Guidelines and Procedures for Resource Allocation and Sharing of Benefits in Transboundary River Basins

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Preface

The Directorate of Infrastructure and Services - Water Division (DIS-WD) for the Southern African Development Community (SADC) organized and conducted two regional workshops for transboundary river basin organizations (RBOs). The First Regional River Basin Organizations (RBOs) Workshop was held in Gaborone, Botswana, in September 2007 under a collaborative arrangement led by the SADC Water Division and supported by GTZ, USAID, and InWEnt.

The main objectives of this initial RBO Workshop were to create a dialogue platform for the RBOs in the region to discuss common challenges, exchange experiences, and identify the main areas where regional support was required under the RSAP-2 Capacity Building activity – Number 3 (CB-3). A key intervention area identified by participants of this workshop was the development of Systems, Guidelines and Procedures as tools to assist the RBOs with their institutional growth. Importantly, ***Guidelines and Procedures for Resource Allocation and Sharing of Benefits in Transboundary River Basins*** was considered key to future negotiations within RBOs within the SADC region.

The recommendations of the Workshop were articulated in a Programme to Strengthen RBOs in the SADC Region which was endorsed by the SADC Water Resources Technical Committee (WRTC) meeting held in Maputo, Mozambique, in May 2007, and later approved by the SADC Integrated Committee of Ministers (ICM) in June 2007. The Second RBO workshops, held in March 2008 confirmed the Scopes of Work for all the USAID and GTZ supported consultancies.

The USAID Southern Africa Okavango Integrated River Basin Management Project (IRBM) agreed to support the development of the resource allocation and benefits sharing guidelines and commissioned the Centre for Applied Research (CAR) to review commonly accepted practices and best management approaches from other parts of Africa and globally. Based upon lessons learned, CAR has developed an approach to preparing programs for allocating resources and the sharing of benefits among the participating member states of Southern African transboundary river basins. These guidelines will be used by the SADC Water Division to assist regional transboundary RBOs develop programs related to the allocation of resources and the sharing of benefits. The Principle Investigator for CAR was Dr. Jaap Arntzen and he was assisted by Mr. Peter Rutherberg and Ms. Phemo Kgomotso.

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List of Abbreviations

ADB	Asian Development Bank
AMCOW	African Ministers' Council on Water
ANBO	African Network of Basin Organizations
BD	Biodiversity
BSAR	Benefit Sharing Allocation Resources
BU	Beneficial Use
CM	Cooperative Management
DP	Development Project
ENWC	Eastern National Water Carriers
EPandL	Environmental Policies and Legislation
EIA	Environmental Impact Assessment
EU	European Union
FWAR	Flexible Water Allocation Rules
GMS	Great Mekong Subregion
IBT	Interbasin Transfers
ICP	International Cooperating Partner
ICPR	International Commission for the Protection of the Rhine
IRB	Incomati River Basin
IRBM	Okavango Integrated River Basin Management Project
IWC	International Water Courses
IWMI	International Water Management Institute
IWM	Integrated Water Management
JPTC	Joint Permanent Technical Commission
LHWP	Lesotho Highlands Water Project
LIC	Large Implementation Capacity
MFMP	Mekong Food Development Programme
MRC	Mekong River Commission
MWRAS	Mekong Water Resources Assistance Strategy
NBSP	National Benefit Sharing Policies
NGO	Non-Governmental Organisation
OBSC	Okavango Basin Steering Committee
OMVS	Organisation for the Development of Senegal River
OR	Orange River
OKACOM	Permanent Okavango River Basin Water Commission
OVTS	Orange Vaal Transfer Scheme
PWC	Permanent Water Commission
RBO	River Basin Organisation
RWRF	Regional Water Research Fund
SADC	Southern African Development Community
SAWLA	South African Water Law Act
SWAM	Shared Water Accounts Management
SWC	Shared Water Course
SWCP	Shared Water Courses Protocol
TA	Technical Advisor
TC	Technical Commission
TCTA	Trans Caledon Tunnel Authorities
TDA	Transboundary Diagnostic Authority
TIA	Tripartite Interim Agreement
TR	Transboundary River
UN	United Nations
VW	Virtual Water
WA	Water Accounting

WB	World Bank
WC	Water Conflicts
WDM	Water Demand Management
WDI	World Development Indicators
WEDandI	Water Efficiency Data and Information
WM	Water Management
WRM	Water Resource Management
WRMD	Water Resource Management Development
WRSA	Water Resource Sharing Allocation

1 Introduction

Most surface water sources in southern Africa are shared between two or more countries. Their use is governed by international and regional conventions and protocols and bilateral agreements. At the SADC level, the SADC Protocol on Shared Watercourses is the primary legal instrument guiding cooperative use of shared rivers and all agreements are based on it. The allocation of shared water resources (i.e. entitlements or rights) traditionally received most focus, but recently there has been a shift in focus towards benefit sharing.

This study to examines models for benefit sharing and allocation of natural resources and presents guidelines based upon principles of best use and sustainable utilisation, conservation, and equitable distribution that can be used by the SADC Water Division to develop their programs.

In compiling this information and preparing the guidelines, a detailed literature review and assessment of existing data were conducted and this was complemented with interviews and questionnaires completed with key informants. The list of consulted persons is provided in Annex 1. The checklist utilized for the interviews and mail survey is presented in Annex 2.

Most of southern African rivers are shared between countries (Table 1.1 and Annex 3).

Table 1.1: Shared river basins in Africa

River Basin	No. of states	Basin states	Basin area (km²)	River length (km)
Limpopo	4	Botswana, South Africa, Zimbabwe, Mozambique	415,000	1,750
Orange-e	4	Lesotho, South Africa, Namibia, Botswana	850,000	2,300
Zambezi	8	Angola, Botswana, Zambia, Zimbabwe, Malawi, Tanzania, Mozambique, Namibia	1,400,000	2,650
Congo	9	Burundi, Rwanda, Central African Republic, Tanzania, Cameroon, Congo, DR Congo, Zambia, Angola	3,800,000	4,700
Incomati	3	South Africa, Swaziland, Mozambique	50,000	480
Okavango	4	Angola, Namibia, Botswana, Zimbabwe	570,000	1,100
Maputo-Usuthu-Pongola	3	South Africa, Swaziland, Mozambique	32,000	380
Nile	10	Tanzania, Burundi, Rwanda, Kenya, Uganda, DR Congo, Eritrea, Ethiopia, Sudan, Egypt	2,800,000	6,700
Save	2	Zimbabwe, Mozambique	92,500	740
Ruvuma	3	Tanzania, Malawi, Mozambique	155,500	800
Cunene	2	Angola, Namibia	106,500	1,050
Cuvelai	2	Angola, Namibia	100,000	430

Buzi	2	Zimbabwe, Mozambique	31,000	250
Umbeluzi	2	Swaziland, Mozambique	5,500	200
Pungue	2	Zimbabwe, Mozambique	32,500	300

Sources: Boroto, not dated and Pallet, 1997.

2 SADC and Shared Watercourses

SADC has actively developed a policy implementation framework since the 1990s, of which the Shared Water Courses Protocol is an integral part. According to the 2005 Regional Strategic Action Plan (RSAP) on Integrated Water Resources Development and Management, the SADC water mission and vision are closely linked to the overall goals of SADC.

	Vision	Mission
SADC Protocol	Become a reputable, efficient and responsive enabler of regional integration and sustainable development	Provide strategic expertise and coordinate the harmonisation of policies and strategies to accelerate regional integration and sustainable development through efficient production systems, deeper cooperation and integration, good governance and durable peace and security so that the region emerges as a competitive and effective player in international relations and the world economy’
RSAP	Provide an effective and dependable framework contributing to poverty eradication, regional integration and socioeconomic development in a sustainable manner	Provide a sustainable enabling environment, leadership and coordination in water resources strategic planning, use and infrastructure development through application of integrated water resources management at member state, regional, river basin and community level

The RSAP objectives are to:

1. Maintain and sustain an enabling environment for regional water resources development and management;
2. Provide a framework for sustainable, effective and efficient planning and management of shared river basins at regional and related national levels;
3. Promote and support strategic infrastructure development for regional integration, socio-economic development and poverty alleviation;
4. Develop, promote and facilitate best practices regarding effective participation by various individual and institutional stakeholders in water resource development and management, including women, youth and other disadvantaged groups;
5. Build and strengthen human and institutional capacity for sustainable management of water resources at basin, national and regional level.

The RSAP identifies four strategic areas, each with a clear focus and inclusive projects (Table 1.2).

Table 1.2: Strategic areas and RSAP-projects

Strategic area	Focus	RSAP-Projects
Regional water resources development planning	▪ Resource assessments and monitoring ▪ Planning mechanisms and	▪ Consolidation and expansion of SADC HYCOS ▪ Standards assessment of

and management	support for major E and D issues ▪ Operational procedures for management of water infrastructure	surface water resources ▪ Groundwater management programme ▪ Support for strategic and IWR planning ▪ Dam safety, synchronisation and emergency operations
Infrastructure development support	Support for water infrastructure development	▪ Regional water infrastructure programme ▪ Implementation of water supply and sanitation
Water governance	▪ Maintaining an enabling environment as per Protocol ▪ Best practices for effective participation of stakeholders in water planning and management	▪ Implementation of SADC water protocol ▪ Public participation in WRDandM ▪ Implementation of RWP and RSAP
Capacity building	Skills and institutional development at all levels	▪ Skills training ▪ Support SADC Water division ▪ Strengthen RBOs ▪ Regional Water Research Fund

The Regional Water Policy (RWP) is based on the SADC declaration and treaty, the southern African vision for water, life and environment, the revised SADC Protocol on Shared water courses, and the Dublin principles of IWRM.

The main policy areas include the following that are most relevant to shared water courses.

Policy area	Policy statement	Details
Regional cooperation in water management	Water for economic integration	▪ Integrated WRD and M based on balance, equity and mutual benefits ▪ Southern African vision as point of departure
	Water for peace	▪ Implementation of SADC protocol ▪ Intersectoral cooperation ▪ Harmonisation of national policies and legislation ▪ Conflict management ▪ Water for international cooperation
Water for development and poverty reduction	Water for socio-economic development, sanitation and hygiene, food security, energy development, industrial development and sports and leisure	
Water for environmental sustainability	Water and environment	▪ Water requirements of environment recognised ▪ Sufficient water allocations for environment
	Water quality management	▪ Minimum standards for shared water courses ▪ Pollution prevention ▪ Import restrictions ▪ EIA requirements

	Alien invasive species	Control of alien species to reduce water consumption
Security from water related disasters	People's protection from floods and droughts	▪ Commitment to human life protection ▪ SADC to coordinate disaster management at shared waters and regional level
	Disaster prediction, planning and mitigation	▪ Capacity building disaster predictions ▪ Integrated and coordinated RBO plans and procedures ▪ Notification duty of impending disasters
Water resources information and management	Data and info acquisition and management	▪ Water resource data management systems ▪ Compatible systems
	Information sharing	▪ Sharing ▪ Public access ▪ Regular dissemination
Water resources development and management	RBO	▪ RBO approach and plans ▪ Water allocation and utilisation based on equitable and reasonable mechanisms through negotiations
	Integrated planning	▪ IWRM based ▪ Joint implementation
	WDM	▪ Utilise shared water more efficiently ▪ WDM is a fundamental requirement of IWRM
	Alternative sources of water	Rainwater harvesting, desalination, treated effluent
	Dam development and management	▪ Integrated planning, development and management ▪ Participatory process ▪ Negotiations of operating rules ▪ Affected communities
Reg. water resources institutional framework	Shared water course institutions	▪ Establishment of SWCI and Water course commission ▪ Consensus decision making ▪ Cooperation with NGOs and civil society groups
	Institutional arrangements at national level	▪ National enabling environments ▪ Decentralisation of water management ▪ Increased participation of NGOs
	SADC secretariat	▪ Support for SWC institutions ▪ Implementation of RSAP, RWP and Protocol
	Monitoring and evaluation	
Stakeholder participation and capacity building	Participation and capacity development	Participatory water management including NGOs
	Gender mainstreaming	Implementation of principles of gender mainstreaming
	Capacity building and training	▪ Capacity development and sharing ▪ Water education and training
	Research, technology development and transfer	▪ Demand driven water sector research with a regional perspective ▪ Sharing of water technologies and info
	Financial sustainability	▪ National financial resources ▪ Cost recovery
Financing IWRM	▪ Cost reduction	Cost reduction measures

	▪ Public-private sector partnerships	

Source: Regional water policy.

Well functioning RBOs are important vehicles for the implementation of the policy[1]. Other requirements include close cooperation with other SADC sectors and harmonisation of national policies and legislation.

Current and future resource allocations and benefit sharing of shared water resources should take a number of issues into consideration, most of which are principles outlined in international water law, including the SADC Protocol on Shared Watercourses. These inlcude:

- **Optimal use-** This entails application of economic principles to the use and management of water, including the efficient allocation and use of water which involves making water available for the most economically productive activity and using the same water for a variety of uses.
- **Sustainable use-** The responsibility for prevention, reduction and control of pollution and environmental degradation of a shared watercourse that may cause significant harm to other watercourse states or their environment, including to:
  - human health or safety
  - the use of waters for any beneficial purpose; or to
  - the biodiversity of the watercourse.
- **Equitable use and reasonable use-** Requires taking into account all relevant factors and circumstances including basic natural conditions in the basin; the socio-economic and environmental needs of the watercourse states concerned, the population dependent on the resource; the effects of the use of a shared watercourse in one state on another's (upstream-downstream issues); conservation, protection, development and economy of use of water resources of the shared watercourse and the costs of measures taken to that effect; and the availability of alternatives, of comparable value, to a particular planned or existing use.

