for over-utilisation of water by the utilities. The Authority executes these By-laws through tri-annual reviews of a Water Purchase Agreement between ZRA and the utilities. However, the water tariff itself is reviewed annually by a Joint Operations Committee comprising ZRA, ZESCO and Zimbabwe Power Company (ZPC, a subsidiary of Zimbabwe Electricity Supply Authority Holdings) (ibid.). As a result, a solution to previous disputes could be found through the joint institution and its technical work.

3.4.6 Mitigation mechanisms for environmental and social impacts

The Kariba dam was, according to Scudder (2005), considered a successful dam even by affected people based on conventional cost benefit analysis. However, the dam also involved unacceptable environmental and social impacts on resettlers, the delta and other wetlands of the Zambezi River.While the French feasibility study for Kariba undertaken in the 1950s made no mentioning of resettlement issues, Kariba led to the resettlement of 57,000 people of the Gwenge Tonga tribe. Resettlement was the responsibility of the authorities of

the territories of Northern and Southern Rhodesia. Self-governing Rhodesia had already decided to relocate the Tonga away from the reservoir area, while the system of indirect rule of Northern Rhodesia included participation of the Tonga in choosing resettlement sites. The problem in Northern Rhodesia however was, despite “commendable” (Scudder 2005) efforts by the colonial officials, one of understaffing, insufficient planning partly due to the decision to increase Kariba’s wall height (thus extending the reservoir and leading to the flooding of already identified resettlement sites), and the suspicion of the Tonga that they had to make way for white farmers (for how Kariba was part of a white development vision, see McDermott Hughes 2006).In the end, the time pressure to complete Kariba due to soaring energy demand in Northern and Southern Rhodesia led to a hasty process. A well-intended resettlement plan therefore resulted in wide impoverishment of the resettled population in Northern Rhodesia/Zambia (Scudder 2005). On the positive side, the Kariba authorities on the Zambian side developed a successful reservoir fishery in Lake Kariba, with fish stocked that was appropriate for the depth of the reservoir. This artisanal fishery provided substantial benefits to thousands of resettlers and hosts in Zambia, and also benefited fishery in Zimbabwe(Scudder 2005).

In the 1990s, ZRA started a rehabilitation programme for the resettled communities in Zimbabwe. In 1998, ZESCO began a similar programme for those resettled in Zambia (ibid.). While the ZRA hoped that the World Bank would fund the Zimbabwean operation, the Bank confined its commitment to the Zambian side. Rehabilitation in Zambia under ZESCO guidance formed part of Zambia’s reform of the energy sector. With funding from the World Bank and the Southern African Development Bank, ZESCO launched a Power Rehabilitation Project to improve energy production at Kariba north bank, Kafue and Victoria Falls (ZESCO without date). The Power Rehabilitation Project also included the Gwembe Tonga Rehabilitation and Development Project (Musonda 2008), to which the World Bank committed US$5 million for the following sectors: (a) the rehabilitation of 365km of a key road (‘the Bottom Road’) that connects the three districts that have received the resettled people; (b) water resources development combining improved water supply and improving cropping patterns along the margins of the reservoir that are timed to coincide with the patterns of reservoir drawdown and refilling; (c) improvement of land use through strengthened agricultural extension facilities, including a pilot agriculture scheme. In addition, a fund is to be created to support micro-projects dealing with land use; (d) upgrading of health facilities and services; and (e) electrification of three of the large villages (Chipepo, Gwembe Boma and Sinazeze), as well as the area around the reservoir (World Bank 1998; Scudder 2005).
While the resettlement programmes focussed on communities affected by the filling of the dam’s reservoir, negative effects also occurred downstream of the dam. The destruction of the natural flood cycle and the reduction in sediments and nutrients that are trapped in the Kariba (and also Cahora Bassa) reservoir led to a decline in fishing, agricultural and grazing resources down to the delta area. In addition, downstream agriculture was made impossible as dam designers tested the dam’s safety by experimenting with flood releases. Flood releases were designed for dam safety rather than environmental flow, thus regularly destroying already planted crops in the downstream areas and flooding villages with no prior or only excessively late notice. Anticipatory flood management that would take into account the amount of rainfall did not begin until the 2001-2002 rainy season (Scudder 2005; Tilmant et al. 2010).

As for the environment, the only effort taken by the colonial authorities when the reservoir began to fill in the late 1950s was Operation Noah. The purpose of Operation Noah was to

rescue several thousands of animals from drowning in the inundating reservoir. In 1998, the ZRA began implementing an Environmental Monitoring Programme (EMP), with funds coming from the SIDA and technical assistance from the Stockholm Environment Institute. The EMP covers the Zambezi River between Chavuma (North-Western Zambia) and its confluence with the Luangwa River (Zambia-Zimbabwe-Mozambique border). One of the outcomes are the 2002 Water Quality Guidelines. In 2006, a MoU between Zambian and Zimbabwean water and environmental monitoring institutions established a Working Group for cooperative water resources and environmental initiatives under the auspices of the ZRA (Mukosa/Mwiinga 2008). However, in the light of the above the discussion on the SADC Water Protocol and the nature of dam operation mechanisms in the region, the environmental programmes seem of limited effectiveness and are only just beginning.

In the Zambezi Basin in general, "environmental requirements are perceived as competing with other interests such as hydropower generation" (SADC 2011: 3). Indeed, as interviewees pointed out, the mode of operation of Kariba and Cahora Bassa is determined by energy generation. The goal is to maximize energy generation as well as income for the dam operators. All other purposes, such as flood forecasting, are secondary (interview with an international consultant based in Gaborone, 29 May 2012). As a result, spillways and flood gates are operated primarily for dam safety reasons to release excess water or floods, and not necessarily for environmental flows or nature. Itezhi-Tezhi Dam in Zambia is the only exception (SADC 2011).Kariba's flood gates are unable to release environmental flows as they are positioned too high in the dam wall. Kariba's only option is therefore to draw down the reservoir when water levels become too high. Cahora Bassa, downstream from Kariba, is able to release environmental flows and therefore protect the downstream areas in Mozambique and the Zambezi Delta, where the combined impact of Kafue, Kariba and Cahora Bassa can be felt (Scudder 2005). This is complicated, however, by the fact that releases are not coordinated between Kariba and Cahora Bassa. Kariba authorities do not notify Cahora Bassa authorities in advance before opening the flood gates. The problem is compounded by the short distance that lies between both dams (interview with an international consultant based in Gaborone, 29 May 2012).

To advance dam harmonization between Kafue, Kariba and Cahora Bassa dams,the Joint Operations Technical Committee was created, which includes Mozambique's Zambezi management authority Administração Regional de Águas do Zambeze (ARA-Zambeze), Hidroelectrica de Cahora Bassa, the Zambezi River Authority, Zimbabwe Power Company, Zimbabwe National Water Authority, and ZESCO (UN DESA 2008; Guale/Macheva 2011). Currently,discussions to experiment with environmental flows at Kariba and Cahora Bassa are being held between SADC and the Joint Operations Technical Committee.In addition, a new MoU between Zambia, Zimbabwe and Mozambique now provides a consultation platform to coordinate better reservoir releases (interview with an international consultant based in Gaborone, 29 May 2012; Guale/Macheva 2011).Besides these initiatives, one of the most recent projects to achieve integrated management of the Zambezi is the project on Dam Synchronization and Flood Releases in the Zambezi River Basin. It is funded by GIZ, DFID and AusAid (SADC 2011) and looks at the entire stretch of the Zambezi Basin.

3.4.7 Conclusions

As for the project's sole purpose, namely to generate energy, this has certainly been accomplished. However, this came at a cost – the haste in north bank resettlement, the suspicion between Zambia and Zimbabwe and their colonial predecessors, a perceived imbalance of costs and benefits on the side of Zambia, and a lack of political will to institute environmental

programmes have all weighed negatively on the project. The following conclusion can be drawn from the case:

- **Institutionalised cooperation in hydropower management facilitatesresolution of conflicts that emerge over time with changes in political, socio-economic and environmental conditions**. The relationship between the riparians involved in the Kariba projectin the past has been characterised by mistrust. However, the establishment of a joint authority responsible for management of the dam under the supervision of national ministries helped build trust among parties. Building on this institutionalised cooperation, bilateral conflicts over the sharing of costs and benefits produced bythe Kariba dam were settled peacefully and with consideration of the mutual needs of both riparians.

- **Programmes for resettlement and mitigation of environmental effects need to be well planned from the early project planning stage and be based on a thorough assessment of socio-economic and environmental conditions.**Inadequate planning for resettlement in the early stages of the Kariba project has led to impoverishment of resettled communities and environmental degradation of resettlement areas. Rehabilitation programmes only started 30 to 40 years after the dam was already built, and thus could not prevent nor make up for the damage done.However, the reservoir fishery in Zambia and the Power Rehabilitation Project that included a resettlement rehabilitation programme for the Zambian Gwembe Tonga provide examples of how benefits can be shared with local communities and the role that national hydropower operators (in this case ZESCO) can play in such programmes.

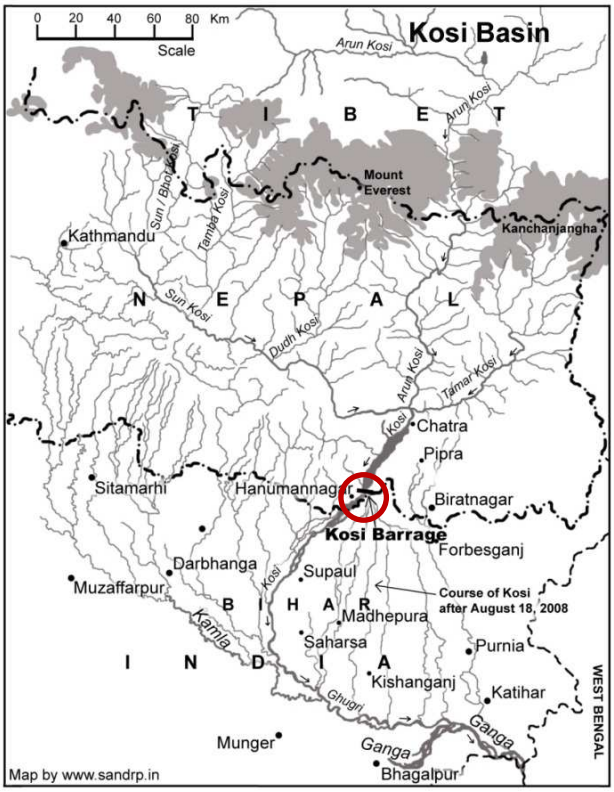
- **Basin-wide coordination is necessary to optimise flows for power generation and the environment**. Such coordination is urgently needed as more projects are being planned and built along the Zambezi and its tributaries without much regard for coordinated management. Basin-wide coordination has been lacking in the Zambezi basin up to now, in the absence of a basin-wide institution. However, recent initiatives provide important steps towards an integrated management of the basin: the Joint Operations Technical Committee and the recently signed MoU provide institutional frameworks for coordinated operation of Kariba and Cahora Bassa dams. Moreover, the SADC-coordinated establishment of an Interim ZAMCOM Secretariat in May 2011 canprovide a framework for a centralised and coordinated dam management in the Zambezi River Basin. The project on Dam Synchronization and Flood Releases in the Zambezi River Basin can serve as an important basis for this.

3.5 Kosi River Basin – Kosi Project

3.5.1 Background

The Sapta Kosi/Koshi/Kosi River[6] Basin (basin area around 69,300 km²; India Water Portal without date) is the biggest river basin in Nepal and part of the Ganga-Brahmaputra-Meghna (GBM) Basin[7]. The Kosi River originates in the Tibet Autonomous Region and the Nepali highlands, enters India in the State of Bihar and joins the Ganges as one of the largest tributaries. With its seven tributaries the Kosi is the third largest river in the Himalayas with the Brahmaputra and Indus River.

The river is also one of the most important and flood prone rivers in Nepal with annual devastating effects in India and Nepal. The high silt quantity carried by the river coupled with the monsoon regime led to disposition of sediments in the plains, which fills up the river's main channel until it overflows and begins a new course. This natural process produced a large inland delta that lies across southern Nepal and the Indian state of Bihar. In 2008 a flood control embankment of the joint Kosi Project in Nepal breached. Approximately 50,000 people in Nepal and more than three million in India were displaced and many lives were lost.



Source: South Asia Network on Dams, Rivers and People (without date).

It is estimated that midstream Nepal has the potential of producing 40,000 MW of hydropower but only manages to produce 600 MW (status 2010), due to limited capacities and

[6] Hereinafter the name Kosi River is used.
[7] GBM Basin covers an area of about 1.75 million km² stretching across Bangladesh (7.4 %), India (62.9 %), Nepal (8.0 %), Bhutan (2.6 %) and Tibet-China (19.1 %) (Pochat without date).

funds as well as political instability (IDSA 2010; GoI 2011; IPPAN/CII 2006; Upreti 2006; Salman/Upreti 2002; IPPAN/CII 2006; Pochat without date).

3.5.2 The regulatory and organisational framework for river basin management

While no regional cooperation for water resources management exists between India, Nepal, Bangladesh, Bhutan and China in the GBM Basin, bilateral agreements between India and its riparian countries have been signed. India and Nepal cooperate on joint multipurpose projectssince both countries are interested in improved flood control as well as in the hydropower and irrigation potential of the Nepalese water resources.

After India's independence the country signed the Kosi Agreement with Nepal in 1954 (amended in 1966) (for details see section 3.5.4). The main catalyst for this agreement was the urgent need for effective flood management, since floods caused by the Kosi River have been severely affecting both countries. A further important aim was to exploit the high hydropower potential of the river.

Further main agreements signed by both countries cover the Gandak irrigation and power project (signed in 1959, amended in 1964) and the Integrated Development of Mahakali River (signed 1996). Through the Gandak Agreement, Nepal and India profit from generated power and water for irrigation. Nepal's right to withdraw water from the Gandak and its tributaries was restricted to ensure the maintenance of minimum water flow for the project. The Mahakali Treaty addresses the construction of the multipurpose Pancheswar Dam (6,000MW). In contrast to the previous treaties, this treaty laid down some principles on the sharing of transboundary river waters. It recognised "the principle of equal rights" and "equal utilisation" of the waters of the Mahakali River (Siwakoti 2010; HMGN/GoI 1966, 1964, 1996).

To manage the common water resources of both countries, a three tier mechanism at the level of Ministers, Secretaries and technical staff was implemented (Email correspondence with a former executive secretary at Water and Energy Commission Secretariat of Nepal, 31 May 2012; JCWR 2009 a/b, 2008): (1) A Joint Ministerial level Commission on Water Resources (JMCWR) at the level of Ministers of Water Resources of India and Nepal addresses bilateral cooperation on water resources. The commission is represented by both countries (the first meeting took place in2012). (2) The Joint Committee on Water Resources (JCWR) headed by the Secretaries of the Water Resources Ministries of India and Nepal reviews the work of various technical/expert groups (set up for the planning and implementation of water resources projects) as well as the work of the Joint Standing Technical Committee (JSTC). It also ensures expeditious implementation of the decisions taken at the JMCWR and informs the respective governments on such matters (the first meeting was held in 2000) (JCWR 2009 a/b, 2008). (3) The JSTC, which held its first meeting in 2008, reviews the progress of tasks assigned to the various bilateral committees related to specific projects, flood forecasting, flood management and inundation problems, operation and maintenance of existing projects (Kosi and Gandak). The JSTC also coordinates the existing committees and subcommittees under the JCWR. A further Nepal-India institution is the Joint Committee on Inundation and Flood Management (JCIFM) (personal communication with Dr. Uttam Kumar Sinha, Research Fellow at the Institute for Defence Studies and Analyses 20.06.2012; GoI 2011, 2012).

3.5.3 The Kosi Project

The Kosi Project, which was developed in the 1950s and construction finished in 1963, can be divided into old and new interlinked components. The old project includes a 1,150m-long barrage that was constructed on the Kosi River 8km inside Nepal, while facilities for power generation were located on both Nepali and Indian territory. The aim of the barrage was to anchor the wayward of the riverbed that had migrated about 120km westward in the last 250 years and to provide irrigation and power benefits to Nepal and India. The barrage's total irrigation capacity was estimated at 11,300 hectares of land in Nepal and around 356,610 hectares in India. Since the barrage is located close to the Nepalese border, it is reported that India's benefits are higher from flood mitigation and irrigation then Nepal´s. As the second part of the old project, 220km-long embankments were built for flood control. These include only a small hydropower component (around 20 MW), which was considered as being problematic from the very beginning because of silt and other technical problems which precluded the envisaged benefits (IPPAN/CII 2006; Salman/Upreti 2002; Pochat without date).

The joint planning of the new component, the Sapta Kosi High Multipurpose Dam within Nepal at Barakshetra, started in 1996. Its main element is a dam that will combine flood control, irrigation facilities and power benefits (3,000 MW at 50% load factor) for both countries. Further elementsenvisaged are a barrage about 8km downstream of the Sapta Kosi High Dam to reregulate the water being released from the high dam, the Sun Kosi Storage with diversion scheme, and 269m inland water ways to provide water for irrigation both in Nepal and India and for the purpose of navigation. The dam and linked elements were planned to be completed in 2013, but since May 2007 the field works at the dam site have been suspended due to security reasons. Nepalese demonstrators are reported to threaten the people working on the site (GoI 2011, 2012; Dhungel/Pun 2010).

The old as well as the new project caused/will cause a loss of fertile land and resettlements on Nepalese side, but no provisions regarding this issue are included in the Kosi agreement (Islam/Deketelaere 2010; Monirul Qader Mirza 2004).

3.5.4 Institutional setup and mechanisms for dam/hydropower management

Floods caused by the Kosi River have been an annual phenomenon affecting both Nepal and India. Thus, the main catalyst for the Kosi agreement was an effective flood management that was supposed to be addressed by the old Kosi Project (barrage and embankments). However, India was also interested in the Kosi water for irrigation and hydropower. This is why India supports Nepal financially and technologically to expand its capacities (GoI 2011; Upreti 2006).

The 1954 Kosi Agreement, which is valid for 199 years, was revised in 1966 under the urging of Nepal to provide more benefits for Nepal. The agreements stipulate, inter alia, that any construction and other undertakings by India in connection with the Kosi Project need to be planned and carried out in consultation with Nepal, and that works and undertakings pursuant to the agreement require the prior approval of Nepal. Moreover, the agreements define that the Government of the Indian State of Bihar is designated Chief Engineer of the Kosi Project (HMGN/GoI 1966). India was therefore responsible for the design, construction and operation of the old project. The Kosi High Level Committee, constituted in 1978, received the mandate for these tasks (GoI 2009). Furthermore, a Coordination Committee for the Kosi Project was set up consisting of three representatives from each country to be nominated by the respective Governments. "The Committee will consider such matters of common interest

concerning the project including land acquisition, rehabilitation of displaced population, maintenance of law and order, soil conservation measures and such other items as may be referred to the Committee for consideration by the Government of Nepal or the Union from time to time" (HMGN/GoI 1966, Upreti 2006). The name of the Committee was later changed to the Indo-Nepal Kosi Project Commission. Moreover, a Joint Committee on the Kosi and Gandak Project (JCKGP) exists, which had his first meeting in 2001.
With regard to the new joint project, the Sapta Kosi High Dam, an agreement was reached to take up joint field investigations, studies and the preparation of a Detailed Project Report. A Joint Project Office was set up in 2004 in Nepal to carry out the relevant studies (GoI 2012). However, as mentioned above, the project got stalled.