Box 1.1: Efforts towards benefit sharing and resource allocation: Current and future developments in the SADC region

Recent trends in the southern African region depict a move towards more cooperation over shared river basins in the SADC region. The past few years have seen the signing of river basin agreements by member states and a strengthening of river basin organisations and the setting up of new ones. International Cooperating Partner (ICP) involvement and commitment towards institutional strengthening and capacity building of these river basin organisations has enhanced the region's capacity towards cooperation over shared water resources. SADC has in the last few years partnered with many of these ICPs in designing programs geared towards these developments, particularly towards the realisation of the SADC Protocol on Shared Watercourses, one of which goals is to improve regional integration through joint management and development of shared water resources. With assistance from regional ICPs, the SADC has so far hosted two regional workshops on strengthening river basin organisations in the region. Through these workshops, the SADC members have expressed interest and commitment to working together towards a realisation of concrete benefits from cooperative use and management of regional shared water resources. The objectives of the first workshop were to create a dialogue platform for the RBOs in the region to discuss common challenges, exchange experiences, and identify the main areas where regional support was required under SADC's Regional Strategic Action Plan on Capacity Building. One of the intervention areas identified by the workshop for regional support to RBOs and adopted as one of SADC's

[1] See page .XIV of the Policy.

Programme to Strengthen River Basins is the development of Systems, Guidelines and Procedures, as tools to assist the RBOs in their institutional development procedures. These tools, which include the current Procedures and Guidelines for Resource Allocation and Benefit Sharing for River Basin Organisations, are being developed by SADC with support from GTZ and USAID.

Some of the results of the 2nd RBO Workshop on Strengthening River Basins that have a bearing on the current work and demonstrate regional commitment towards improved management of shared river basins, which promotes equitable resource allocation and sharing of benefits show that RBOs in the SADC region would like to strive towards cooperative management of shared water resources that ensures equitable sharing of benefits and costs. This would be done on the basis of planning, management and monitoring tools and will work towards providing leadership on the process of equitable sharing of benefits and costs of cooperation.

Source: Based on the results of the 1st and 2nd RBO Workshops.

The operational development of resource allocation and benefit sharing can draw from different sources, including the Helsinki rules. The latter rules are more explicit, for example about the need to avoid wasteful water use, but are less detailed concerning resource conservation and environmental water requirements. The SADC Protocol, the Helsinki Rules and the Helsinki Convention do not offer guidelines for prioritising factors that need to be considered for determining reasonable and equitable use, but only state that 'the weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors' and that these are 'to be considered together and a conclusion reached on the basis of the whole' (Article 8.b). Article 10 of the Helsinki Rules prioritises 'requirements of vital human needs' in resolving conflicts between uses, where there is no agreement or custom.

Table 1.3 highlights important aspects of the existing legal instruments that need to be considered in operationalising benefit sharing and resource allocation.

Table 1.3: Comparison of the SADC Protocol, the Helsinki rules and the Convention on the Law of navigation uses of international water courses

Factor-topics	1996 Helsinki rules	2000 SADC Protocol	1997 Convention on the law of the non-navigational uses of international watercourses	Comment
Supply	Basin geography, in particular extent of drainage area in each basin state	Geographical, hydrological, climatic, ecological and other natural factors	Geographic, hydro graphic, hydrological, climatic, ecological and other natural factors	SADC protocol in line with UN 97 convention; more comprehensive and less specific as it captures all supply factors in one factor
	Basin hydrology, in particular the water contribution of each country			
	Climate affecting the basin			

Demand	Past utilisation of basin water, in particular existing uses	Existing and potential uses of the watercourse	Existing and potential uses of the watercourse	All recognise existing uses but SADC and 97 Un Convention add potential uses
	Economic and social needs of each basin state	Economic, social and environmental needs	Economic and social needs of each basin state	SADC protocol adds environmental water requirements
	Basin water dependent population in each country	Shared watercourse dependent population in each country	Shared watercourse dependent population in each country	Same
	Comp. costs of alternative means of meeting economic and social needs	Availability of alternatives of comparable value to a particular planned or existing use	Availability of alternatives of comparable value to a particular planned or existing use	Similar
	Avoidance of unnecessary waste in water use in each country			Implicit SADC Protocol
External-ities	Practicability of compensating other basin states as a means of adjusting conflicts			Not in SADC protocol
	Degree to which needs of a state may be satisfied without causing substantial injury to a co-basin state	Effects of the water use in one state on other states	Effects of the water use in one state on other states	Different formulations; Helsinki is more explicit
Water manage-ment		Conservation, protection, development and economy of use of water resources of the shared water courses and the costs of the required measures	Conservation, protection, development and economy of use of water resources of the shared water courses and the costs of the required measures	Not covered by Helsinki rules
			Regular exchange of data and info among basin countries Take appropriate measures to prevent harm to other countries	

			Notification requirement of new projects	

3 Literature review of resource allocation and benefit sharing arrangements in shared river basins

3.1 Introduction

Internationally accepted criteria for allocating shared water resources, or their benefits do not exist (Wolf, 1999). Therefore, the main challenge is to generate guidelines for watersheds which are by nature hydrologically, politically, economically and culturally unique. The 1997 United Nations Law of Non-Navigational Use of Shared Watercourses suggests a framework for management and allocation of international waters based on criteria such as equitable and reasonable utilisation and resource conservation. These criteria have been adopted in the Revised 2000 SADC Protocol on Shared Water Courses. However, little progress has been made to-date with the actual operationalisation and implementation of these criteria.

In this chapter, the main findings of a literature review are presented. In addition, views expressed during interviews have been incorporated.

The results of the interviews indicated that the degree of water scarcity in the shared water course is perceived to be the most important factor that influences the process of reaching and implementing shared water course agreements. Other important factors include the number of shared water course countries, existing water allocations and the level and quality of governance in SWC countries. The interviews show that there is no common interpretation of the terms and concepts used in the Protocol. Furthermore, respondents felt that there is considerable overlap between terms such as conservation, needs, and uses. This hampers operationalisation and implementation. Finally, weights need to be accorded to different factors listed in several articles of the Protocol (e.g. Articles 7 and 8). There is no clear consensus about the weights of each factor, and it is therefore indeed advisable to determine weights at the river basin level.

Interviewees expressed concern about the unequal capabilities of RBOs and representatives of SWC countries. This requires capacity building efforts and active involvement of civil society.

A conclusion to be derived from the interviews and limited literature review is that water accounting and the concept of virtual water for SWC management can be useful tools, if applied appropriately. The most important results are summarised in Box 3.1 and Box 3.2. Water accounts are important as they provide baseline information as well as information about the benefits, water use efficiency, and water demand management. Ideally, accounts are prepared in physical (m^3) and monetary terms (Pula, Rand, US$) and therefore bridge the gap between physical water allocations and economic benefit generation and distribution. Moreover, RBOs can review different utilisation scenarios with the aid of water accounts. A detailed example of Botswana's water accounts and draft accounts for the Orange River basin are provided in Annex 3.

***Box 3.1:* Water Accounting**

At least three SADC countries have national water accounts (Botswana, Namibia and South Africa) There is one incomplete example of a river basin wide water account (Orange River). SADC anticipates supporting a regional water accounting project aiming to promote the development of water accounts in more SADC countries.

Potential benefits of water accounts:

- Records the amount of water resources in the countries (stock accounts): normally for ground and surface water but in principle also for treated effluent;
- Records the uses of water resources in the countries and in the basin by economic sector;
- Identifies benefits of water uses and their efficiency (value added/m^3) and will be able to identify opportunities to increase basin benefits (e.g. using scenarios);
- Time series provide insight in the trends and variation in water resources and their use; and
- Closes linkages between environmental and economic planning and concerns.

Water accounts include:

- Physical and monetary stock and flow accounts;
- Data requirements (specific to the country's part of the river basin);
- Size of the basin;
- Amount of available water at the start and end of the year at the entry and exit of the country;
- Water abstractions in the country for human activities (domestic, agriculture, industry, government etc); and
- Natural changes during the year: inflows-recharge and evaporation.

Constraints to complete water accounts:

- Lack of country-specific data and sharing of national data;
- Few countries have comprehensive accounts. Shortcomings may exist in the areas of monetary accounts and water quality, and incorporation of treated effluent; and
- No successful comprehensive applications for river basins as yet.

Conclusion:

Preparation of water accounts for SWC is highly relevant and must be pursued in future. The opportunities depend on the data available at the level of the SWC countries.

Virtual water is an interesting concept, but it is considered to be less relevant to SWC management than water accounts. The concept can be used to demonstrate that beneficiaries of water are not confined to SWC states as trade embodies virtual water. It is also used to demonstrate that global water use efficiency can be increased through trade and virtual water streams (Hoekstra, 2002 and 2005). Virtual water is linked to the water footprint (www.waterfootprint.org), which has been derived from the better-known ecological footprint (Hoekstra, 2008).

Box 3.2: Virtual water

Virtual water is the amount required for the production of food and other commodities. For example, virtual water of maize or wheat is the amount of water required to produce one unit of maize/wheat. The concept has been used to estimate the amount of water saved through commodity trade. Particularly trade in crops from water abundant and efficient countries to water scarce and (semi-)arid countries leads to global savings in water use (around 16%). This is in line with production and trade flows based on comparative advantages and would enhance regional integration.

Within the river basin approach, it raises the issue as to whether it is better to let the water flow to meet countries' consumption needs (e.g. food) or to concentrate production where water is abundant and subsequently export food to water scarce countries. This is only an issue when water productivity and efficiency significantly differs among SWC countries. Moreover, water and food security issues have to be considered too, particularly in regions with governance and political concerns and differences.

As an example, Botswana has adopted a food security policy and hence imports a lot of virtual water at lower costs than producing its own food. Food imports are paid for from mineral revenues. This works based on two conditions: availability of global food surpluses and ability to pay for food imports. These conditions are uncertain and change in time. Trade in virtual water is high. Other countries opt for a degree of food self sufficiency, even if it is achieved at higher costs than imports but at lower risks. In this case, trade in virtual water is low but it is likely to lead to greater water efficiency. Obviously, these policy options have markedly different impacts on the river basins and abstraction patterns.

Potential benefits of virtual water for resource allocation and benefit sharing:

- Only likely to occur when significant differences in water use efficiency exist among SWC countries; it assumes that similar enabling environments prevail in SWC states.

Constraints:

- Requires regional and national political stability;
- Foreign exchange availability;
- May compromise national security (compare with power shortages);
- Poor transport and communication infrastructure in Southern Africa.
- Does not apply to the subsistence food production sector.

Conclusion:
Virtual water is a concept that influences the choice and location of projects that abstract water from the river. The immediate relevance and application for SWC management is limited.

Sources: Hoekstra and Hung, 2002 and 2005; Hoekstra, 2008.

3.2 Water resources sharing and allocation in shared river basins

3.2.1 Models and issues

Increasing scarcity of water resources and greater variability in available water supply are causing acute difficulties for water allocation agreements among users of water bodies. Most studies approach the allocation issue via market solutions or via cooperation in the form of joint project development.

According to Molle et. al. (2007) three non-exclusive modes of allocation are commonly recognised. In the first mode, the state allocates water administratively according to rules that may or may not be transparent or explicit. Allocation is sometimes volumetric and various mechanisms are used to reduce entitlements in times of shortage. Second, allocation can be determined by a group of users among themselves. This case is common in smaller systems, but users may also manage large schemes. Third, water may be allocated through markets of tradable rights, as in Australia and Chile. Water rights underly all three modes of water allocation. As Meizen-Dick and Rosegrant, 1997 (cited in Molle, 2007) state, each of these modes has prerequisites, advantages, and drawbacks related to their impact on equity, economic efficiency, and environmental sustainability.

Fixed amount and flexible water allocations

Fixed amount allocations entitle a country or user to a fixed amount of water per annum. In contrast, flexible water allocations entitle a country or certain use to a percentage of the river flow or a range of water depending on rainfall conditions. Bennet *et al* (1998, cited in Kilgour and Dinar, 2001) argue that a percentage allocation mechanism is likely to be more efficient, but according to Kilgour and Dinar (2001), application of the model to a variable flow regime in the Colorado River yielded inconclusive results. This study did not address water quality issues. Giannias and Lekakis (1996, 1997) and Lekakis (1998), cited in Kilgour and Dinar (2001), applied the model of fixed allocation and quality considerations to the case of the Nestos River shared by Bulgaria and Greece. They argue that bilateral water markets and fixed allocations could provide overall efficient solutions. Generally, agreement seems to exist that flexible allocations are better adjusted to highly variable environmental conditions than fixed allocations. A case in point is the 1994 peace Treaty between Israel and Jordan. The latter is guaranteed a minimum of 30 MCM/year from the Jordan River, to be supplied during the summer months (Beaumont, 1997, cited in Wolf, 1999). As a result of severe summer drought in 1999, Israel faced difficulties in delivering the agreed-upon amount, and suggested modifying the agreement (GWR, 1999). Jordan insists that the 30MCM/year minimum is integral to the peace agreement.