3.5.5 Mechanisms for cost and benefit sharing

Nepal and India agreed in the Kosi Agreement[8] that Nepal held the prior right to withdraw water from the Kosi River and/or its tributaries. Besides, Nepal had the right to obtain up to 50% of the hydroelectric power generated by India in any power house in the vicinity of the barrage. The tariffs for electricity to be supplied to Nepal were to be set by mutual agreement. Power generated from the Kosi in India was to be exported to the Indian-Nepal border through transmission lines, which India constructed. Nepal additionally received royalties in respect to the power generated and utilized in India:(HMGN/GoI 1966). However, according to a former executive secretary at the Water and Energy Commission Secretariat of Nepal (personal communication, 31 May 2012), the power plant on the Kosi was out of operation after a short period of time and until now due to sedimentation problems. Since then India has been providing compensation power through the existing grid system of Northern Bihar to the adjoining towns of Nepal.
India also paid Nepal compensations for the loss of land, houses and/or other immovable property flooded or damaged by the project as well as for material used from the Nepal territory for construction or maintenance. Nepalese land, on which the old project was built on, was leased by India for a period of 199 years at an annual nominal rate (initially it was given for an unlimited period).Tariff rates, assessment of compensations and manner of payments were fixed later in separate mutual agreements (HMGN/GoI 1966).
According to Nepalese media, India will bear most of the cost for studies for the new Sapta Kosi High Dam, which are reported to cover topological, geological and seismological surveys and drillings across the project sites and EIAs (Giri 2012).

3.5.6 Conclusions

Based on the little information available, it can be assumed that both countries were able to benefit to a certain extent from the joint Kosi Project in the last yearswith regard to irrigation, flood prevention and hydropower. However, inefficient implementation and bad maintenance prevented the project from generating the expected benefits to both riparians. While the Sapta Kosi High Dam project was stalled and the Kosi barrage is not generating power as planned, some conclusions can be drawn from this case:

- **Mechanisms for cost/benefit sharing and compensation need to be specific enough to prevent diverging interpretations and mistrust**. The Kosi Agreement's stipulations regarding cost and benefit sharing lack specification regarding sums/tariffs or payment

[8] The following information relates to the amended agreement of 1966.

conditions.This led to dissatisfaction on Nepalese side, concluding that India did not fairly compensate Nepal, that Nepal received fewer benefits than envisaged(Islam/Deketelaere 2010), and that India did not comply with its maintenance obligations. Furthermore, no environmental and social mitigation measures were included in the Kosi Agreement, which enforced Nepal's perception that it had to burden most impacts without benefiting from the Kosi project.

- **Agreements perceived as unfair by one side and lack of institutionalised cooperation inhibit further collaboration on mutually beneficial hydropower projects.** Inadequate cost/benefit sharing arrangements, lack of impact mitigation measures as well as the weak legal and institutional foundation of joint project management led to tensions and a lack of confidence on both sides. The consequence is that although agreements were signed, only minimal progress in cooperation can be seen and riparians, especially Nepal, are reluctant to promote further cooperation on the Sapta Kosi High Dam.

3.6 Comparative overview of the case studies

The following comparative matrix gives an overview of main legal and institutional frameworks for hydropower cooperation as well as management and impact mitigation measures applied in the studied cases.

Frameworks/ Mechanisms	Legal Frameworks and Organisational Setups				
	Senegal/Mali/Mauritania	**Brazil/Paraguay**	**Canada/USA**	**Zambia/Zimbabwe**	**India/Nepal**
Overall regulatory and organisational framework	- Convention portant création de l'organisation pour la mise en valeur du Fleuve Sénégal (OMVS) was signed by Senegal, Mali and Mauritania in 1972 to promote cooperation in developing the river.	- La Plata Basin Treaty was signed by Argentina, Bolivia, Brazil, Paraguay and Uruguay in 1969 to promote and coordinate joint development of the basin. - Conflicts with Argentina on Itaipu were resolved by Tripartite Agreement on Corpus and Itaipu, which established allowed water levels.	- Boundary Waters Treaty (1909) addresses transboundary water issues. - The bilateral International Joint Commission was established to monitor transboundary agreements.	- SADC Protocol on Shared Watercourse Systems, 1995 (revised in 2000) sets a framework for utilization of shared watercourses. - Agreement on Zambezi Watercourse Commission (ZAMCOM) was signed by Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe in 2004. - ZAMCOM is responsible for water management for the entire Zambezi River Basin. An Interim ZAMCOM Secretariat was set up in May 2011.	- No basin wide agreement exist for Ganges Brahmaputra Meghna Baisn - Several bilateral agreements exist (Gandak Agreement 1959 (amended in 1964) was negotiated for the Gandak hydropower project, Mahakali Treaty was signed in 1996 for the construction of the Pancheswar Dam). - Joint Ministerial Level Commission on Water Resources was established for bilateral cooperation on water resources.
Specific legal framework pertaining to hydropower projects	- Droughts and economic development shortfalls in all countries led to cooperation on dam construction. - Convention on the Legal Status of the Jointly-Owned Structures was signed in 1978. - Convention on the Financing of the Jointly-Owned Structures was signed in 1982.	- To meet rising energy demands both countries agreed on the Act of Iguazu (1966) that provided for feasibility studies on the construction of a dam. - Itaipu Treaty (1973) was signed for the construction and management of the joint Itaipu hydropower project at a border location due to most effective terms in energy generation capacity.	- Rising energy demand in both countries and devastating floodsled to joint dam planning. - Columbia River Treaty (1961) includes agreements on the construction of 4 dams (3 on CA territory and 1 on U.S. territory), compensation payments and joint management regulations.	- Rising energy demand resulted in joint dam planning and construction. - The Zambezi River Authority (ZRA) Act (1987, amended in 1999) established the ZRA. - ZRA By-Laws (1999) laid down a tariff structure and water allocation regulations.	- Devastating flood and increasing energy and irrigation demand especially in India led to the planning of the Kosi Project. - Kosi Agreement 1954 (amended in 1966) includes the construction of Kosi barrage and embankments, compensation and management provisions.
Institutional framework for dam management	- Infrastructure is co-owned and co-managed by member states through OMVS. - Société de Gestion de l'Energie de Manantali (SOGEM), a public company supervised by OMVS, is responsible for Manantali Dam management, maintenance and operation. - Operation and maintenance of energy generation has been contracted to Eskom Energy Manantali (EEM). ESKOM terminated the concession in October 2011.	- Bi-national public company Itaipu Binacional owned by riparians operates the dam and power generation. - Itaipu Binacional Executive Board of Directors are appointed by the riparian governments through their respective national utilities. - Supervisory Board is made up of representatives from national governments and utilities in equal number from both countries.	- U.S. and Canadian Entities are responsible for operation of dams on their territory and the coordination of operation of all dams. - U.S. entity is represented by a federal power agency (electricity marketing) and the Army Corps of Engineers (dam operation). - Canadian entity is represented by a provincial power agency. - Dam operation is coordinated through operation plans and weekly consultations of the entities. - Assured Operation Plans (AOP) for flood control and power generation operation are developed every 6 years. - Detailed Operation Plan (DOP) updates the AOP annually. Herein also other issues like fisheries or recreation can be incorporated.	- Central African Power Corporation managed the dam from 1963-1987. - Since 1987, theZambezi River Authority (ZRA) is responsible for operation and maintenance of the dam. - ZRA is governed by Council of Ministers, consisting of minsters and permanent sectaries from the Ministries of Energy and Finance of both countries. ZRA bodies have equal number of staff from both countries. - The two power stations of the dam are operated separately by the national utilities: north bank power station by Zambia, south bank power station by Zimbabwe.	- Coordination committee for Kosi Project was established in 1955 (later named Joint Committee on Kosi). - Government of the Indian State of Bihar is designated Chief Engineer for Kosi barrage. It established the Indian Kosi High Level Committee in 1978 to implement the project. - Construction or other undertakings by India need to be planned and carried out in consultation with Nepal for Kosi barrage. Prior approval of Nepal is also required. - Joint Project Office for the planned Sapta Kosi High dam was established in 2004.