Interviewees expressed strong reservations about fixed amount allocations as they do not recognise the dynamics of the shared water course and instead argued that flexible guidelines need to be developed.

Beneficial use

An important shift in thinking occurred when water was allocated for beneficial use rather than for use per se. This utilitarian (economic) view created an opportunity to link resource allocation with benefit generation and sharing. This approach needs to incorporate the obligation not to cause significant harm to other countries and to offer mitigation and compensation where harm cannot be avoided.

3.2.2 Resource allocation criteria and issues

According to Wolf (1999), resource allocation criteria rely on relative hydrology (from where the river or aquifer originates and how much of that territory falls within a certain state) or chronology (who has been using the water longest) of use and is provided for by law. In reality, rights seem to always give way to needs (easily quantified) and prior uses also seem to always be protected (first come first served basis). Needs are defined as irrigable land, population, or the requirements of a specific project, such as hydropower generation, among othes.

Box 3.4: Resource allocation of Nile water between Egypt and Sudan

In agreements between Egypt and Sudan signed in 1929 and in 1959, for example, allocations were arrived at on the basis of needs, primarily of agriculture. Egypt argued for a great share of the Nile because of its larger population and extensive irrigation work. In 1959, Sudan and Egypt then divided future water from development equally between the two. Current allocation of 55.5 BCM/yr for Egypt and 18.5 BCM/yr for Sudan reflect these relative needs (Waterbury, 1979, cited in Wolf 1999). Because of its relative success, needs-based allocations have been advocated in recent disputes; for example, in and around the Jordan River watershed where riparian disputes exists not only along the river itself, but also over several groundwater aquifers (Wolf, 1999).

Keeping to an extreme position (such as absolute sovereignty for upstream states and historic rights for downstream states) leads to very little room for bargaining over resource allocations. Most states have come to accept some limitation to both their own sovereignty and to the river's absolute integrity. The doctrine of limited territorial sovereignty reflects rights to reasonable use of water of an international waterway, yet with the acknowledgement that one should not cause harm to any other riparian state.

The uniqueness of each basin and its riparian states suggests that any universal set of principles must, by necessity, be general in scope. Problems can arise when attempts are made to apply this reasonable but vague language to specific water conflicts.

Recently, there has a need for incorporating the allocation of water resources according to its economic value into water conflict resolution. A distinction here is made between 'efficiency' (i.e. the allocation of water to its highest value use) and 'equity' (the distribution of gains from an allocation; Howe, 1996, cited in Wolf, 1999). The idea of efficient distribution is that different uses and users of the water along a given waterway may place differing values on the resource.

Therefore, water sharing should take into consideration the possibility of increasing the overall efficiency of water utilisation by re-allocating the water accordingly. Allocating water according to its economic value follows one of two approaches:

- A 'planning authority' who assumes what is 'best' for society – a 'social planner' in economic terms – who views the region as one planning unit. The social planner maximises regional welfare subject to all available water resources in the region and given all possible water utilizing sectors. In some instances the social planner (government) also includes all possible preferences (policy); and
- A second approach is the 'water market' approach, which employs the market mechanism to achieve an efficient allocation of scarce water resources among competing users and uses.

The first approach is most common and the second is rarely used at the regional level.

In order to achieve the cooperation of all states, the parties involved should realise some mutual benefit that can be achieved only through cooperation and be allocated to the parties. In cases of cooperation, each party needs to participate voluntarily, and accept the joint outcome from the cooperative project. Once a cooperative interest exists, the only problem which remains to be solved is the allocation of the associated joint costs or benefits. For a cooperative solution to be accepted by the parties involved, it is required that:

- Joint cost or benefit is partitioned such that each participant is better off compared to non-cooperative outcomes;
- Partitioned costs or benefits to participants are preferred in the cooperative solution compared to sub-conditions that include part of the potential participants; and
- All costs or benefits are allocated.

The next section explores the concept of benefit sharing and discusses the different mechanisms that can be used for equitable sharing of benefits that accrue from cooperative use of shared water resources.

3.3 Benefit sharing mechanisms

The debate around the water conflicts and 'wars' has shifted towards cooperation and amicable sharing of benefits (Klaphake and Scheumann, 2006; Phillips *et al*, 2006). This process of 'desecuritisation of water resource management' opens the way to negotiated agreements between states and the consequent sharing of benefits. Unfortunately, the benefit sharing concept and models are little developed as yet (Phillips *et. al.,* 2006) and there is no clearly defined framework for equitable sharing. It is clear, however, that benefit identification and sharing needs to be based on a thorough analysis of the potential benefits and understanding of hydro politics (Turton, 2002). Key issues are the identification and realisation of the types of benefits at stake (3.3.1) and their distribution and sharing (3.3.2).

> *'The question is not whether the concept of benefit sharing has appeal, but rather how it can be operationalised. In other words, how is it that riparians to a transboundary river arrive at 'seeing' the benefits from optimal water management, such that their interests coincide with cooperation?' (Qaddumi, 2008)*

Most interviewees stated that benefit sharing is very important for southern Africa. This requires that all countries benefit from SWC management, have a common interest and vision and that they have the required political will. There is need for cooperation but some curiosity and suspicion about each other's development activities is healthy and essential for participation in joint planning and informed decision-making. The main challenge is to change prevailing mentalities, understand the benefit sharing concept and options and the resource allocation-benign use-benefit generation and benefit sharing.

According to Turton (2008), viable benefit-sharing requires that two objectives are pursued. The first objective is to rationalise water allocation *between* sectors within a given country. There would need to be an agreement about a coherent picture of national interests in water. The second is to rationalise water allocation *between* sectors at the international level. The balancing of these two key areas could unlock the type of value that would provide sufficient incentives to induce states to cooperate, and possibly concede some of their existing water allocation (Turton, 2008).

3.3.1 Types of benefits

Sadoff and Grey (2002) outline four types of benefits that can be derived from cooperative management of transboundary rivers:

- Benefits to the river (environment)
- Benefits from the river (economic);
- Reduction of costs because of the river (political); and
- Benefits beyond the river (catalytic).

Each type of benefit is briefly discussed below.

Benefits to the river (reflecting the indirect use value)
Underpinning all others, benefits to the river are provided through opportunities from improved water quality, river flow characteristics, soil conservation, biodiversity and overall sustainability. These address the challenges of degraded water quality, watershed, wetlands and biodiversity that often occur due to neglect and underinvestment. Efforts such as those addressing sediment control problems ensure the well-being of the ecosystem will

contribute to the protection of public goods such as lakes and rivers (Jagerskog et al, 2007). As Phillips et al (2006) argue, protection of the environment becomes a specific management objective that can commence and drive the type of cooperative spirit that underpins any form of benefit-sharing.

Benefits from the river (reflecting the direct use value)
River flows and water uses can be optimised to yield, inter alia, more food, more power, and more navigational opportunities, while sustaining environmental integrity. Benefits arising from the river can be increased through improved water resources management for hydropower and agricultural production, flood-drought management, navigation, environmental conservation, water quality and recreation. Some benefits involve consumptive use (e.g. water abstraction); while others are non-consumptive (e.g. recreation, hydropower and transport). These can play a role in counteracting the challenges presented by increasing demands for water, and sub-optimal water resources management and development.

As deriving benefits from the river often entails river developments, the distribution of associated costs becomes as important as the benefits derived from that development. As Sadoff and Grey (ibid) state, there will often be difficult tradeoffs to be assessed between environmental conservation and river development, with these assessments best made at the basin scale.

Reduction of costs because of the river (politics and security)
Non-cooperation over the management of shared water resources has costs. Phillip et al (2006) actually argue that in a highly securitised situation, the primary interest of the riparian states is to attain their rightful volumetric allocation (at the least) from the shared water resource, while in a situation of desecuritisation, riparian states will be more open to discussion. The challenge is to realise a policy shift to cooperation and development, away from dispute/conflict; from food (and energy) self-sufficiency to food (and energy) security; reduced dispute/conflict risk and military expenditure. Furthermore, political tensions that arise over the control of river and river flows (often inextricably linked to, and perhaps even indistinguishable from, other tensions) may reach the point where they colour the geo-political relationships between basin states and become obstacles to regional growth.

Benefits beyond the river (catalytic)
Lack of cooperation over political and economic issues does not only result in a loss of economic gains and opportunities that could be derived from cooperation, but also in regional fragmentation. Cooperation over shared water resources has been credited with creating the opportunity for positive spill over effects that can enhance integration of regional infrastructure, markets and trade. The formation of regional coalitions such as SADC is important in the context of joint resource management such as transboundary river systems, fisheries and tourism (Heyns, 2005).

Interviewees for this study emphasised that the benefits of regional cooperation need to be identified and communicated to all stakeholders in order build support for cooperation. Even if a country is not directly affected by a project, it may derive indirect benefits from it (e.g. through electricity generation and security in the region). Examples of regional (extra) benefits of shared water management include: larger joint fund raising capacity, larger implementation capacity and benefits to other sectors such as transport, tourism and wildlife.

3.3.3 Benefit distribution and sharing mechanisms

Benefits have been unevenly distributed and mostly determined by the level of economic development, political significance and power and existing resource rights. This can result in inequitable and unfair distribution and often promotes better resource re-allocation and fairer sharing of the benefits.

Benefit sharing can be arranged between riparian states, society and the environment, between different economic sectors, different social groups and different generations (current and future).

Benefit sharing between riparian states
Benefit sharing at this level usually entails negotiation over sharing the benefits of water projects that are implemented on internationally shared rivers (e.g. dams, large scale irrigation and inter-basin transfers). The best known example in southern Africa is the Lesotho Highland Water Development Project (see Chapter 4). Lesotho and South Africa decided to share the costs and benefits of developing and using water resources based on the volumetric allocations for urban water supply made to each recipient country. Benefits go beyond volumetric allocations and monetary compensation to include hydropower production and the accompanying avoidance of thermal emissions that could have been made had an alternative approach for electricity production been taken.

Benefit sharing between different sectors
Traditionally, the agricultural sector gets the bulk of the river water, and yet its output is lower than that of most other sectors. Therefore, benefits can be enhanced by increasing water allocations to other sectors; this could be particularly important in shared river courses with high rates of water abstraction and alternative resource uses for agriculture.

The idea of efficient distribution is that different uses and users of the water along a given waterway may place differing values on the resource (Wolff, 1999). Within the IWRM context, resource allocation and benefit sharing would typically involve measures that aim to increase the efficient use of water (e.g. through water demand management) and that optimise the economic returns of water resources through encouraging higher value uses (Gupta and van der Zaag, 2008). Within the same river basin, it could involve, for example, using the same water for hydropower generation (a non-consumptive activity) upstream and irrigation downstream. It could also involve reallocation of water from low value generating water-intensive sectors, such as irrigated agriculture, that generate low economic value to sectors that generate higher economic benefits (e.g. industry and tertiary sectors)[2]. National and regional policies have to now neglected the issue of optimal water allocations across economic sectors.

Recently it has been recognised that provision of water for the environment is one component of an inter-sectoral water allocation process in which the right to the use of water is distributed among various users (Kashaigili et al, 2005). As Phillips et al (2006) note, maintaining environmental flows can be a significant tool for benefit sharing, especially with regards to poorer groups who depend on the river for livelihood security.

Benefit sharing between society and the environment
In the past water allocation has been limited to consumptive uses and users, and has resulted in increased off-stream uses, resulting in substantial changes in the flow regimes of many rivers. As the IWRM approach attempts to balance environmental, social and economic considerations in decision making about the use of water, sometimes tradeoffs have to be

[2] Such figures exist for Botswana, Namibia and South Africa through the water accounts that these countries have developed.

made between different water users. Sometimes short term gains must to be compromised in the interest of a longer term goal. For instance, the benefits of an ecologically healthy river can be shared between current and future users by preserving the integrity of the present ecosystem through provision of water to the environment as a user.

Kashaigili et al (2005) note a need for understanding the trade-offs between fresh water for basic human needs, food production, and the maintenance of freshwater ecosystems. One of the most challenging questions is how much water is required to sustain specific levels of environmental benefits.

Benefit sharing between social groups
In many cases, benefit sharing arrangements lack a well defined framework for equitable sharing that actually extends to the local communities and affected people for maintenance or improvement of livelihoods (Mokorosi and van der Zaag, 2007). The same authors state that the distribution of benefits *within countries* is often neglected. The issue of 'who benefits' involves consideration of the rights of local communities, sustainable development of the country, fair and equitable sharing of benefits among different stakeholders, and intergenerational equity. Where compensation is provided, such measures should offer sustainable compensation (e.g. replacement assets) and not just one-time cash payment compensation (Mokorosi and van der Zaag, 2007).

Development projects involving complicated engineering works, such as inter-basin transfers (IBTs) and large dams may involve diversion works, tunnels and/or large pumping schemes and reservoirs. Associated costs are often high and it is important that parties that lose out because of the project are adequately compensated.

3.3.4 Concluding remarks

The main challenge for allocation of resources and the sharing of benefits in a transboundary river basin context is how to allocate resources and identify and share the net benefits (benefits minus the costs). The current situation regarding resource allocation and benefit sharing is often not equitable and fair, as it primarily reflects a first-come, first-served basis. Benefit sharing is a relatively new concept that may resolve inadequacies in resource allocations in an easier and more acceptable manner than re-allocation of resources to countries or sectors. Phillips *et al* (2006) note the importance of the need for a holistic analysis of utilisation of transboundary waters before any resource allocation and benefit sharing mechanisms are put in place. As every river basin is unique with its own cultural, physical, economic, political and environmental characteristics, benefit sharing mechanisms are situation specific and depend to a large extent on the capacity and autonomy of the implementing agencies (RBO or member state countries). They state that there is need for greater specificity in determining benefit sharing, and even more need for precise quantification of benefit sharing in relation to water allocations and economic factors. This should be a two-way process as benefits should also go upstream.

Factors that should be considered in resource allocation and benefit sharing include (Phillip *et al,* 2006):

- Member states increasing water use efficiencies within their respective countries prior to benefit sharing negotiations;
- Quantifying benefits (and their relationship to volumetric allocations of water); and
- Recognizing that the status quo is not always an appropriate starting point in negotiating benefit-sharing as powerful countries tend to have access to more than an equitable share. There must be an agreed, appropriate starting point for negotiations for either volumetric allocations or benefit sharing. Inadequacies of the

current situation may be best addressed by benefit sharing and incorporation of these concerns in future resource allocations.

During interviews conducted for this study, it was argued that civil society should play a major role within river basins to ensure stakeholder participation and fair distribution of benefits.

With regards to inter-basin transfers and dams, the issue of benefit sharing arises where there are perceived impacts, and or costs to the development of the project. At the national level, this can involve monetary transfers as monetary compensation as in the case of the Lesotho Highlands Water Project (LWHP).

Because inter-basin transfers and dams often alter the flow of rivers, concerns about environmental integrity and the ecological state of water sources often arise in debate and sometimes contention. Environmental flow allocations require a certain amount of water be purposefully left in or released into an aquatic ecosystem to maintain it in a condition that will support its direct and indirect use values. Environmental flows provide critical contributions to river health development and poverty alleviation and ensure the continued availability of the many benefits that healthy river and groundwater ecosystems bring to society (King et al, 2002; and Dyson et al, 2003 as cited in Kashaigili et al, 2005).

Box 3.5: Conditions for equitable and fair use and benefit sharing

Regional level

- Guidelines should clarify the issues and relationship of benefit transfer to upstream and downstream stakeholders;
- Unique characteristics of each basin need to be highlighted, and distinctions between co-riparian countries need to be revealed;
- Establishment of water entitlements for the environment, e.g. basic needs and the ecological reserve as enshrined in the South African Water Law (Act 38 of 1998);
- Need to adopt a multi-spatial and interlinked analysis;
- Should adhere to an IWRM framework; and
- Should attempt to increase water use efficiency and optimal water utilization.

National level

- Should adhere to national benefit sharing policy and guidelines;
- Establish water entitlements for the environment (e.g. basic needs and the ecological reserve as enshrined in the South African Water Law (Act 38 of 1998);
- Adhere to an IWRM framework;
- Harmonise water and environmental policies and legislation; and
- Utilize water efficiency data and information.

Local level (often overlooked)

- Ensure access to direct project benefits for local population;
- Involve all parties potentially affected by dams should be done at early stage of the project plan; and
- Ensure strong local authorities in terms of decision-making, by providing requisite negotiation, financial management and administration skills (institutional capacity is required in order to enable local authorities to have full autonomy).

IBT and water development programs can provide tangible benefits to the countries sharing a river through among other things hydropower potential which in turn have wider economic development benefits. Increased food and energy production made possible by water development and sharing can contribute to regional economic integration, food and energy security in the region as well as water security.

4 Case studies of shared river basin management

This chapter presents case studies from three river basins in southern Africa and three from elsewhere (West Africa, Asia and Europe) to illustrate some of the key issues and constraints present in determining resource allocation and benefit sharing mechanisms, processes and procedures in shared river basins. These case studies draw on regional experiences and lessons learnt from Orange- River, Okavango and Incomati River Basins and broader lessons from the Senegal, Mekong and Rhine Rivers.

A number of countries in southern Africa are engaged in benefit sharing and developing projects in shared river basins. Water development projects such as dam building and interbasin transfers have been carried out on a few shared river basins for purposes of supplying water to cities, for irrigated agriculture and hydropower production. In the case of the Okavango, resource allocation and the sharing of tangible benefits has not begun save for cooperative management of the river. Benefits of cooperation on this river are those often categorised as 'soft' that usually include improved relations between riparian members. There are currently no specific resource allocation and benefit sharing mechanisms in place. In the other two river basins (Orange-Senqu and Incomati), mechanisms are in place for resource allocation and the sharing of benefits accruing from cooperative use of the resource. Significant parts of the cooperative arrangements for these basins pre-date the SADC Protocol on Shared Watercourses. The Senegal case study is discussed as an example of complimentary interests over cooperative water management that yields benefits for all members of a river basin.

4.1 The Orange-Senqu River Basin

4.1.1 Introduction

The Orange-Senqu river basin area covers about 1 million km^2 with more than half of the basin in South Africa and the remainder of the area in Namibia, Botswana and Lesotho. The river flow stretches 2,300 km, starting in the mountains in north eastern Lesotho into South Africa and discharges into the Atlantic Ocean through Namibia. The main tributaries of the Orange are the Senqu in Lesotho, the Caledon bordering Lesotho and South Africa, the Vaal in South Africa, and the Molopo and Nossop rivers (which form the border between South Africa and Botswana), and the Fish river in Namibia (Heyns, 2003). The mean annual run off totals about 11,500 Mm^3/a mostly from the Vaal and Senqu rivers. Interestingly, Botswana contributes no run off to the Orange-Senqu basin as reflected in Table 4.1[3].

Table 4.1: Riparian states' runoff contributions to the Orange-Senqu Basin

Country	Basin area		Mean annual runoff	
	Km^2	Percentage	Mm^3/a	Percentage
Botswana	120,000	11	0	0
Lesotho	30,000	5	4700	41
Namibia	250,000	25	500	4
South Africa	600,000	60	6300	55
Total	**1,000,000**	**100**	**11,500**	**100**

Source: Heyns (2004)

[3] Botswana lies partly within the basin and the nearest point of its border is 200km from the Orange River, to which it has yielded no significant flow in living memory (Conley and Van Niekerk, 2000). The ephemeral Molopo River is blocked by Kgalagadi Desert dunes downstream of its confluence with the Nossop River from Namibia and never reaches the Orange; these rivers can therefore be seen as an endoreic system. The ephemeral Nossop River summer run off rarely reaches the confluence with the Molopo (2003).

The Orange-Senqu basin has varied climatic conditions hence wide-ranging rainfall amounts, with Lesotho highlands receiving an excess of 2000 mm/a and Namibia receiving up to 50 mm/a. Potential evaporation averages 1200 mm/a in the catchment area of Lesotho and 3500 mm/a at the river mouth. The basin population is estimated at 19 million inhabitants.

4.1.2 Water uses on the Orange-Senqu River Basin

The basin is relatively well developed in terms of dams and water transfer schemes. For instance, the basin has irrigation potential of about 390,000 ha. and 303,000 ha. of this is currently being utilised (AMCOW and ANBO, 2007).

South Africa is by far the main user of the basin's water resource. There are 29 dams in the basin and 22 of these are in South Africa. Examples of the major dams include the Gariep Dam (capacity of 5600 Mm^3) and Van der Kloof Dam (capacity 3200 Mm^3).

There are two inter-basin transfers, one within South Africa and one between Lesotho and South Africa. Water from the Gariep Dam is directed to Vanderkloof Dam via hydro-electric generators and also directed to the Eastern Cape through the Orange-Fish tunnel (with a maximum capacity of 54 cubic metres a second). The main purpose of the tunnel is to divert water to the Eastern Cape for irrigation (for about 51 500 ha), urban, and industrial use. The tunnel has a diameter of 5.3 m and is 82.5 metres long, and runs 405 metres below ground level at its deepest point (Earle *et al,* 2005). South Africa uses water for irrigation and generation of hydro-electric power and to a lesser extent for industrial and mining purposes.

Namibia uses the basin mainly for irrigation. Water uses in Lesotho are mainly for generation of hydro-electric power and for agriculture. There are few people living in the basin on the Botswana side, and Botswana's use of water is largely limited to the use of surface water of ephemeral Nossop and Molopo Rivers for the livestock sector.

The Lesotho Highlands Water Project (LHWP) is an inter-basin cross-border project transferring water from the mountainous water-rich area in Lesotho to South Africa (Box 4.1).

The most significant benefit Lesotho derives from the Orange River water is from revenue from the transfer of water into South Africa through the LHWP, currently at around two cubic kilometres per year, earning the country sufficient income to completely pay off its foreign debt. With the realisation of further phases of the project the amounts of water delivered to South Africa will increase as will the sale of electricity generated in Lesotho through the LHWP infrastructure.

Through the project, rather than allowing the surplus water to flow downstream unregulated across the border into South Africa, Lesotho benefits from the controlled delivery of the water to South Africa through LHWP infrastructure (Heyns, 2004). The financial benefits from the project to Lesotho, in the form of royalties, have improved the infrastructure in the country and they contribute to government revenues and development (Earle et al, 2005).

Box 4.1: Lesotho Highlands Water Project (LHWP)

The LHWP is an agreement conceived in 1986 between Lesotho, rich in water resources, and South Africa, a water scarce economic giant. It involves transferring water from the mountainous area in Lesotho to Gauteng, South Africa for domestic and industrial uses, and hydropower generation for Lesotho on the basis of royalties by South Africa to Lesotho for the next 50 years. South Africa chose the LHWP over the localized Orange Vaal Transfer Scheme (OVTS) because it was cheaper. The LHWP uses the gravity system to transfer water hence saves South Africa the costs of having to pump against higher head from the Orange River. The system transfers about 40% (70 m^3/s) of water from e River in Lesotho to the Vaal River basin in South Africa (Lindemann, 2005).
The LHWP has six phases and Phase 1A and 1B are complete and the costs of Phase 1A and 1B are US$ 1.09 billion and US$ 0.45 billion, respectively (Bernauer et al, 2007). South Africa paid the full cost of the two phases. In the Treaty, Lesotho and South Africa agreed to share the difference in cost, called the net benefit, of the LHWP over its alternative scheme, the OVTS on a ratio of 56% to Lesotho and 44% to South Africa. Lesotho's share of net benefits to be obtained by using the LHWP is called the "royalties" while South Africa's share is referred as "cost savings"(Bernauer et al, 2007: 28).
A joint permanent commission was created to represent both governments in the implementation of the project. Moreover the Lesotho Highlands Development Authority (LHDA) and Trans Caledon Tunnel Authorities (South Africa) were established to implement the project in both countries. Lesotho has an advantage due to its high altitude storage possibilities in deep dams with lower evaporative losses than possible elsewhere in the basin.
This power scheme produces 182 MW of hydro power for Lesotho, making it power independent. Lesotho was a net importer of electricity prior to LHWP. Moreover, South Africa pays Lesotho USS$ 45-47 million per year as royalties for water delivered by Phase 1A. Another positive impact on Lesotho's economy and development is the infrastructure brought along with the LHWP, such as roads, electricity power substations, transmission lines and telecommunications. The LHWP also generates direct and indirect employment opportunities for local communities. Therefore the LHWP is a critical project that in many ways favours poverty relief and development for Lesotho (Lindemann 2005, Bernauer et al, 2007). However, the LHWP has environmental and social negative impacts especially in Lesotho. More than 3,000 people have been displaced and lost private and communal resources such as houses and arable, pastoral and ancestral land. There have been experiences of reduced fish stocks, loss of medicinal plants and wild vegetation among others (Mokorosi and Van der Zaag, 2007).

The LHWP generated job opportunities for South African workers (engineers and consultants). South Africa also benefits from the increased project-related exports to Lesotho. The LHWP's physical advantages saved significant costs to South Africa by employing gravity to transfer the water.

Despite the environmental and social losses, the LHWP provides a good model of transboundary resource allocation and benefit sharing.

The Namibian and South African governments plan to build a dam on the Lower Orange River. Lesotho and South Africa announced that the second phase of the LHWP is being considered. Additional water will be required in the future for the development of the proposed Kudu gas field power station at Oranjemund in Namibia (Heyns, 2004). While total demand at 1994 level lies at about 3,5 km^3/yr, the total requirements at 2005 level, as determined by the Orange River Replanning Study, are estimated to be at just over 4,5 km^3/yr. Of this, 2968 million m^3/yr are estimated for consumptive use and 1550 m3/yr are estimated for inter basin transfers into the Vaal River system from the LHWP and into the Fish River system from Gariep dam (Earle et al, 2005).

4.1.3 Historical overview and institutional arrangements

Historically, South Africa has been at the centre of partnership on the shared water resources. Prior to the formation of Orange River Basin Commission and the subsequent signing of the ORASECOM Agreement, bilateral treaties were either signed between South Africa and Lesotho or between South Africa and the other Orange River basin members, Namibia and Botswana (Table 4.2). Botswana and South Africa established a Joint Permanent Technical Commission which undertook studies on the hydrology of the Molopo River and its structures and the hydrology of the Nossop River. South Africa and Lesotho have signed several agreements including the Lesotho Highland Water Project Treaty which entails transfer of water from the highlands of Lesotho to South Africa (see Box 4.1). The connection between South Africa and Namibia dates back to 1919 when the League of Nations entrusted South Africa with the mandate to administer Namibia after Germany lost the First World War. Namibia and South Africa established the Joint Technical Committee and a Permanent Water Commission in 1987 and 1992, respectively. The latter replaced the former committee. In 1993, the two countries entered into an agreement on the Vioolsdrift and Noordoewer Joint Irrigation Scheme for water, maintenance and operational costs sharing.