Frameworks/ Mechanisms	Benefit and Cost-Sharing Mechanisms				
	Senegal/Mali/Mauritania	**Brazil/Paraguay**	**Canada/USA**	**Zambia/Zimbabwe**	**India/Nepal**
Benefit and cost sharing mechanisms	- Distribution key (*clé de repartition*, 1985) for costs and benefits according to projected use of benefits from irrigation, navigation, and hydropower from joint management of Manantali and Diama Dams. - EEM transfers tariff revenue to SOGEM, minus management costs. SOGEM uses this income in order to maintain the dam structure, to service its debt, and to endow the Fond de Risque Hydraulique. This fund ensures the financial security of SOGEM in case a low water table leads to less energy production. - The goals of improved navigation/irrigation could not be achieved.	- Costs, hydropower benefits, social and environmental mitigation measures are split equally between Brazil and Paraguay. - Itaipu Binacional pays monthly royalties to both governments for use of the hydraulic resource. - Unused energy must be sold to the other party, so that Paraguay mainly sells its energy to Brazil. Because the terms of the sales and compensations agreement was to the detriment of Paraguay, the terms were renegotiated in 2009 (previously the prices were fixedand sold to Brazil's utility Eletrobras; now Paraguay sells the energy directly to the Brazilian market).	- Each country was/is responsible for construction and operation of dams on their territory. - USA pays compensation for downstream benefits generated by Canadian storage dams (so-called Canadian Entitlement). - USA paid Canada compensation for resettlement and damages due to inundation of Libby Dam. - USA paid Canada compensation for flood prevention. - Additional compensation payments are agreed on a case by case basis for power losses caused due to dam operation to meet fisheries and recreational requirements. - Specific terms of the treaty (e.g. 'Called Upon' flood provision, Libby Dam coordination) will continue as long the need and relevant dams exist, even if the treaty is terminated. For incurred costs the USA will pay compensation. - Since the Canadian Entitlement expired in 2003 benefits became unequal: Whereas the Canadian Entitlement is currently larger than expected in 1964, U.S .benefits are smaller due to national interest conflicts (mainly hydropower vs. fisheries).	- ZRA is funded by both states based on the actual water use for energy generation by the national utilities (previously each country had to pay the same amount to the ZRA). Now the payments are based on water tariff structures, which are reviewed annually by the Joint Operation Committee.	- Generated power by the Kosi barrage was shared equally between both countries. - India paid Nepal compensations for losses/damages/material used as a result of the barrage/inundation; - Nepal receives royalties from India for generated and utilized power in India by the barrage. - Since the barrage doesnot produce energy, it is reported that India compensates Nepal with power from India. - Perceived inequalities in cost benefit sharing led to mutual mistrust, which created big obstacles in subsequent development efforts.

Frameworks/ Mechanisms	Environmental and Social Impact Mitigation Mechanisms				
	Senegal/Mali/Mauritania	**Brazil/Paraguay**	**Canada/USA**	**Zambia/Zimbabwe**	**India/Nepal**
Environmental and social impact mitigation and monitoring measures	- Resettlement program for Manantali Dam was funded by UNDP, USAID and the government of Mali (including electrification, poverty reduction measures). - In 1998 an environmental monitoring program (PASIE) was established. PASIE developed a basin management plan including a plan for rural electrification and health and a multi-stakeholder Environmental Observatory. - Conflicts of interest between the peasantry (prefers recessional agriculture) and the state's interest in irrigation led to introduction of environmental flow regime. TheEnvironmental Observatory ensures the permanent institutionalisation of the regime. - The 2002 Water Charter laid out mechanisms for reviewing new projects, environmental protection mechanisms and rules for stakeholder participation.	- In Brazil, the royalties are used for an extensive revenue sharing programme with localities affected by the dam. - Itaipu Binacional runs extensive environmental and social mitigation programmes. - Itaipu Binacional regularly cooperates for the implementation of their programmes with local communities, researchers, and government agencies. - Increased fish supply in the reservoir by measures like the introduction of e.g. spawning channel, germplasm bank, aquaculture, seasonal prohibition on fishing.	- Additional agreements (SOA) can be signed to react flexibly to special national requirements (regarding e.g. fisheries, recreation) and to provide extra benefits for both partners. - Also, conflicts of interest between the USA and Canada could be solved in the frame of SOA, but occasionally long negotiations on SOAs with years of stagnancy are possible. - Established in 1995, the Canadian Columbia Basin Trust compensates affected communities for social and environmental impacts. The Province of British Columbia endowed the trust and also pays an annual operational endowment from its general revenues.	- Operation Noah rescued thousands of wild animals during the filling of the Kariba reservoir. - World Bank-funded rehabilitation programmes for resettled communities on Zambian side. - An Environmental Monitoring Programme was established 1998 by ZRA, resulting in Water Quality Guidelines (2002). - Working group for cooperative water resources and environmental initiatives exist under ZRA. - Well implemented reservoir fishery on Zambian side could compensate downstream fishery losses. - Environmental and social projects were/are initiated and funded by donors. - New SADC project on Dam Synchronization and Flood Releases in the Zambezi River Basin to achieve coordinated management of dams in the Zambezi River Basin.	- none

4 Lessons learnt

The cases analysed in this study clearly show that riparian countries have generated significant benefits from transboundary cooperation in hydropower development and management, be it through the sharing of related costs or through increased hydropower generation due to the better location and coordinated operation of joint dam projects. However, in all cases where riparian countries or local communities felt that they did not receive a fair share of the benefits, disputes arose and the disadvantaged parties eventually managed to force changes in dam operation patterns or benefit sharing agreements. Moreover, the hydropower projects examined all have deficits in sustainability as social and environmental concerns were not incorporated into project design. Mitigation measures introduced at a later stage have proven to be of limited effectiveness. They also regularly result in reduced hydropower benefits that could have been foreseen or even prevented, had comprehensive and coordinated planning taken place from the beginning.

The principal lesson that can be drawn from the case studies is thus that some form of institutionalised cooperation,e.g. in form of a river basin organisation, is necessary for the comprehensive and coordinated planning of hydropower projects in transboundary basins. Transboundary cooperation will enable riparian countries to sustainably develop rivers for economic benefits while mitigating conflict potential between sovereign countries, as well as within countries.

Starting from the current situation in the Mekong Basin, the following sections summarise the lessons on cooperative mechanisms for sustainable hydropower development and management learnt from the comparative analysis of the five case studies. A concise summary of the lessons is further available in a fact sheet annexed to this report.

4.1 Point of departure in the Mekong Basin

In contrast to some of the river basins analysed in this study, the MRC is in a comparatively good position, because at a time where major hydropower development is envisaged, it already has established cooperation mechanisms that can provide a basis for joint planning and management.

The LMB, through the Mekong Committee, the Interim Mekong Committee and the MRC, already has a long history of basin-wide planning under the aegis of a regional organisation. Moreover, since its formation in 1995 and thus for a period of almost two decades, the MRC has conducted basin planning under the principle of IWRM. The MRC has essential policies and management functions in place:

- The 2011 Knowledge Base on Benefit Sharing;
- The Five Proceduresand the Guidelines;
- The 2011 Integrated Water Resources Management-based Basin Development Strategy;
- The 2009 Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin;
- Experience with stakeholder involvement (regional consultation workshops on the Basin Development Plan);
- The Strategic Environmental Assessment conducted by ICEM;

- Experience with assessment tools – both for the project level (Hydropower Sustainability Assessment Protocol, SAP) and basin/sub-basin level (Rapid Basin-wide Hydropower Sustainability Assessment Tool, RSAT);
- An ISH-led regional cooperation mechanism (MRC 2010: 8), which the ISH has begun setting up and is now strengthening: National ISH Coordinator Network, the Regional Technical Review Group, and the Regional Advisory Committee.

A substantial knowledge base thus already exists within the MRC. It should be deployed for the planning, construction, and post-construction social and environmental monitoring of major infrastructure projects.

The majority of the population in the LMB practices subsistence living based on natural hydrological cycles. There exists, therefore, a “high degree of dependence on water resources” of the riparian population (MRCS without date: 10). At the same time, the rapid economic growth in the Lower Mekong countries coupled with rapid population growth has produced rising demand for the Mekong’s waters, especially for hydropower and intensive irrigated agriculture (ibid: 12-14). According to ICEM (2010: 9), “[p]ower demand is expected to grow at 6-7% annually to 2025”. In addition, climate change and flood and drought risk management represent further significant interventions into the hydrological cycle (MRCS without date).
The primary challenge in sustainable hydropower development in the LMB will therefore be to reconcile conflicts between sectoral water use strategies, between local livelihoods and national development objectives, and between the four member countries with regard to their national water use objectives. The advantage in the Lower Mekong Basin is that a functioning basin organisation exists in the form of an independent technical body that possesses the tools and technical expertise to conduct comprehensive basin planning. The MRC has a highly valuable role to play in the sustainable development and management of hydropower projects in the LMB. Building on the existing policies and management functions of the MRC, the following lessons provide helpful approaches to meet this challenge.

4.2 Lessons learnt from the case studies

4.2.1 Basin-wide institutions can provide an essential framework for co-ordinated hydro-power development and management

The case studies clearly show that the coordinated planning and operation of multiple hydropower schemes is essential in order to achieve a combination of optimal hydropower output in the whole basin (rather than for individual projects) along with requirements for environmental and social mitigation. The Columbia case also provides evidence that it is possible to synchronise the operation of dams to meet dam safety, hydropower generation, flood and drought management, as well as social and environmental needs. Transparency and trust on all sides are necessary to accomplish such a complex task. Institutions covering large parts, or at best the entiretyof the river basin provide essential frameworks for cooperation. Where basin-wide institutions do not exist or are ineffective,arrangements with affected states that are not directly involved inthe project can be of additional value for regional hydro management:

- Canada and the USA established the International Joint Commission in 1909 in order to address the increasing economic development of the border rivers. The Commission could later be drawn on in order to negotiate the coordinated development of dams in the Columbia River Treaty.
- In the Senegal River Basin, the OMVS was created before any dams were planned. Therefore, when planning began, a functioning organisation was in place that could coordinate basin management for irrigation, hydropower production and navigation (although the navigation component was never realised). Coordinated management from the start also meant that conflicts between the member countries arising from water use could be avoided.
- In the Parana Basin, where no basin institution exists, Brazil and Paraguay had to conclude a separate agreement with Argentina in order to determine the minimum water levels that are discharged from the Itaipu reservoir to allow hydropower production at the Yacyreta Dam, which is located downstream from Itaipu on the border between Argentina and Paraguay.
- In the Zambezi River Basin, where no basin institution existed until the formation of the Interim ZAMCOM Secretariat in May 2011, the SADC Water Protocol functioned as a substitute. However, it proved to be of limited effectiveness. One factor for why the SADC Water Protocol failed to be effective is the continuing lack of trust between Zambia and Zimbabwe, as well as the use of the SADC Water Protocol by Zimbabwe as a foreign policy tool.
- In the case of Kosi, a lack of trust between the riparians prevented the generation of maximum benefits from the development of the river, despite the existence of joint institutions.