Table 4.2: List of Treaties/Agreements

Date	Treaty basin	Signatories	Treaty Name
1978	Orange-Senqu	Lesotho, South Africa	Joint Technical Committee
Oct 24, 1986	Orange	Lesotho, South Africa	Lesotho Highland Water Project Treaty
1987	Orange	Namibia, South Africa	Joint Technical Committee
Nov 19, 1991	Orange	Lesotho, South Africa	Protocol IV on Water Treaty
Aug 31, 1992	Orange	Lesotho, South Africa	Ancillary Agreement
Sep 14, 1992	Frontier	Namibia, South Africa	Permanent Water Commission
Jan 1, 1999	Orange	Lesotho, South Africa	Protocol VI on Water Treaty
Nov 3, 2000	Orange-Senque	Botswana, Lesotho, Namibia, South Africa	Formation of ORASECOM Agreement

Source: AMCOW and ANBO (2007)

ORASECOM, regarded as an organisation with international and national legal personality serves as technical adviser to the Riparian Countries on the development, utilization, and conservation of the water resources of the basin. The Commission was mandated to develop a comprehensive perspective of the basin, study the present and planned future uses of the river system, and determine the requirements for flow monitoring and flood management (AMCOW and ANBO, 2007). The ORASECOM Agreement recognises the Helsinki Rules, the United Nations Convention on the Non-Navigational Uses of International Watercourses and the SADC Protocol on Shared Watercourse Systems. It also refers to the Revised Protocol on Shared Watercourses with respect to definitions of the key concepts "equitable and reasonable" and significant harm (Earle et al, 2005). In addition to these, a Joint Permanent Technical Commission to represent both Lesotho and South Africa in the implementation of the project.

Through a Treaty, a Joint Permanent Technical Commission (JPTC), later renamed to *Lesotho Highlands Water Commission* (LHWC), with a secretariat in Lesotho, was established to monitor and oversee the Treaty. In addition, two implementing agencies with autonomous statutory, the Lesotho Highlands Development Authority (LHDA) and the Trans-Caledon Tunnel Authority (TCTA) were established to implement the project in Lesotho and South Africa respectively. The LHDA is responsible for the management of the dam construction and related issues within Lesotho itself while the TCTA is responsible for the management of the complex set of delivery tunnels into South Africa.

4.1.4 Resource allocation and benefit sharing

The Orange-Senqu river basin is a fairly developed river basins, with a number of dams and water transfer schemes. Prior to the formation of ORASECOM, there has been intensive utilization of the basin water resources. Botswana's geographic position in the basin and its hydrological characteristics determines its lower use of basin water, confining its consumption to the seasonal surface water in the Nossop and Molopo Rivers. These rivers are said to have contributed nothing to the flow of the basin. Therefore, Botswana's inclusion or position in the basin is seen as strategic in nature (Earle et al 2005, Kranz et al 2005). Lesotho, an upstream state, benefits from the LHWP through royalties paid by South Africa. On the other hand, downstream Namibia is disadvantaged as it receives little water and this has negative implications for the estuary in the Lower Orange. South Africa implemented developments on the Orange and is the main beneficiary of the basin water resources.

4.1.5 Concluding remarks

An increased demand for water to support industrial development and irrigation water exists within the basin, particularly in South Africa. In addition, there are concerns over environmental impacts of water abstraction and shortage of water reaching the estuary in Namibia.

The basin is already heavily used and future projects and demands will increase pressure on the basin. Maintenance of environmental flows should be a major concern. The basin contains the most famous example of costs and benefit sharing of projects (LHWP), which could be expanded in future to include other member states (Namibia and Botswana), although, Botswana does not contribute run-off into the river. Bilateral agreements can be used to develop SWC management plans and the case study shows that agreement between countries unequal in development level and power is possible. It should, however, be a special concern during negotiations as to ensure benefits for the smaller state(s).

4.2 The Okavango River Basin

4.2.1 Introduction

The Okavango River is shared by the countries of Angola, Namibia and Botswana, with Angola upstream and Botswana at the tail of the river. The Okavango Delta, which lies in the inner landscape of Botswana and contains one of the most unique aquatic ecosystems on the African continent and an area of globally significant biodiversity and wetland conservation (RAMSAR site), is not yet heavily affected by human interventions (Klaphake and Scheumann, 2006). The river derives from the Angolan highlands of north of the Kuando-Kubanago region and flows through arid Kavango region of Namibia into the Kalahari sands of north-western Botswana. The Okavango basin has several unique features including the fact that it is endoreic and does not flow to the sea (Ashton and Turton, 2005). The length of the Okavango River from its source in Angola to the mouth in the delta is 1,100 km. The majority (94.5%) of Okavango River water runoff comes from Angola and the remainder is shared by Namibia and Botswana (Table4.3). The basin population is small at around 1.1 million.

Table 4.3: Okavango River Basin characteristics

Country	Average annual rainfall in the basin			Irrigation potential (ha)	Water runoff (%)	Population	Okavango catchment
	Min	Max	Mean				
Angola	525	1,320	865	200,000	94.5	845,880 (76%)	200,192 (48%)
Namibia	355	595	465	2,000	2.9	144,690 (13%)	153,783 (37%)
Botswana	415	570	495	6,060	2.6	122,430 (11%)	59,575 (15%)
Okavango basin	355	1,320	680	208,060		1,113,000	413,550

Sources: Okacom 2007 and FAO (1997)

4.2.2 Water uses on the Okavango River Basin

Currently, there are no large dams or inter-basin transfer schemes within the basin. The irrigation potential of an estimated 200,000 ha. in Angola remains underutilized. Current use is mostly for domestic purposes and subsistence agriculture. The downstream countries of Namibia and Botswana could tap extensive groundwater resources, with only little water taken from the river, for small irrigation projects and household consumption. Current demands for water derive mainly from growing industrial activities, population centres outside the basin as well as the environment (Nicol, 2003). The environmental demand is of particular importance to the Okavango Delta, from which the majority of tourists visit Botswana. Future demands in Angola could lead to greater abstractions and reduced downstream flows.

Economies of the Okavango basin are far less reliant on agriculture compared to other river basins in the SADC region, with Namibia having the highest contribution at 11.3% of GDP from agriculture in 2001, followed by Angola with 8% and Botswana with 2.4 % (World Development Indicators, 2002, cited in Nicol, ibid). Low income communities practicing mixed arable and pastoral agriculture are found along the river and heavily depend on the river's resources. Industrial, urban and domestic demands by Namibia and Botswana may become increasingly important and in the case of Namibia, originate from outside the basin itself. The need to utilise the waters of the Okavango to augment the water supplies in the central area of Namibia via the proposed Eastern National Water Carrier (ENWC) had already been identified in 1973 (Heyns, 2005). Botswana also proposed tapping the Okavango waters for irrigation south of the Delta but has since terminated the plans. In Botswana, the growth of population centres in and around the Delta adds to resource demands, including the abstraction of groundwater.

4.2.3 Historical and institutional arrangements

In September 1990, Angola and Namibia agreed to endorse and affirm the old agreements on the Cunene River between the colonial powers (Portugal and South Africa) and to re-establish the Permanent Joint Technical Commission (PJTC) on the Cunene. In November of the same year, Botswana and Namibia established the Joint Permanent Technical Commission (JPTC) to deal with water resources of common interest of the Okavango. The watercourse states that are riparian to the active, perennial runoff in the Okavango basin are Angola, Botswana and Namibia and all three were represented on a bilateral basis in either the PJTC or the JPTC. The Namibian government brought the two commissions together at a joint meeting in Windhoek to discuss the future development of the Okavango basin and the possibility to establish a tripartite water commission (Pinheiro et al, 2003).

Established in September 1994 by the three countries sharing the Okavango, the Permanent Okavango River Basin Water Commission (OKACOM) is the oldest of this type of commission in the SADC region. It precedes the SADC protocol and was based on the Helsinki Rules and Agenda 21 Principles. Its establishment was facilitated by an interstate agreement aimed at the equitable use and sustainable development of water resources of the Okavango River by the three riparian members. It is an interstate organization, recognized as an independent entity with international legal personality. The general objective of OKACOM is to act as technical advisor to the contracting parties on matters relating to the conservation, development and use of transboundary water resources of common interest within the Okavango River Basin (OKACOM, 2007).

The 1994 OKACOM Agreement is a simple document which established the Commission as a single entity with no formal internal organs. The Commission comprised nine permanent members, three from each member country and appointed by the contracting parties. In order for the Commission to fulfil its objective as technical advisor to their governments, it was agreed for the extent permitted by its contracting party's laws and procedures, to provide such information as the Commission may require for the performance of its functions, and to notify the Commission of any proposed development or any other matters that fall within the functions of the Commission (OKACOM, 1994).

The initial activities of the Commission, which involved a project to prepare a comprehensive integrated water resources management strategy for the basin, highlighted the increased need for coordination. To facilitate this, OKACOM constituted the Okavango Basin Steering Committee (OBSC), a technical advisory body to the Commission whose primary aim was to manage the project on behalf of OKACOM (Pinheiro et al, 2003). The OBSC by default became a permanent organ of OKACOM and continued to provide technical advice to the Commission at its routine meetings. In early 2007, OKACOM reviewed its organizational structure to bring it in line with the Revised SADC Protocol on Shared Watercourses, and gave the OBSC formal status and recognized it as a permanent and formal internal body of OKACOM with defined functions, roles, responsibilities as well as operational procedures. The membership of the OBSC is comprised of technical specialists from related government departments and agencies of the three countries (OKACOM, 2007).

One of the most significant institutional developments of OKACOM is the recently established Secretariat as another organ of OKACOM. In 2004, the Commission recognised the need to establish a Secretariat which would implement the decisions of the Commission. In April 2005, the Commission signed a Memorandum of Understanding establishing a Secretariat to discharge the functions of the Commission. The technical work towards the definition of the legal status of the Secretariat, including the drafting of the agreements was done over two years with technical assistance from the Okavango Integrated River Basin Management Project (IRBM), funded by USAID.

4.2.4 Resource allocation and benefit sharing

As mentioned above, the Okavango River Basin remains largely undeveloped and has no major water development projects except for small abstraction in Namibia for agriculture. The most significant user of the Okavango water therefore remains the Okavango Delta, which is Botswana's prime wildlife and tourism area.

Upstream abstractions (and global climate change) are likely to affect the downstream Delta. The needs of Namibia have been pressing over the years and are seen as legitimate, but a deliberate sharing of volumes of water has so far not been initiated on the Okavango River. There is an increasing realisation that in reaching cooperation and agreement at basin level, benefits can be made available to local users through decisions that address water development for sustainable livelihoods and poverty reduction (Nicol, 2003). There is consensus that there needs to be a realisation of benefits from cooperative use of the Okavango resources not only for the downstream Botswana state, but also for the upstream members, especially Namibia, which is the driest of the three and has pressing water demands for its dry capital, Windhoek.

4.2.5 Concluding remarks

The Okavango Basin is a ‘special’ case because of the limited abstraction and infrastructure that has taken place to-date and because of its importance as a unique ecosystem, which supports tourism in Northern Botswana. The ‘downstream’ landlocked Delta is perhaps the most sensitive area of the basin in terms of trade-offs between co-riparian development trajectories. Not only is the ecological integrity of the delta a major international issue, but tourism development of the resource is an issue of critical national economic importance for the Botswana government. For Namibia, the need is mainly for industrial and municipal water. The different needs clearly illustrate the ‘disparate levels of dependence upon the basin’s natural resource basin in each country create barriers to harmonised development of the basin as a whole’ (GEF, 2000, cited in Nicol, 2003).

4.3 The Incomati River Basin

4.3.1 Introduction

The Incomati River Basin is shared by three countries (Swaziland, South Africa and Mozambique). The basin is relatively small, covering land area of approximately 50,000 km^2 with the riparian states taking up 6%, 63% and 31% of the basin, respectively. The river stretches 480 km, flowing from eastern part of South Africa through the north of Swaziland, into southern part of Mozambique and it then discharges into the Indian Ocean. The basin comprises six main tributary rivers namely; Komati, Crocodile, Sabie, Massintonto, Uanetze and the Mazimechopes.

The Incomati basin has a varied climate, characterized by warm to hot and humid conditions in the Mozambican coastal plain and lowveld (150 m.a.s.l) to cooler and dry conditions in the South African Highveld (2000 m.a.s.l). The mean annual rainfall is about 740 mm/year and the mean annual potential evaporation is 1,900 mm/a.

4.3.2 Water uses

The estimated net runoff of the Incomati River was in 2002 estimated at 3,587 Mm^3/yr and the total consumptive water use amounted to 1,800 Mm^3/yr. Over half of the runoff is already used; irrigation and plantation sectors are the major consumers of the basin water followed by water transfer schemes, mainly used for cooling water for thermal power generation and irrigation of sugar cane. The domestic sector consumes about 5% of the basin water and about 1593 Mm^3/annum is required to sustain the river ecosystem (environmental flow). This leaves only a small amount for further abstraction (around 200 Mm^3/yr). The water use is summarised in Table 4.4.

Table 4.4: Water use in the Incomati basin

	Current water uses (2002)	South Africa	Swaziland	Mozambique
Domestic	Population	1,744,000	142,000	450,000
	Percentage rural	55%	70%	70%
	Domestic water supply norm	100 l/c/d	100 l/c/d	50 l/c/d
	Rural water supply norm	25 l/c/d	35 l/c/d	20 l/c/d
	Unaccounted water	45%	50%	50%
	Net abstraction (abstraction-return flow) from surface water for domestic use	98 Mm^3/yr	6 Mm^3/yr	10 Mm^3/yr
Industrial	Industrial requirement	35 Mm^3/yr	3 Mm^3/yr	6 Mm^3/yr
Inter-basin transfer	Inter basin transfer	132 Mm^3/yr	135 Mm^3/yr	0 Mm^3/yr
Irrigation	Total irrigated area	85,500 ha	4,700 ha	14,500 ha
	Water use efficiency	60%	50%	50%
	Net water use irrigation (off-take-return; assume half of losses are return flow)	670 Mm^3/yr	48 Mm^3/yr	150 Mm^3/yr
Forest plantations	Area under forest plantation	316,000ha	29,400 ha	2,000 ha
	Stream flow reduction	473 Mm^3/yr	46 Mm^3/yr	2 Mm^3/yr
Environment (Non-consumptive)	Estimated environmental demand	587 Mm^3/yr	239 Mm^3/yr	767 Mm^3/yr
Transboundary commitment				
Dam storage	Total dam storage capacity	922 Mm^3/yr	182 Mm^3/yr	878 Mm^3/yr

Source: Van der Zaag and Vaz, 2003.

4.3.3 Historical overview and Institutional arrangement

Mozambique gained independence in 1975 and thereafter its political relationship with South Africa suffered. However, the relationship between Swaziland and South Africa improved leading to more bilateral meetings between them and fewer tripartite meetings. Therefore South Africa and Swaziland developed. After a severe drought in 1982, the three riparian states met and established a Tripartite Permanent Technical Committee (TPTC). Several tripartite meetings were held until 1985. Between 1985 and 1991, no tripartite meeting was held, however, several bilateral meetings between Swaziland and South Africa occurred. The three countries signed a tripartite agreement in 1991, which led to the establishment of Joint Incomati Basin Study in 1992. In 1994, multi-party elections were held in Mozambique and South Africa attained majority rule. Bilateral agreements between Mozambique and South Africa and Swaziland and Mozambique were produced in 1996 and 1999, respectively. The three riparian states developed an interim agreement for the Incomati and Maputo basins, in 1999, and signed the agreement in 2002 during the World Summit on Sustainable Development in Johannesburg.

Each of the three governments has national institutions mandated with the regulation of uses of Incomati basin water resources; the Department of Water Affairs and Forestry in South

Africa, the National Water Directorate in Mozambique and the Department of Water Affairs through the National Water Authority in Swaziland. In addition, the day-to-day activities and the allocation and management of water resources have been delegated to decentralized bodies such as the regional water administrators (ARAs) in Mozambique, and Catchment Management Agencies in South Africa and River Basin Authorities in Swaziland.

4.3.4 Resource allocation and benefit sharing

The sharing of the Incomati basin water resources was based upon the 1966 Helsinki rules, the UN Convention on the Law of the Non-Navigational uses of International Watercourses (1997) and the revised SADC Protocol on Shared Watercourses, 2000. These instruments provided the basis for negotiation of the basin issues.

Box 4.2: Criteria for flow regime

The following criteria in establishing the flow regimes were considered:

- The geography, hydrological, climatic and other natural characteristics of each watercourse
- The need to ensure water of sufficient quantity with acceptable quality to sustain the watercourses and their associated ecosystems
- Any present and reasonably foreseeable water requirements, including that of aforestation
- Existing infrastructure which has the capacity to regulate stream flow of the watercourses and
- Agreements in force among the parties.

Source: Van der Zaag and Vas, 2003.

The Water Resource Yield Model (WRYM) was used to analyse water availability and supply to various users in the basin. The WRYM was developed by the consulting engineers BKS (South Africa) and Acres International (Canada) in partnership with the South African Department of Water Affairs and Forestry. The three member states agreed to allocate water resources under the Tripartite Interim Agreement (TIA), based upon the results of the modelling. The TIA assigned water allocations for domestic, livestock, and industrial uses as well as to ecological water requirements in case of water shortage or drought.

Table 4.5: Consumptive water use (Mm^3/a) in the Incomati basin, as allowed by TIA, excluding evaporation losses from dams

Country	Water generation	Priority uses	Exotic tree plantations	Irrigation	Inter-basin transfer	Total water use	% of total use	Use as % of water generated
South Africa	2,937	205	475	786	131	1,598	68	54
Swaziland	479	22	46	126	136	329	14	69
Mozambique	171	19	25	280	88	412	18	241
Total	3,587	246	546	1,192	355	2,338	100	65
% of total use		11	23	51	15	100		

Source: TIA (2002) as quoted by van der Zaag and Vas, 2003.

As a result of bilateral meetings with between Swaziland, South Africa agreed to pay half of the consultants' fees as way of ensuring its commitment to the negotiated agreement. The construction of Maguga Dam in Swaziland and Driekoppies Dam in South Africa was a joint venture; with South Africa funding the construction of Driekoppies Dam and paying 60% of the total cost of construction of Maguga Dam in Swaziland. South Africa held a 60% share of Maguga Dam in Swaziland and agreed to allow small holder irrigation downstream. In addition, the Komati/Lomati water was allocated to Swaziland and South Africa at 32.5% and 67.5% of the total resources respectively.

Anticipated projects

Mozambique needs to rehabilitate old and derelict irrigation systems and tourism interests along Incomati River. Maputo requires an additional water demand of up to 88 Mm^3/annum within ten years. To meet this demand, Mozambique plans a new Moamba Major Dam (capacity-702 Mm3) and increasing the reservoir level of the existing Corumana Dam (adding 495 Mm^3 for maximum supply of 1,373 Mm^3).

In South Africa, the planned construction of Montrose dam (capacity 68 Mm^3) and Mountain View dam (capacity 139 Mm^3) will provide more water along the Crocodile tributary/river.

4.1.5 Conclusion

The Incomati Basin provides a good model for sharing water resources in a heavily used basin with little room for additional abstractions. In this context, management must consider re-allocation of water rights to high-value uses, reuse and recycling of wastewater and other water demand management measures that increase water use efficiency.

Resource allocation in the Incomati Basin is determined by a computer model that prioritises domestic use, livestock and industry and ensures environmental flow during droughts. The Tripartite Interim Agreement is founded on international laws and conventions. The riparian states have accepted and implemented the principle of equitable resource sharing. Jointly owned infrastructure has been developed (e.g. Maguga dam in Swaziland), the benefits of which are shared. Earlier agreements between South Africa and Swaziland have facilitated cooperation towards preparation of the TIA.

Continuous sharing of information and capacity building is required to sustain the Incomati River Basin.

4.4 The Senegal River basin

4.4.1 Introduction

The Senegal river basin covers an area of about 436,000 square kilometres and is shared by four West African states; Mali, Mauritania, Senegal and Guinea (Table 4.6). The Senegal River is about 1,800km long, the second largest in West Africa. Its main tributaries are the Bafing, Bakoye and Faleme Rivers, and its catchment area is in the Fouta Djallon Mountains in Guinea and in southwestern part of Mali. The annual river discharge in Guinea is estimated at 8km^3 and it increases by 20km^3 due to inflow increase from several tributaries by the time the river reaches the meeting point of Mali, Mauritania and Senegal (Finger and Teodoru, 2003). The basin is highly varied but mostly characterized by the sub-saharan desert conditions. Parts of the basin, in upland Guinea for example, receive up to 2000mm of rainfall per annum while the drier regions receive up to 450 mm/a.

Table 4.6: Physical characteristics of Senegal River Basin countries

		Mali	Mauritania	Senegal	Guinea
Surface area (km^2)	National	1,248,574	1,030,700	197,000	245,857
	Basin	150,800	219,100	35,200	31,000
	% of basin	35	50	8	7
Rainfall (mm/a)	National	850	290	800	2,200

	Basin	300-700	80-400	150-450	1,200-2,000
Temperature	National average	29	28	29	26
	Basin min and max	15-42	18-43	17-40	10-33

Sources: Organisation for the Development of Senegal River (OMVS), AMCOW and ANBO (2007)

The Senegal River basin has a total population of 3.5 million inhabitants. The majority (85%) of the population leaves next to the river. The main socio-economic activity is agriculture dominated by livestock rearing. Fishing is the second largest economic activity in the basin (OMVS, undated). The basin has a potential irrigable land of about 320, 000ha and about 35% of this is currently irrigated (Table 4.7).

Table 4.7: Socio-economic activities in the basin

	Senegal River basin	Mali	Mauritania	Senegal
Population (in million)	3.5	11	3	10
Irrigated land (ha) national		78,630	49,200	71,400
Part in basin		4,000	44,449	67,830
Cattle	2,700,000	6,427,000	1,394,000	2,927,000
Sheep and Goats	4,500,000	15,986,000	10,850,000	8,330,000
Fish catch (t/year)	26,000-47,000	100,000	620,000	395,000

Source: Organisation for the Development of Senegal River (OMVS)

4.4.2 Water uses in the basin

Agriculture is the main user of the basin water mainly for irrigation and livestock purposes. The industrial sector is less developed in the basin. The Senegalese Sugar Company is the basin's largest agro-industrial unit in operation with the potential of 8,000 ha of sugar cane. Its subsidiaries manufacture polyvinyl chloride pipes and produce livestock feed. There are other small industries in Senegal and the industrial rice paddies in Mauritania (OMVS).

Table 4.8: Water use by sector (in million m^3)

Sector	Mali	Mauritania	Senegal
Agriculture	1,319	1,499	1,251
Domestic use	27	101	68
Industry	14	29	41
Total	1,360	1,630	1,360
Per capita (m^3/year)	161	923	201

The basin has potential of producing 1200MW of hydro-electric power and only 200MW has been produced from the Manantali Dam's hydro-power station (Varis et al, 2006). The dam has a capacity of 11.5 billion m^3 and it was also built to control floods. Another dam, the Diama, is located near the mouth of the river for the purpose of obstructing seawater intrusion, enables irrigation and facilitates the filling of Lake Guiers and Rkiz in Senegal and Mauritania, respectively. Navigation on the Senegal River is limited, but its development has potential to reduce transportation costs to the Atlantic Ocean and it may also boost the gold panning mines in Mali (OVMS; Finger and Teoduro, 2003).

4.4.3 Historical overview and Institutional arrangement

In 1963 and 1970, the four riparian states met and signed the Bamako and Dakar Conventions, respectively. The main objective of the agreements and meetings was to pursue joint development programs rather than individual agendas (Lautze et al, 2005). The joint approach to basin management was facilitated by several factors. First, the four riparian states were colonies of France, which treated them as a single territory until just prior to independence. They had a history of cooperation. Second, the French administration adopted a basin-wide approach to water management, thus promoting such cooperation in the post independence era. Third, the Senegal River serves as a border between some riparian states, enhancing the need for cooperation in the utilisation of the river. Finally, after independence, the riparian states had limited financial capital and technical capacity requiring the need to pool their resources (Lautze *et al,* 2005).

In 1968, the four countries formed the Organisation of the Boundary States of Senegal River. The main objective of this organisation was economic and political integration. After four years, Guinea withdrew from this organisation due to the political differences between Guinea and the other three riparian states (Lautze et al, 2005; Nile Basin Initiative, 2007). This organisation was replaced by the Organisation pour la Mise en Valeur du Fleuve Senegal (OMVS) in 1972. Functions of the OMVS mandate include policy development, regulation of project implementation, and determination of water resource allocation and benefit sharing in the basin (AMCOW and ANBO, 2007).

Table 4.9: List of treaties/agreements

Date	Treaty basin	Signatories	Treaty name
July 26, 1963	Senegal	Guinea, Mali, Mauritania, Senegal	Bamako Convention
Jan 30, 1970	Senegal	Guinea, Mali, Mauritania, Senegal	Dakar Convention
March 11, 1972	Senegal	Mali, Mauritania, Senegal	Nouakchatt Convention
Aug 11, 1972	Senegal	Senegal, Mali, Mauritania	Convention Creating Senegal OMVS
Dec. 21, 1978	Senegal	Senegal, Mali, Mauritania	Common Works Legal Statute Convention

Source: AMCOW and ANBO, 2007.

Three fora have been established by the OMVS: The Permanent Water Commission, the Advisory Committee, and the Regional Planning Committee. The Permanent Water Commission comprises the Council of Ministers, or representatives of the member states. Its main function is to define water allocation among the member states and sectors, namely: industry, agriculture, and transport. At national level, the member states have established National Offices that are represented in the Advisory Committee of the OMVS. They assist the organization in implementing its projects and coordinating its activities in the member states (AMCOW and ANBO, 2007).

In 2002, the Senegal River Water Charter was signed to modernise the set of international agreements which had previously focused more or less on development. The Charter has brought the Senegal Basin in line with current best practices for River Basin Organisations

(RBOs). Furthermore, in 2006 the International Code of Navigation and Transport and the Treaty of Guinea's Accession to the OMVS (Guinea joining the OMVS) strengthened the OMVS.