The large number of dams proposed in the Lower Mekong makes coordination of these projects necessary in order to provide for dam safety, optimal hydropower generation, flood and drought management, as well as social and environmental needs. The MRC presents a suitable framework for this. While the entirety of theMekong Basin is not covered by a basin organisation, cooperation with China, which is already a MRC Dialogue Partner, has been enhanced through, for example,the Ecosystem Study Commission for International Rivers (MRC 2010).

4.2.2 Designating or creating a specified agency for dam operations management can facilitate day-to-day cooperation

Frequent consultation between riparian countries is necessary for decision making in day-to-day dam operations as well as to flexibly respond to upcoming management challenges (e.g. floods and drought). Designating or creating a specified agency for dam operations management can facilitate day-to-day cooperation in dam operation. Where basin-level organisations exist, agencies mandated with dam operations management regularly are established as subordinate bodies.

The case studies show that an entity to manage the dam was created in cases where dams are located on national borders or where dams are co-owned, co-financed or built with compensation and benefit sharing mechanisms. This holds true for dams located in the sovereign territory of a country and for dams located on the border between two countries.

- Dams located in sovereign countries:

  - The dams built in accordance with the Columbia River Treaty are located in national territories. In this case, a joint commission and national entities act as the keepers of the treaty and continuously coordinate dam management.
  - In the case of Manantali Dam located in Mali, the OMVS member states created the co-owned company SOGEM to manage the co-financed and co-owned dam.

- Dams located on national borders:
  - Brazil and Paraguay created the co-owned company Itaipu Binacional in order to manage the co-financed Itaipu Dam.
  - The Zambezi River Authority, a bi-national quasi government institution, manages the co-owned Kariba Dam.

In the LMB, once decisions upon joint hydropower projects are takenby the riparians, sub-institutions or agreements under the framework of the MRC could be established to facilitate operations management for specific dams. This refers especially to dams which are built as part of a cost-benefit sharing mechanism, and/or where dams are located on a national border, e.g. on the Mekong along the Lao-Thai border. Such sub-institutions or agreements need to comply with MRC rules and should be limited todam-specific issues to prevent overlap with the mandate of the MRC. A recent example of a such sub-institution is the Navigation Facilitation Committee between Cambodia and Vietnam.
In establishing organisational setups for dam management, staffing arrangements should be carefully considered in the sense that a balance must be struck between political and technical decisions, that is, between a staffing policy based on national parity and a staffing policy based on technical expertise. If national parity is important, then a strict policy that staffs all departments of an organisation based on national shares should be foregone in favour of a policy that tries to achieve national parity in terms of employee numbers in the organisation as a whole.

4.2.3 Cost and benefit sharing mechanisms need to be fair and flexible

Cost-benefit sharing schemes are a valuable tool that aims to provide maximum project benefits while compensating each party involved or affected according to the costs they have to bear. In order to achieve this goal, the case studies reveal that effective schemes should not only encompass one-off payments, but also flexibly designed arrangements for long-term cost and benefit sharing.
The case studies show that treaties and cost and benefit sharing arrangements are often re-negotiated because they are seen as unfair by one of the parties, particularly where parties are unequal in terms of their economic and military capabilities.

- The Kosi Agreement between India and Nepal, originally put in place in 1954 for 199 years, was altered in 1966 at the request of Nepal to provide more equal benefits to both contracting parties.
- Similarly, the Itaipu Treaty between Brazil and Paraguay turned out to be to Brazil's benefit, considering that Brazil bought the unused share of Paraguay's electricity at preferential prices.
- In the Zambezi Basin, Zambia insisted on the re-negotiation of the Kariba arrangement under which CAPCO managed the sales of Kariba's electricity production, thus leading to the dissolution of CAPCO and the inauguration of the ZRA.

While it may be difficult to foresee political and economic changes that affect the use of the electricity from the respective dams, relevant agreements should be designed in a way that allows for future alterations should one contracting party later find itself in a disadvantaged position. Furthermore, agreements have to be flexible enough to allow for the updating of the operation and the distribution of costs and benefits when political, social, economic and/or environmental conditions change.
At the same time, essential cost and benefit sharing principles that were mutually agreed upon when the treaties were negotiated need to be kept in place in order to provide for sufficient planning reliability and disaster prevention. The Columbia River Treaty is exemplary in this respect, as it stipulates that while the Treaty can be unilaterally cancelled after 60 years, certain key provisions, mainly regarding flood prevention, must remain in place nevertheless. It further stipulates that the USA must compensate Canada for any for operational costs resulting from these provisions.

4.2.4 Social and environmental mitigation measures as well as their financing need to be considered from the planning stage

Where past hydropower projects did not adequately address social and environmental effects, corrective measures have had to be introduced at a later stage, often as a result of social pressure or international disputes. Experience from these international river basins shows that mitigation measures as well as sustainable financing concepts for their implementation need to be considered from the early project stage in order to promote sustainability and prevent conflict and unexpected costs.
In all the cases studied here, social mitigation was either not incorporated into the original agreements, or as in the Kariba and Itaipu resettlement, it was carried out hastily and compensation was inadequate, partly based on insufficient knowledge of the social and environmental effects of the dam. Dam construction thus led to impoverishment, loss of social networks and the dissatisfaction of resettlers who had been deprived of their livelihoods. In almost all cases, social and/or environmental mitigation measures had to be incorporated into the project at a later stage:

- In the Columbia River case, the Province of British Columbia founded the Columbia Basin Trust 30 years after the Columbia River Treaty was signed and endowed it with income generated from the dams.
- In the Kariba case, the World Bank financed an extensive rehabilitation project in the 1990s, 30 years after the construction of Kariba Dam., including rural electrification programmes. The programme, which included among others rural electrification projects, was run by ZESCO, the Zambia Electricity Supply Corporation and unfortunately was confined to the Zambian side.
- In the case of Itaipu, democratisation in Brazil and Paraguay led to an overhaul of social mitigation policies for infrastructure projects. Brazil mandates the sharing of revenues from energy plants with the directly affected population. Itaipu Binacional also has put elaborate social and environmental mitigation mechanisms in place.
- In the case of the OMVS, the decision was eventually made to build social mitigation measures into the programme structure. The measures included the introduction of environmental flows to maintain floodplain agriculture, clearly showing the social notion of the environment. In addition, rural electrification programmes were established using the energy produced from Manantali Dam. Overall, however, the OMVS is still adjusting to the challenge of implementing social and environmental protection in the river basin management regime.

The case studies further reveal that social and environmental measures cannot be limited to short-term compensation or impact mitigation. Sustainable mitigation of negative effects requires long-term efforts in joint monitoring, social and environmental management/mitigation, and benefit-sharing with affected groups.
The Columbia and Itaipu cases are instructive in the way they funded social mitigation programmes. Using revenue generated from the operation of the hydropower dams, funding programmes were created that are steered to local development in the areas most affected by the dams. In addition, local communities are given a stake in determining how the funds are to be used.

The MRC providesa suitable planning framework for sustainable development and management of hydropower projects that includes monitoring and mitigation of social and environmental effects. This framework includes the Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT), the Hydropower Sustainability Assessment Protocol (SAP), as well as the Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin. A fund could further provide opportunities for the sustainable funding of social and environmental mitigation measures in the LMB. International experience shows that such a fund could be financed by multiple sources, including revenue derived from hydropower generation and royaltiesor contributions from private developers/operators. The participation of affected communities can also be beneficial to determine usages of the fund. A fund that is set up as part of the dam planning process rather than only after the construction of the dam can further provide a preventive tool which can be used to avoid negative social and environmental effects from the very start of a dam project.

4.2.5 Cooperation on the regional as well as local level is necessary to effectively design and implement social and environmental mitigation measures

Social and environmental impacts of hydropower projects are interrelated and often complex. Mitigation measures thus need to be based on a thorough understanding of the interrelationships across the basin and of the specific situation upstream and downstream of the dam. Cooperation and the exchange of data and information locally as well as across borders are crucial to designing the most appropriate mitigation measures for each dam and to monitoring their effectiveness. Joint monitoring and implementation of mitigation measures should be institutionalised, for example as part of specific programmes or sub-agencies. Agencies mandated with the operation of hydropower schemes, as well as local communities, can also play important roles in implementing and monitoring mitigation measures.

The case studies particularly show the need for transboundary cooperation in order to effectively mitigate impacts on migratory fish as well as to implement environmental flow regimes.Mitigating impacts in downstream fisheries requires approaches that facilitate fish migration, such as fish passages. However, the design of fish passages is complex and must be tuned to the nature of the fish passing them and to the location in the river where the particular fish swim. As fish migrate long distances up and downstream during different stages of their life, transboundary cooperation and exchange of data are required to study migratory fish, to design appropriate fish passages, and to monitor their effectiveness. The case of the Columbia River clearly shows the negative effects of neglecting protection of migratory fish in dam design. The main dams in the Columbia River Basin have been built too high to in-

stall fish ladders. The United States and Canada are thus forced to regularly negotiate and adjust reservoir levels and flows to enable fish spawning and migration to make up for at least some of the fisheries lost in the basin.

Introducing environmental flow regimes is a common measure to protect riverine ecosystems, wetlands, etc., as well as the livelihoods of those depending on these areas. The cases of Manantali Dam and Kariba Dam show the difficulties inherent in implementing artificial floods and environmental flow regimes as well as the need for cooperation on various levels. Transboundary cooperation is necessary to determine the effects at distanceslong downstream of the respective dam and to coordinate dam operation patterns where cascades of dams exist. Cooperation on the local level is required to assess how changes in the hydrological cycle may affect food security and the lives of riparian communities. In the Senegal Basin, the donor-funded Environmental Impact Mitigation and Monitoring Programme PASIE promoted cooperation within the OMVS on environmental flows, environmental monitoring and exchange of data. Under PASIE, the OMVS further set up a multi-tiered multi-stakeholder structure of regional, national and local level committeesto promote involvement of local communities in the planning and management of environment and water resources in the basin.In the Zambezi basin, in absence of a basin-wide organisation, a specific coordinating committee was set up to advance dam harmonization between the Kariba and Cahora Bassa dams and to discuss environmental flows.

The MRC has already acquired broad knowledge of social and environmental aspects in the LMB. It also has established transboundary research and monitoring programmes, such as the fisheries programme, the Water Quality Monitoring Network and Ecological Health Monitoring Network. This knowledge base,as well as the transboundary cooperation established under the MRC, provides a suitable basis for coordinating environmental mitigation measures of planned dam cascades.Trade-offs between power generation, environmental flow requirements, and fisheries protection might be necessary, as was the case in the Columbia River basin, and should thus be taken into account in the planning of dams.
Detailed design of mitigation measures as well as monitoring their effectiveness, however, further requires site specific knowledge and localised monitoring systems. The Itaipu and Kariba cases show that dam operators themselves can play a leading role in managing social and environmental monitoring and mitigation programmes, while cooperating with researchers and local communities for programme development and implementation.

5 Annexes

5.1 Fact Sheets

Case Study

Columbia River Project – Coordinated management of national dams with compensation payments for downstream benefits and upstream costs

Columbia River Basin

Basin area
668,400 km²

Riparian countries
- Canada (up-/downstream)
- USA (up-/downstream)

Main treaty
Columbia River Treaty (1964)

Members to agreement
Canada, USA

Case study dams
- Mica (CA), 1973, 1,805MW
- Keenlyeside (CA), 1969, 185MW
- Duncan (CA), 1968
- Libby (US), 1973, 600MW

Main goals of the project
- Flood control
- Hydropower

Main mechanisms
- Compensation payments for downstream benefits, damages due to inundation, and flood prevention, respectively
- National agencies coordinate management of dams in joint committees and operation plans
- Possibility of additional operational agreements to stay flexible and to consider extra benefits/mitigate impacts
- National compensation for social and environmental impacts through the Columbia Basin Trust

Cooperation background

- In 1909 the Boundary Waters Treaty was signed between Canada and the USA. It provides principles and mechanisms to resolve and prevent disputes regarding transboundary water resources. The treaty further established the International Joint Commission.
- In view of the high hydropower potential of the Columbia River the USA and Canada began negotiations on energy production in the 1940s. Flood prevention was the second main concern of the countries, playing out especially after the devastating flood of 1948.
- Preliminary investigations and negotiations resulted in 1961 in the Columbia River Treaty (CRT) (implemented in 1964). The agreement includes the construction of four dams, obligations for flood control as well as stipulations on cost and benefit sharing. It is valid for 60 years.
- A range of treaties, conventions and agreements regarding other transboundary rivers have further been signed by Canada and the USA.

Joint planning and dam management mechanisms

- One U.S. and one Canadian Entity were designated as in charge of implementing the CRT. The U.S. side is represented by Bonneville Power Administration and the U.S. Army Corps of Engineers, which is responsible for operating the Libby Dam; the Canadian Entity is represented by British Columbia Hydro and Power Authority, which is responsible for operating the Canadian treaty dams.

Source: Hyde, John 2011

Case Study

Columbia River Project – Coordinated management of national dams with compensation payments for downstream benefits and upstream costs

- The duties of the Entities include: coordination of plans and exchange of information; periodic calculation of compensations and benefits; establishment and operation of a hydro-meteorological system; preparation of hydroelectric operating plans and flood control operating plans for the Canadian storage; etc.
- The Entities coordinate weekly on planned storage discharge and to take corrective measures if necessary due to specific reasons.
- Under the treaty, two main operating plans guide system operations: the Assured Operating Plan (AOP), which is developed by the Entities for a six-year period to guide flood control and power generation operations, and the Detailed Operating Plan (DOP), which is prepared annually.
- The treaty allows Canada substantial flexibility to operate its individual projects as long as the net flow requirement at the border of the USA is met.

Specific provisions/measures

Cost and benefit sharing

- Canada paid/pays for the construction and operation of the three Canadian project dams, whereas the USA covers costs for the Libby Dam.
- The USA share with Canada one-half of the estimated increase in U.S. downstream power benefits (called the 'Canadian Entitlement'). Canada sold this Entitlement for US$254 million to a consortium of U.S. utilities for a period of 30 years. Since the agreement expired in 2003 the power benefits are delivered on a daily schedule to the Province of British Columbia.
- The USA further paid Canada one-half of the value of the estimated future flood damages prevented in the USA during the first 60 years of the treaty. Canada chose to receive a lump sum payment (in total US$64.4 million). In addition, the U.S. Entity can call upon Canada to operate additional storage for additional compensation payments by the USA ('Called Upon' flood control).
- The USA compensated for the costs for resettlement and relocation of transport infrastructure in Canada for the inundation caused by the Libby reservoir.

Impact monitoring/mitigation

- The Entities regularly adopt Supplemental Operating Agreements (SOA) to address national environmental and social concerns (such as fish flow and recreation water level requirements, wildlife and vegetation issues, heritage site protection), and to gain additional power benefits during the operating year. Within this framework it is e.g. possible to adjust storage releases in both countries, either on a mutual basis or with one side receiving compensation for incurred power losses in return for adapted storage releases.
- In Canada the Columbia Basin Trust was set up in 1995 to compensate people affected in the basin for social and environmental impacts. The trust was endowed by the Province of British Columbia with CAN$295 million and CAN$2 million annually for 16 years. This Trust also runs social and environmental monitoring programmes.

Imprint:
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Case Study

Kosi Project – Downstream riparian responsible for construction and operation of infrastructure, sharing of power generated

Kosi River Basin

Basin area
69,300 km²

Riparian countries
- China (upstream)
- Nepal (midstream)
- India (downstream)

Main treaty/organisation
- Kosi Agreement (1954, amended 1966)
- Established the Coordination Committee for Kosi Project

Members to agreement
India, Nepal

Case study dams
- Kosi Project (barrage 20MW /embankments), 1963,
- Sapta Kosi High Dam, 3,000MW, planned for 2013

Main goals of the project
- Flood control
- Hydropower
- Irrigation

Main mechanisms
- Nepal had the right to obtain up to 50% of the hydroelectric power generated by India at fixed tariff rates.
- Compensation payments for losses/damages/used material due to the project/inundation
- Payment of royalties for generated power

Cooperation background

- India and Nepal have both been interested in exploiting the high potential that Nepalese water resources provide for hydropower generation and irrigation. Since Nepal has limited capacities to develop its water resources, India supported Nepal financially and technologically, though with limited success. Major flood events have repeatedly triggered cooperation.
- In 1954, the Kosi Agreement covering the Kosi Project (barrage and embankments) was signed (amended in 1966). The project was planned to reduce the devastating floods in this area, to anchor the wayward of the riverbed that had migrated tremendously in the last 250 years, and to generate hydropower.
- Bilateral cooperation between Nepal and India on water resources management has further taken place, e.g. within the framework of the Gandak irrigation and power project (agreed 1959) and the 1996 Mahakali Treaty on the construction of the multipurpose Pancheswar Dam.
- In the beginning of the 2000s both countries further agreed on joint field investigations, studies and the preparation of project reports for the Sapta Kosi High Dam Multipurpose Project and the Sun Kosi Storage-cum-Diversion Scheme, which are additional elements to the earlier Kosi Project.
- To manage the common water resources of both countries, a three tier mechanism at the level of Ministers, Secretaries and technical staff was established in the last decade.

Source: South Asia Network on Dams, Rivers and People

Case Study

Kosi Project – Downstream riparian responsible for construction and operation of infrastructure, sharing of power generated

Joint planning and dam management mechanisms

- The amended Kosi Agreement provides that any construction and other undertaking by India in connection with the Kosi Project need to be planned and carried out in consultation with Nepal. Also, a prior approval of Nepal is required.
- The Government of the Indian State of Bihar was designated as the Chief Engineer of the Kosi project. Thus, India was responsible for the design, construction and operation of the barrage/embankments. The Government of Bihar constituted the Kosi High Level Committee to implement the Kosi Project (barrage and embankments).
- Moreover, a Coordination Committee was established to manage the Kosi Project (barrage and embankments).
- In 2004 a Joint Project Office (JPO) was set up to carry out pre-feasibility studies for the planned Sapta Kosi High Dam.

Specific provisions/measures

Cost and benefit sharing

- Nepal had the right to obtain up to 50% of the hydroelectric power generated by India in any power house in the vicinity of the barrage. The tariff rates for electricity for Nepal were fixed later in a mutual agreement. However, due to the heavy silt production by the river the barrage produced energy only for a short period.
- Nepal received royalties at agreed rates for power generated with water from the barrage and utilized in India. No royalties were paid for the power sold to Nepal.
- India paid compensation for the loss of lands, houses and/or other immovable property flooded or damaged by the Kosi project (barrage/embankments) as well as for material from Nepalese territory used by India for construction or maintenance of the project.
- India also constructed transmission lines to the Nepal-Indian border for the transfer to Nepal of power generated in India.
- The Nepalese land on which the project was built is leased to India for a period of 199 years at an annual nominal rate.