4.4.4 Resource allocation and benefit sharing

The member states of the OMVS have declared all the developed infrastructure are jointly owned and indivisible property of member states and the capital and recurrent costs are distributed between co-owner states on the basis of benefits each co-owner derive from utilisation of the structures (Nile Basin Initiative, 2007). The riparian states developed a benefit sharing model because:

- The four riparian states initially had similar water utilisation levels;
- There were no prior major water developments in any of the cooperating states; and
- They started from the same institutional levels.

The valuation and allocation of benefits in the Senegal River basin is based on the allocation/distribution key. The allocation/distribution key is a decision making and arbitration tool founded on the principles of equity, efficiency and solidarity. It is premised on scientific objectivity but with flexibility to accommodate special aspects or considerations.

The construction of the Diama and Manantali Dams, completed in 1986 and 1988, respectively, represents the major infrastructural development within the basin. The Diama dam is located at the mouth of the Senegal River, 27km upstream the city of St. Louis, Senegal. The dam was built mainly to prevent the intrusion of salt sea water into in-land. The sea water renders the agricultural land unusable. The Manantali dam is situated in Mali over the Bafing River and it has been built mainly to regulate water flow for traditional flood-recession farming, for irrigation of up to 400,000 ha of land, and for producing 800 GWh of electricity per year. It also improves navigation along a 900 km stretch from St Louis to Ambibedi in Mali.

Box 4.3: Cost-Benefit sharing in the Senegal River Basin

The International Human Dimensions Programme on Global Environmental Change reported that Mauritania bears 22.6% of the costs of the co-owned structures and receives 33.6% of the 375,000 ha of land for irrigation in the agreed development program, and 15% of the anticipated power generated. Mali bears 35.3% of the costs, receives 52% of all energy generated and is the main beneficiary of the navigation program. Senegal, which receives 64% of irrigated land and 33% of energy generated, assumes more than 42% of the costs. This is an excellent example of the end result of negotiated trade-offs when states set out to equitably share costs and benefits. It also illustrates that these trade-offs are more easily accomplished when there is a suite or package of projects involved which increase the scope for constructive negotiations (Nile Basin Initiative, 2007: 12). The benefit sharing is likely to be revised with the re-entry of Guinea into the OMVS.

In terms of financing, the member states jointly borrow finance but each state is responsible for paying its share of the debt. The allocation/distribution key is used to determine the ratio of costs to be incurred by each member state, in proportion to the benefits derived by each state.

Challenges

The major limitation is the availability and management of information and the capacity of the OMVS to deal with complex issues of water and environment. There is need to strengthen cooperation for basin management and sustainable development.

4.4.5 Concluding remarks

The Senegal River Basin provides a model for transboundary water resource allocation and benefit sharing in Africa for an under-utilized basin. The countries use an allocation distribution key based on efficiency, equity, solidarity, flexibility and scientific objectivity. In summary, factors that favoured cooperative shared water course management include:

- France, during its colonial era, promoted a coordinated river basin approach;
- Member states were at similar levels of development; and
- Few major prior developments on the river existed and allowed experimentation.

The OMVS operates at multi-levels; from the regional to national and at the local level. Benefit sharing has evolved beyond the resources of the river to include economic integration, while countries that have forgone their benefits are compensated. All infrastructure works are jointly owned and the costs are distributed in proportion to the benefits. The case study also indicates that political factors can influence the participation of member states in joint actions, as illustrated by Guinea's withdrawal and later re-entry into OMVS.

4.5 The Mekong River Basin

4.5.1 Introduction

The Mekong River is one of the world's major water systems originating in China's Qinghai Province near the Tibetan Plateau. The main river channel of the Mekong River is about 4,500 km long from its source in China to the river mouth in Vietnam and contains 800,000 km^2 within the basin. It flows through China and Myanmar and enters an alluvial delta where Laos, Burma and Thailand meet – the Golden Triangle. The river forms a border between Laos and Thailand, then flows through Cambodia before culminating in the Vietnam delta and the South China Sea. The river has an average annual runoff of about 475 km^3 per year and average annual withdrawals of 60,000 Mm^3, which is 12% of the annual flows.

Table 4.10: Baseline information for countries of the Mekong Basin

	China	Myanmar	Thailand	Laos	Cambodia	Vietnam
National Area (Km^2)	1,115,000	676,552	513,115	236,800	181,035	331,690
Basin Area (Km^2)			184,200	202,400	154,730	65,170
Average Annual Precipitation (mm)		5,000	1,400	1,780	1,400	1,680
Contribution to flow	16%	2%	18%	35%	18%	11%
Population	42,276,946	47,305,319	60,037,366	5,260,842	11,339,562	76,236,259
Gross Domestic Product (in US $ billions)		41.4	153.9	1.8	3	248
Per capita GDP per year		875	2,565	342	265	326

in US$							

Note: The total basin area shown represents 76% of the total Mekong river basin and the remaining 24% (188,460 km^2) is shared between China and Myanmar.
Sources: The Water Page (2007); Nguyen (2003)

The Mekong river basin is divided into the upper and the lower Mekong portions. The lower basin consists of Laos, Thailand, Cambodia and Vietnam while the upper basin is made up of upstream countries; China and Myanmar. Over 60 million people live in the lower Mekong Basin. The percentage of the territory and population within the basin varies considerably from one country to another. Cambodia and Lao PDR lie largely within the basin but together constitute 27% of the basin population. The basin territory in Thailand is only 37%, but comprises 42% of the basin's population. In Vietnam, the Mekong delta and Central Highlands comprise only 20% of the country but contribute 31% of the basin's population. Approximately 80% of the basin's population lives in rural areas.

4.5.2 Water use

Ninety percent of the riparian population depends on the Mekong River for resources ranging from drinking water, agriculture, transportation, industry, manufacturing, energy and recreation as well as for survival of plants and animals. Water use is dominated by the agricultural sector, particularly, rice cultivation mainly in the Vietnam delta. To produce one kilogram of rice requires 3,000 to 5,000 thousand litres of water depending on the rice variety and type of irrigation (Paul et al, 2004).

No details were found on the amounts abstracted in each country by sector.

4.5.3 Historical overview and institutional arrangements

Water resource management in the Mekong developed during the Cold War in Southeast Asia and was influenced by the introduction of socialist systems in several nations in the mid-1970s. (Browder and Ortoloano 2000:511 cited by Woods, 2003).

The heavy reliance of the Mekong basin's inhabitants on the river, especially for agriculture and fisheries, presents a number of complex, interrelated issues for transboundary governance and sustainable development. Transboundary environmental governance principles remain a priority for Southeast Asia because of the economic, livelihood, and cultural importance of the Mekong River to the riparian states (Woods, 2003). In order to achieve transboundary governance, the riparian countries agreed on the development of a Mekong River Commission with the exception of China which was not a member of the United Nations in 1957 and Myanmar. Institutional mechanisms for Mekong cooperation among the riparian countries in the lower basin have been in place since 1957 and were revived in 1995 (Ringer, 2000). Due to the many years of wars, ideological conflicts, and other issues among the riparian countries from the 1960s to the 1980s, implementation of various management plans did not materialize. The agreement for the Mekong River Commission (MRC) was prepared in April 1995 between the governments of Cambodia, Lao PDR, Thailand and Viet Nam. The main objective of the MRC is to develop cooperation for sustainable development and joint management of their shared water resources and development of the economic potential of the river (Pasch, undated).

The MRC has a strategic plan for 2006-2010, the main objective of which is to identify potential transboundary issues for negotiation, mediation and conflict prevention and develop a mediation and conflict management agency. The strategic plan adopted the Mekong Water Resources Assistance Strategy (MWRAS) in 2006 which was developed by the World Bank (WB) together with Asian Development Bank (ADB). This was introduced to provide guidelines for the coordination and utilization of the Mekong river basin's water resources, ensuring that the principles of balanced development are incorporated into water resource projects (Cuomo and Fewer, 2007).

4.5.4 Resource allocation and benefit sharing

The MRC agreement does not cover the utilisation of tributaries. Therefore, member states are at liberty to use tributaries without consulting other members of the MRC. Furthermore, the MRC focuses on water sharing rather than benefit sharing (Backer, 2007).

The Great Mekong Sub-region (GMS) Tourism Development Project was established in December 2002 with the assistance of Asian Development Bank (ADB) to improve tourism related infrastructure, support community-based tourism projects in rural areas and ease the movement of tourists across borders. The Mekong Flood Management Programme was finalised in 2002, and focuses on land use planning measures, structural measures, flood preparedness measures and flood emergency measures (Paudyal, undated)

China and Burma are not signatories to the Mekong River Commission, but have observer status. This is a major concern as China has a significant influence as an upstream riparian government and the country is embarking on the construction of hydropower dams. Subsequently, constructed dams will drastically change the river's natural flood-drought cycle and block the transport of sediments and livelihoods of millions living downstream. The notable dam is the 300-metre-high Xiaowan dam, with a designed maximum capacity of 10,000 million cubic metres, with the potential to relieve some of the heavy annual flooding in the lower Mekong basin (Nguyen, 2003). China's uneven enforcement of environmental laws exacerbates the water pollution problems caused by industrial and domestic point discharges into the river (Goh, undated).

Table 4.11: Existing and planned dams on Mekong River in China

Name	Height	Gross/Active storage (billion m^3)	Power capacity	Construction status
Manwan	126	0.92/0.25	1,500	1986-1993
Dachaoshan	110	1.04/0.25	1,350	1997-2003
Jinghong	118	1.04/0.25	1,500	Planned
Xiaowan	300	14.55/0.99	4,200	2002-2012
Nuozhadu	254	22.7/1.22	5,000	NA
Mengsong		NA	600	NA
Gonguogiao		0.51/0.12	750	NA
Total		**4068/3.20**	**14,900**	

Source: Nguyen (2003).

Box 4.4: Challenge of member states attitude towards MRC

A major challenge to the MRC is the basin states' attitude to cooperation. Thailand, the regional economic power and relatively upstream, is said to prefer a loosely defined framework. Thailand finds the demands of downstream states too strict and is not keen on the detailed flow management scheme; especially since China is not a signatory to MRC. Thailand prefers that the MRC play a facilitator role rather than imposing regulations on member states. Lao PDR has abundant and unexplored water resources and 97% of its territory is within the basin. Lao is sceptical of certain recommendations of the MRC, particularly those of public participation and it has been suggested that Lao does not want strict water flow regime as demanded by downstream members. The people of Cambodia depend on the fisheries resources of the basin and developments upstream will severely affect Cambodia. Therefore, Cambodia supports a strict water flow regime more than other member states. Cambodia is still recovering from decades of war and the situation is aggravated by lack of resources and limited capacity to undertake studies. A quarter of Vietnam's territory lies in the Mekong river basin and delta with 17 million inhabitants. The area produces 90% of the rice and 53% of the shrimp and fish exports from Vietnam (Quang 2002 as quoted by Backer, 2007). The area contributes 27% to Vietnam' GDP hence Vietnam prefers a more strict water flow regime. The attitude of MRC member states towards cooperation, emanating from varied needs and priorities for the use of basin resources, is partially a determinant of success or failure of the MRC.

Source: Adapted from Backer, 2007.

4.5.5 Concluding remarks

The MRC has completed numerous studies about the river and protection of the environment, but the data and information are poorly used. The MRC's role is that of a facilitator not regulator, hence its role and powers are very limited. The focus is on water allocations and benefit sharing is not actively pursued. Interestingly, the MRC had adopted a wide ranging flood control program, which deals with emergencies as well as preventive measures. The following problems have been experienced in the MRC:

- Upstream countries (China and Myanmar) are only observers;
- MRC does not cover management of most tributaries;
- Focus on water allocation and sharing, not benefits; and
- Countries have different expectations of cooperation ranging from loose cooperation to agreement about a regulatory framework.

The MRC appears not well positioned to handle emerging dam projects such as the proposed Don Sahong Dam in Laos. This proposed dam will have detrimental effects on migratory fish and people downstream. The MRC has been criticised by citizen groups for its lack of procedures for planning the development of dams.

Overall, the abstractions from the Mekong are still relatively low (12%), but a large part of the local population is dependent on its resources.

4.6 The Rhine River Basin

4.6.1 Introduction

The Rhine River Basin covers an area of 195,000 km^2 shared across nine countries. Fifty-five percent of the Rhine Basin area is within Germany, eighteen percent in Switzerland and six percent in France. The remainder is shared by The Netherlands, Luxembourg, Italy, Liechtenstein, Belgium and Austria (Raadgever, 2005). The Rhine River is about 1,300 km long and 62% of the river is navigable. There are several important tributaries and they include the Aare, Neckar, Main, Moselle, Saar and Ruhr rivers. The average river discharge at the mouth is 2200m^3/s and the river has favourable hydrologic characteristics and flow distribution over the year. The river basin has 60 million inhabitants (Huisman, de Jong et al. 2000 as quoted in Raadgever, 2005). About 20 million people, mostly in Germany and Netherlands, depend on the Rhine as a source of drinking water. The Rhine River is also used for irrigation, recreation, navigation, generation of hydroelectric power, and industrial processes.

About 20% of the world production of chemicals substances is produced in the Rhine basin (Dieperink, 1997). The main water management issues in the Rhine River basin are pollution control and flood protection (from river and sea water). The Rhine River was heavily polluted in the 1960s and 1970s. Intensive transboundary management efforts, including a focus on reducing the number of non-point discharges, have led to a remarkable turn-around and the Rhine River is now amongst the cleanest rivers in Europe (Raadgever, 2005).