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Case Study

Itaipu Dam – Bi-national public company owns and manages dam with benefit sharing through power sales

Parana River Basin

Basin area
2,582,672 km²

Riparian countries
- Brazil (upstream)
- Paraguay, Argentina (downstream)

Main treaty/organisation
- Itaipu Treaty (1973)
- Established Itaipu Binacional

Members to agreement
Brazil, Paraguay

Case study dams
Itaipu Dam 1984, 1,400MW

Main goals of the project
Hydropower

Main mechanisms
- Managed by a bi-national company, Itaipu Binacional
- Costs, hydropower benefits and social and environmental mitigation measures are split equally between Brazil and Paraguay
- Unused energy must be sold to the other party
- Itaipu Binacional pays monthly royalties to both governments for the use of the hydraulic resource
- In Brazil, the royalties are used for an extensive revenue sharing programme with localities affected by the dam
- Itaipu Binacional runs extensive environmental and social mitigation programmes

Cooperation background

- There is no river basin management for the Parana River. However, an umbrella treaty, the Rio de la Plata Treaty, in theory provides for integrated river basin planning of the entire Rio de la Plata Basin, of which the Parana River forms a part.
- Brazil and Paraguay have a common interest in hydropower development on the Parana River. This is why in 1966 both countries signed the Act of Iguazu, which provided for detailed studies on creating a hydropower dam.
- In 1973, both countries signed the Itaipu Treaty for the Itaipu Dam. This dam has no connection to the Rio de la Plata Basin Treaty.
- In terms of basin-wide collaboration, an agreement with Argentina was concluded to maintain stable water levels that would not endanger downstream electricity generation in Argentina.

Joint planning and dam management mechanisms

- The Itaipu Treaty established the company Itaipu Binacional, which is co-owned by both governments; through their national utilities, the governments appoint the board of directors in equal portions.
- The investment costs for the dam were split between both countries, with Brazil acting as guarantor of the loans.

Source: World Water Assessment Programme 2009, reprinted in Flinker 2012

Case Study

Itaipu Dam – Bi-national public company owns and manages dam with benefit sharing through power sales

Specific provisions/measures

Cost and benefit sharing

- The installed capacity of 14,000MW is shared 50/50 between both countries. The party that does not use its share of the energy must sell it to the other party. The buying party in addition pays compensation for the additional benefits it receives from using the other's hydraulic resource entitlement.
- In reality, this means that Paraguay has sold/sells its unused share of the energy to Brazil. In addition, Brazil paid/pays compensation to Paraguay.
- The terms of the sales and compensation agreement were re-negotiated in 2009 on the insistence of Paraguay. Since then, Paraguay receives higher compensation payments. Furthermore the two parties have been negotiating whether Paraguay should be allowed to sell its unused energy directly to the Brazilian market instead of selling it to the Brazilian utility for fixed prices.
- Itaipu Binacional also pays monthly royalties to both governments for the use of the hydraulic resource.

Impact monitoring/mitigation

- When Itaipu was established, both countries were ruled by military regimes that did not have environmental and social impact legislation in place. The resettlement of 40,000 people on the Brazilian side and of 25,000 people in Paraguay resulted in widespread poverty among the resettled populations. The legal situation changed after the transition of both countries to democracy.
- On the Brazilian side, the royalties are used for an extensive revenue sharing programme with localities affected by Itaipu. This procedure followed Brazilian legislation stipulating that royalties from energy generation must by law be paid to central and local government agencies following a distribution key. This ensures that the localities most affected also receive the most royalties from the energy project.
- In Paraguay, royalties are paid to the national treasury and then used according to current government policy.
- Itaipu Binacional itself runs extensive environmental and social mitigation programmes. Expenses must be equal on the Brazilian and Paraguayan sides. Pushes by the Paraguayan government to increase social and environmental spending therefore had to be matched by Brazil. This resulted in a large budget of Itaipu Binacional for social and environmental monitoring programmes.
- Itaipu Binacional regularly cooperates in the implementation of its programmes with local communities, researchers and government agencies.
- The fish supply in the reservoir could be increased by measures such as the introduction of e.g. a spawning channel, germplasm bank, aquaculture and a seasonal prohibition of fishing.

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Case Study

Manantali Dam – Co-owned infrastructure with cost and benefit sharing based on expected use of multiple benefits

Senegal River Basin

Basin area
289,000 km²

Riparian countries
- Guinea, Mali (upstream)
- Senegal, Mauritania (downstream)

Main treaty/organisation
- Convention portant création de l'organisation pour la mise en valeur du Fleuve Sénégal (1972)
- Established the OMVS

Members to agreement
- Senegal, Mail, Mauritania (Guinea joined 2006)

Case study dams
Manantali 1988, 200MW

Main goals of the project
- Irrigation
- Hydropower
- Navigation

Main mechanisms
- Dams are co-owned by member states
- A co-owned company is responsible for management of the dam
- Costs and benefits are allocated according to projected use of benefits (clé de repartition)
- Environmental flow regime established to enable smallholder recessional agriculture

Cooperation background

- In 1963 Guinea, Mali, Senegal and Mauritania signed the Bamako Convention. The Convention declared the Senegal to be an international river. The riparian countries had complementary interests in developing the river for navigation, irrigation and hydropower generation
- In 1972 against the backdrop of the Sahel drought, Senegal, Mauritania and Mali signed the Convention portant création de l'organisation pour la mise en valeur du Fleuve Sénégal, which created the Organisation pour la mise en valeur du Fleuve Sénégal (OMVS). Guinea did not participate because of political difficulties internally and within the region, but joined the Convention in 2006.

Joint planning and dam management mechanisms

- Two additional conventions lay down the legal basis for dam operation: the 1978 Convention on the Legal Status of the Jointly-Owned Structures, and the 1982 Convention on the Financing of the Jointly-Owned Structures. The most important stipulations are:
  - The members co-own the dams and all other structures;
  - Investment costs and operating expenses are allocated to the co-owners according to their use of the benefits generated from the dams;
  - The co-owners guarantee repayment of loans extended to the OMVS;
  - Two dams, Diama in the delta and Manantali upstream, are operated jointly to maximise irrigation in the middle valley. Apart from that, Diama is designed for delta irrigation and prevention of saltwater intrusion in the delta. Diama has also a ship lock to enable navigation. Manantali is designed for irrigation, navigation and hydropower generation.

Source: World Water Assessment Programme 2003: 451

Case Study

Manantali Dam – Co-owned infrastructure with cost and benefit sharing based on expected use of multiple benefits

- The dams are operated by separate entities, which are again co-owned by the OMVS members: the Société de Gestion de l'Energie de Manantali (SOGEM) operates Manantali, and the Société de Gestion et d'Exploitation de Diama (SOGED) operates the Diama Dam.
- Energy production was contracted to Eskom Energie Manantali (EEM), a subsidiary of South Africa's utility Eskom; EEM withdrew from this contract in 2011.
- EEM transferred the income from the energy sales from Manantali to SOGEM, minus the management fees. This makes up SOGEM's revenue.

Specific provisions/measures

Cost and benefit sharing

- The international status of the Senegal River implicates that riparian countries forego volumetric water allocation and move directly to the allocation of benefits from water use.
- Costs and benefits are allocated in the 'clé de repartition', which reflects the anticipated usage of the benefits by each member country:

Benefit allocation	Mauritania	Mali	Senegal
Irrigation potential	31%	11%	58%
Hydropower potential	15%	52%	33%
Navigation potential	12%	82%	6%
Total cost allocation	**22.6%**	**35.3%**	**42.1%**

Impact monitoring/mitigation

- Manantali necessitated the relocation of 10,000 people. Resettlement was funded by UNDP, USAID and the government of Mali and included electrification and poverty reduction measures such as micro subsidies.
- The triple goal of irrigation, hydropower and navigation is based on the cessation of the naturally occurring floods. However, farmers downstream resisted this since the opportunities for local farmers declined as a negative consequence of the dam while the development of large scale corporate irrigation facilities could not keep up. OMVS therefore changed the management of Manantali to release one annual artificial flood to enable flood recessional agriculture.
- Under donor encouragement, OMVS set up an environmental monitoring programme (PASIE) in 1998. PASIE developed a basin management plan, including a multi-stakeholder Environmental Observatory and a Health Plan.
- The Environmental Observatory has the general tasks to monitor environmental effects of basin development and to design mitigation measures. In addition, it ensured the continuation of the annual artificial floods for smallholder recessional agriculture and therefore the permanent institutionalisation of an environmental flow regime. The Health Plan is designed to mitigate the increase in diarrhoea, schistosomiasis and malaria.

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Case Study

Kariba Dam – Co-owned dam with cost-sharing based on actual water use for national power generation

Zambezi River Basin

Basin area
1,350,000km²

Riparian countries
Zambia (source), Angola, Namibia, Botswana, Zimbabwe, Malawi, Mozambique (delta)

Main treaty/organisation
- Zambezi River Authority Act (1987)
- Established the Zambezi River Authority

Members to agreement
- Zambia, Zimbabwe

Case study dams
- Kariba Dam 1960 (south bank power station), 1975 (north bank power station)
- North Bank: 720MW
- South Bank: 750MW

Main goals of the project
Hydropower

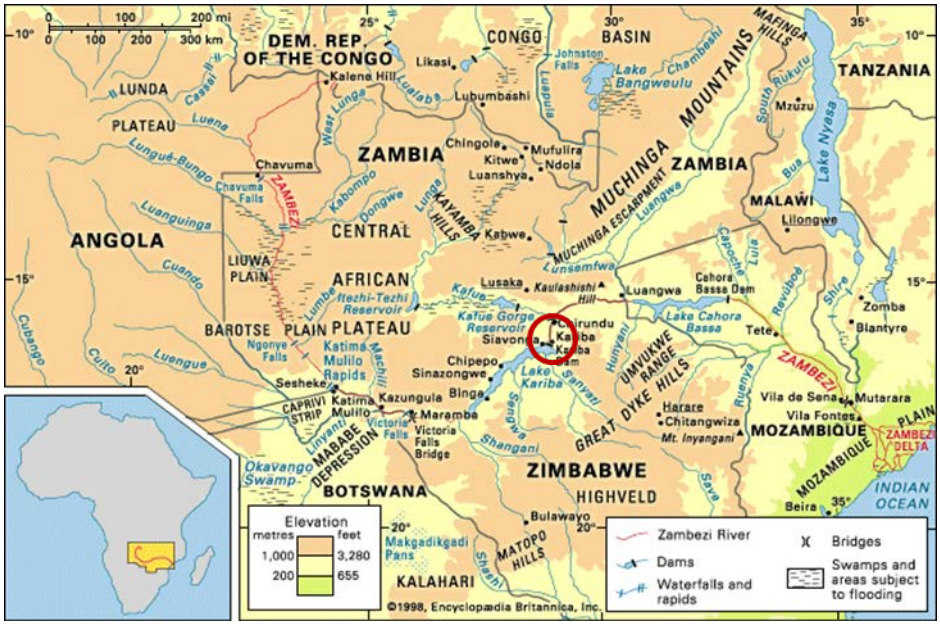
Main mechanisms
- The bi-national Zambezi River Authority only manages Kariba Dam. It is co-owned by both governments
- The power houses on the north bank and the south bank are managed by the national utilities of Zambia (north bank) and Zimbabwe (south bank)
- ZRA is funded by both government based on the water that the national utilities use for energy production

Cooperation background

- Kariba was planned and built by British authorities in the Central African Federation. The governments of two of the federal territories, Northern and Southern Rhodesia had interests in hydropower development, but differed in choice of location. The Federal government decided in favour of Kariba in 1955.
- Basin-wide cooperation dates back to 1987, when riparians adopted the Zambezi Action Plan (ZACPLAN) to establish a Zambezi Watercourse Commission (ZAMCOM). However, a lack of political will hampered implementation of the ZACPLAN.
- Negotiations on ZACPLAN led the already established Southern African Development Community (SADC) to adopt the SADC Water Protocol. The SADC Water Protocol effectively functioned as ZAMCOM Agreement surrogate. All further planning for ZAMCOM were coordinated by the SADC Water Division.
- Only in May 2011, an Interim ZAMCOM Secretariat was established and the work transferred from SADC to the Interim Secretariat.
- However, Kariba, Cahora Bassa and other dams on the Zambezi and its tributaries continue to be operated as individual projects.

Joint planning and dam management mechanisms

- Kariba was first managed by a Federal Power Board, then after independence by the Central African Power Corporation (CAPCO). CAPCO's wide mandate included electricity sales and power-related investment.
- Conflicts between post-independence Zambia and Zimbabwe led to CAPCO being replaced by the bi-lateral Zambezi River Authority (ZRA) in 1987. ZRA's mandate is confined to managing the dam, while the power houses are operated by the national utilities.



Source: Encyclopaedia Britannica, http://www.britannica.com/EBchecked/media/206/The-Zambezi-River-basin-and-its-drainage-network

Case Study

Kariba Dam – Co-owned dam with cost-sharing based on actual water use for national power generation

Specific provisions/measures

Cost/benefit sharing

- ZRA is funded by both states through their national utilities. When the ZRA was founded, the funding arrangement was that both governments would contribute equal amounts. The arrangement was later altered to even out perceived imbalances. Now, payments are made based on the actual water use by the utilities for energy generation. The water tariff itself is reviewed annually by a Joint Operations Committee.

Impact monitoring/mitigation

- As for the environment, the colonial authorities launched Operation Noah, a large-scale programme to rescue wildlife from the inundating reservoir.
- While the 1950s feasibility study made no mention of resettlement, some efforts were made: The resettlement procedure was the responsibility of the governments in the Central African Federation: Northern Rhodesia resettled members of the Gwembe Tonga tribe on the north bank, Southern Rhodesia the south bank Gwembe Tonga.
- North bank resettlement focussed on reservoir resettlement and was comparatively well planned, but shortage of funds, time and staff as well as the suspicion of the Gwembe Tonga led to widespread impoverishment, particularly a decline in agriculture and cattle grazing.
- Reservoir fisheries were successfully established.
- In the 1990s, the ZRA began compensation procedures for the Zimbabwean resettlers. The move was matched on the Zambian side by Zambia's national utility ZESCO with funding from the World Bank and the Southern African Development Bank.
- In 1998, the ZRA started an Environmental Monitoring Programme with funding from SIDA.
- To advance dam harmonization between the Kariba, Kafue and Cahora Bassa dams, a Joint Operations Technical Committee (JOTC) was created, including authorities and operators responsible for operating those dams. In this framework, also discussions to experiment with environmental flows at Kariba and Cahora Bassa are being held between SADC and the JOTC.
- A project on Dam Synchronization and Flood Releases in the Zambezi River Basin, is further currently ongoing under the auspices of SADC and funded by GIZ, DFID and AusAID.

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Lessons learnt

Transboundary mechanisms for sustainable hydropower development and management

Transboundary cooperation in hydropower development and management can significantly increase the project benefits by allowing for the more efficient location and operation of infrastructure, or by sharing related costs and exchanging know-how between riparian countries. Hydropower projects, however, regularly come along with adverse environmental and social effects that not only surface in close vicinity but also further up- and downstream of the dam. Cooperation between riparian countries as well as with national stakeholders and local communities is thus also necessary to effectively mitigate social and environmental impacts. Transboundary hydropower cooperation can therefore reduce the conflict potential on all levels and also generate win-win situations, which would not have been possible unilaterally.

How can sustainable transboundary hydropower cooperation be set up in regulatory and organisational terms? What impact mitigation measures and cost-benefit sharing arrangements exist, and what are the challenges in implementing these? To answer these questions, a set of case studies was analysed to draw the following lessons learnt:

Basin-wide institutions can provide an essential framework for coordinated hydropower development and management

Where hydropower schemes with potential transboundary impacts exist or are planned in a basin, coordinated development and management is necessary to achieve the optimal hydropower output of all included projects while effectively mitigating social and environmental impacts.

- Basin-wide institutions, such as river basin organisations, can provide an essential framework for collaboration. They can facilitate cooperation on joint hydropower projects by establishing a trustful riparian relationship and maintaining transparency.

Designating or creating a specified agency for dam operations management can facilitate day-to-day cooperation

The day-to-day management of joint hydropower projects requires frequent consultation between riparian countries to respond flexibly to upcoming management challenges, such as e.g. floods and droughts. Regardless of whether the dams are located on national territory or on a river forming the border between riparian countries, the case studies show that where dams are co-owned, co-financed or built with compensation and benefit sharing mechanisms, a specified agency was created to manage dam operation. Regular consultation can also provide room for solving project-specific disputes.

- Companies co-owned by riparian countries as well as bi-national quasi-governmental institutions have both shown to be effective in managing and operating co-owned hydropower infrastructure. Where dams are not co-owned, as e.g. in the Columbia basin, close coordination of national agencies in operational committees represents a further option.
- Where basin-level organisations exist, agencies mandated with dam operations management regularly are established as subordinate bodies to these.

Lessons learnt

Transboundary mechanisms for sustainable hydropower development and management

Cost-benefit sharing mechanisms need to be fair and flexible

Cost-benefit sharing schemes are a valuable tool that aims to provide maximum project benefits while compensating each party involved or affected according to the costs they have to bear.

- In order to achieve this goal, the case studies reveal that effective schemes should not only encompass one-off payments, but also flexibly designed cost and benefit sharing arrangements that allow contracting parties to react to political and economic changes that affect the use of the respective dams by the riparian countries.
- At the same time the essential cost-benefit sharing principles that were mutually agreed upon when the treaties were negotiated need to be kept in place in order to provide for sufficient planning reliability and disaster prevention.

Social and environmental mitigation measures as well as their financing need to be considered from the planning stage

In the past, the mitigation of social and environmental impacts was either not incorporated into transboundary hydropower projects or it was carried out hastily based on insufficient knowledge of the environmental and social effects of the dam. In all of the examined cases, corrective measures had to be introduced afterwards, often as a result of social pressure or international disputes. To provide effective mitigation and prevent related conflicts,

- social and/or environmental impact mitigation measures, such as rural development programs or rehabilitation projects, need to be incorporated into the project from an early stage and be based on sound knowledge and participation of affected communities; and
- the costs of social and/or environmental measures need to be considered in the project's cost calculations. Trusts or funds financed through project revenues can ensure a sustainable financing concept for mitigation measures.

Cooperation on the regional as well as local level is necessary to effectively design and implement social and environmental mitigation measures.

Social and environmental impacts of hydropower projects are interrelated and often complex. Mitigation measures thus need to be based on a thorough understanding of the interrelationships across the basin as well as of the specific situation upstream and downstream of the dam.

- Cooperation and the exchange of data and information locally as well as across borders are crucial to designing the most appropriate mitigation measures for each dam, to coordinating mitigation measures across basins, and to monitoring their effectiveness.
- Joint monitoring and implementation of mitigation measures should be institutionalised, for example as part of specific programmes or sub-agencies. Agencies mandated with the operation of hydropower schemes, as well as local communities, can also play important roles in implementing and monitoring mitigation measures.

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