4.6.2 The EU Water Framework Directive (WFD)

The WFD, officially launched in 2000, establishes a framework for water management in Europe (Barraque and Mostert, 2006). The environmental objective of the WFD is to achieve a good status for all Europe surface and underground waters within a 15 year period (Barraque and Mostert, 2006; Jones, 2001). It obliges EU countries to establish integrated river basin management. The WFD has several key tasks for integrated river basin planning and management and each key task has a compliance deadline for all EU members. The challenge to the implementation of the tasks is the short timeframe especially because of the unique circumstances in each EU state.

WFD tasks with 'minimum compliance' deadlines (Jones, 2001, 9):

End 2003:
WFD transposed into national legislation / River Basin Districts identified
⇩
End 2004:
Analyses of pressures/impacts and economic use completed
⇩
End 2006:
Monitoring programmes operational
⇩
End 2006:
Public consultation on River Basin Management Plan (RBMP) components commenced
⇩
End 2009:
RBMPs published
⇩
End 2010:
Pricing policies in place
⇩
End 2012:
Programme of measures operational
⇩
End 2015:
Environmental objectives achieved

4.6.3 Lessons learned

Transboundary management was pursued in response to serious pollution problems, i.e. there was an immediate reason and potential benefit. The discharge of industrial chemicals and domestic sewerage into the Rhine River by upstream countries led to pollution of the river thus making the water unusable for drinking purposes by downstream countries. The Netherlands took the lead in advocating for basin wide management of the Rhine River to ensure balanced use.

The Rhine River shows that SWC management can be successful, but it requires time, commitment and compromise. Moreover, SWC management benefits from a pragmatic, business-like approach (Mosterd, forthcoming).

The lack of an institution or framework delayed the development of basin wide management of the river (Dieperink, undated). The development and implementation of a management plan of the shared watercourse is normally a long process that requires institutional capacity and political will. An enabling framework is important to make progress, such as:

- The establishment of the International Commission for the Protection of the Rhine (ICPR) has helped to reduce pollution of the river with France agreeing to reduce the salt discharge by 50% and other riparian states co-financing the measure; and
- The Convention on the Protection of the Rhine.

Different policy actions are necessary, including:

- List of banned substances for discharge into the river;
- Variety of regional and national legislative instruments; and
- Binding regulations directly applicable to all member states.

The legislative instruments are important in achieving goals within the river basin. The role of economic instruments remains unclear.

Box 4.5: Cost and benefit sharing arrangements for the Rhine River

The Convention on the Protection of the Rhine against Pollution by Chlorides was concluded in 1976 and this convention required France to reduce chlorides discharge into the Rhine by 60kg/s before the 1st of January 1980. Switzerland, Germany and The Netherlands contributed 6%, 30% and 34%, respectively towards the initiative as a concession to France in order to get an agreement (Barraque and Mostert, 2006). The reduction of chloride discharges by France was not implemented after studies concluded that it would be better to invest in water purification infrastructure in Netherlands rather than funding pollution reduction in France.

Another example of benefit and cost sharing: Netherlands financially contributes to measures in Germany to absorb excess water during floods in order to prevent flood damage in The Netherlands.

Flood control is an important component of transboundary water management. The 1993 and 1995 Rhine floods indicated the need to adopt a basin wide flood management approach. The ICPR developed a Flood Action Plan in 1998, which outlined measures for flood prevention focusing on creating more space for flood water. In addition, there is exchange of information and discussion on strengthening flood defence measures (Becker et al., undated).

Transboundary water management can work provided key barriers are overcome. Dieperink (1997) has identified three important types of barriers that the Rhine basin regime had successfully overcome in time. These are institutional, cognitive and political barriers.

Mosterd (forthcoming) attributes the success of Rhine management to the following factors: *a joint vision, a phased approach, monitoring and open access to Rhine reports for civil society, small secretariat, good technical dialogue and collaboration between countries, and non-binding action programmes*.

The involvement of NGOs and civil society (with observer status on the commission) and open access to monitoring reports have provided pressure on governments to act and opportunities for assessing progress.

Positive experiences with the Rhine have encouraged SWC management in other basins such as the Elbe River in central Europe. According to Dombrowsky (2008), the International Commission for the Protection of the Elbe (ICPA) has successfully reduced water pollution, mostly from point sources. The ICPE successfully stimulated action of member state countries. Factors that facilitated its success included (Dombrowsky, 2008): *provision of upstream and down-stream incentives in terms of the environment and development; a favourable political environment (i.e. the collapse of the DDR, westernization and availability of funding)*.

5 Guidelines for resources allocation and benefit sharing arrangements in shared water courses in SADC

5.1 Introduction

This chapter outlines the steps proposed to develop allocation and benefits sharing mechanisms within a river basin. First, a general approach for planning the sustainable use of the basin is presented; then methods for developing water allocation and benefits sharing framework and mechanisms are illustrated.

Shared water resources and regional integration
The use and benefits of shared water courses gain importance with mounting water scarcity and competition among water users. Shared water courses (SWC) should be an integral part of regional economic cooperation and are vital for southern African development. The 2001 SADC Shared Water Courses Protocol must be implemented within this broader context and RBOs need to understand their roles.

Equitable and fair use of shared water courses
Articles 7 and 8 of the Protocol deal with the allocation and use of water resources to ensure they are used in an equitable and reasonable way to achieve optimal and sustainable utilisation and benefits. The interest of member states and the protection of the SWC have to be taken into account. Article 8 specifies the factors that have to be considered in the determination of equitable and reasonable use. ***The RBOs and stakeholders have to determine the weight of each factor and can add additional factors.*** Resource allocation and use has to be equitable and reasonable, but each RBO needs to elaborate these concepts and negotiate a reasonable and equitable sharing of resources and benefits.

Two part approach towards managing shared water courses
This chapter advocates 'diversity in unity', which requires a two-step approach towards guidelines.

First, a ***broadly defined SADC-wide framework*** needs to developed, which provides general guidance to the management of southern African river basins based on the SADC Protocol. Second, ***SWC specific plans*** need to be developed because river basins show great diversity in terms of environmental and socioeconomic conditions and utilisation of shared waters. This diversity must be recognised, and inevitably leads to different approaches to shared water management, conservation and utilisation.

Guidelines to promote shared water course management need to be developed to support this process. Such guidelines have to be broad, workable and flexible for the following reasons:

- Each river basin has unique environmental, socio-economic and institutional conditions;
- International river basin management is promoted world-wide, but there is as yet no single fully successful example, which could be used as the model for other basins; and
- Trans-boundary river basin management can be an arduous and time consuming process that urgently needs to make progress and show results.

Resource allocation, benefit generation and sharing
In the literature, there has been a shift in emphasis from resource allocation to benefit sharing. The interviews conducted for this study showed that this shift has widespread support among stakeholders. However, it is important to realise that this implies a change in

strategic emphasis rather than a fundamentally different approach as ***resource allocation and benefit sharing are two sides of the same coin*** (allocation and benefit chain). Benefit generation links resource allocation and benefit sharing. Resources are allocated and used to generate subsistence and/or commercial benefits and only generated benefits can be shared or distributed. The emphasis on benefit sharing has several advantages:

1. It focuses on beneficial use of water resources instead of resource entitlement;
2. It links benefit sharing with resource use, which the entitlement approach does not;
3. It encourages collaboration and economic cooperation between countries and thus contributes to regional economic integration and rapid growth; and
4. The Protocol requires that adverse impacts on other countries need to be mitigated and compensated. Mitigation and compensation requirements can be financed from the generated benefits. Therefore, a distinction must be made between the gross and net benefits. In the latter mitigation and compensation costs are deducted from the gross benefits.

However, benefits are often difficult to articulate and quantify and thus the concept could remain unconvincing to negotiating partners. ***Therefore, the benefits need to be clearly identified and articulated.***

Resource allocation and benefit sharing are vital for the success of river basin management and these guidelines focus on their development and implementation. The lofty and legalistic language of international treaties needs to become operational for individual RBOs in the SADC region. These guidelines attempt to facilitate the processes of resource allocation and benefit sharing at the RBO level. RBO experiences with improving resource allocation and benefit sharing need to be incorporated in regular revisions of these guidelines. As one interviewee put it, ***prevailing mentalities focused on resource allocation need to be changed and the understanding of benefit sharing needs to be expanded. This is a process, not an event.***

Powers of the RBO

The powers of each RBO compared to that of its member states may differ. While a regional approach may require ceding some sovereignty of member state countries, this could be difficult to realise in the short term, unless the additional benefits are fully documented and understood. Moreover, the establishment of a sizeable RBO involves significant costs and creates an additional layer of bureaucracy that may not be immediately justified. Sovereignty issues should not become a stumbling block to cooperation. Benefit sharing should recognise sovereignty as being important by presenting alternative ways to address it.

Therefore, two models emerge. First, a situation could exist where a small RBO mostly offers advice to member states and implements agreements reached by SWC countries (e.g. Mekong and Senegal Rivers). Second, a larger and stronger RBO may be developed that has more powers and implementation capacity and can become pro-active and develop regional plans. In this case, member states relinquish some of their resource rights to the RBO.

5.2 Approach and framework towards shared water courses management

The general approach to preparing a framework comprises the following components:

- Guiding principles for water management, conservation and utilisation (5.2.1);
- Components and orientation of the shared water management strategy (5.2.2);
- General framework for resource allocations (5.2.3); and
- General framework for benefit sharing (5.2.4).

5.2.1 Guiding principles

A number of principles guide the sustainable cooperative management of shared river basins.

1. Shared water courses need to be managed in line with the concept of integrated water resources management, which is the cornerstone of regional and most national water policies and strategies. The implementation if IWRM requires that:

    - Water resources are treated as economic goods with a price and cost, which need to be used efficiently. The RBO has to specify pricing principles for commercial and subsistence use and promote beneficial, productive use.
    - Water resources are considered to be finite and the limits need to be recognised;
    - Water management needs to involve the main stakeholders;
    - Water resources need to be managed at the lowest appropriate and feasible level;
    - Water supply and demand management measures need to be considered, compared and the best ones implemented. This requires full consideration of water demand management measures and water use efficiency.

2. Shared water course management needs to create benefits or lower costs and ***all*** countries need to benefit. This requires that resource (water) allocations and benefit distribution are closely linked. Only beneficial water use is warranted. Countries that loose out because of shared water management need to be compensated.

3. RBOs and the member states should focus on the *economic* benefits and costs. These include the *financial* costs and benefits plus externalities (positive and negative) and future costs and benefits. Some costs and benefits may be hard to quantify, but they still need to be considered. Multi-criteria analysis and multi-objective models can assist to explore the optimal way forward.

4. Resource allocations and benefit/cost distribution need to be considered at the regional, national and local level. While the international treaties mostly focus on regional and national benefits, countries need to ensure that national and local levels materialise. Local benefits are essential for compliance with the RBO agreement. Therefore allocation has to be defined at different levels in the basin; spatially (regional, national and local) and between sectors (e.g. agriculture, mining, industry, water providers and the service sector). Resource allocations must take temporal variability into account.

5. Shared water course management (SWCM) needs to be multidisciplinary in nature and should at least comprise the following areas of expertise: economics, social, cultural, ecological, institutional, political and hydrological.

6. SWC management must be pursued within the broader context of promoting regional economic integration and growth as well as transboundary resource management.

7. Management of SWC will be based on cooperative rather than confrontational management. The perceptions and motivations of all stakeholder groups must be understood and reflected in any cooperative arrangement that is to be viable in the long run.

8. SWCM needs to recognise and honour the ecological water requirements to ensure conservation of the aquatic ecosystem as well as river dependent land ecosystems. The assessment of the ecological flow requirements and the application of the precautionary principle for new water allocations need to be integral parts of SWCM.

9. Information acquisition and data sharing are essential for cooperative management of shared water resources and for making the benefit sharing concept operational. Data must be shared between countries but also be available to the relevant stakeholders, including civil society.

5.2.2 Management approach

The most common categories of projects that impact on SWC are the following:

- Dam construction for irrigation and hydropower;
- Inter-basin transfers (within and between countries);
- Large scale abstractions (e.g. for irrigation); and
- Other projects (e.g. projects that affect the water quality).

Some basins (e.g. Okavango River) are underdeveloped in terms of infrastructure and water use. Other basins such as the Orange River are already heavily used. The latter require different management approaches and have different management priorities compared to the former.

Generally, management approaches need to have the following characteristics:

- Be forward looking. Historical injustices need to be addressed within the forward looking perspective;
- Participatory and inclusive in terms of countries and stakeholders;
- Be practical and realistic and adopt an incremental approach;
- Develop common approach towards the agricultural sector and dam construction and management;
- Be pro-active in terms of initiating and developing projects and benefit sharing arrangements;
- Balance regional and national interest in terms of benefits, costs and sovereignty;
- Identify and recognise past injustices with present and future needs, and recognise the political sensitivity of each; and
- Balance development and conservation.

IWRM has important implications for the SWC management approach (Box 5.1).

Box 5.1: SWC management implications of IWRM.

IWRM component	Implications for the management approach
Economic good	▪ Commercial use needs to be based on the user-pays-principle ▪ Commercial abstraction should generate net regional value added ▪ Commercial use should promote the highest value use at the regional level ▪ Domestic and subsistence use should be accorded priority over commercial use ▪ Shared WC management should contribute to regional growth,

	reduction of poverty and livelihood improvements
Ecological resources	▪ Ecological water requirements need to be given second priority (after subsistence use and before commercial use) ▪ EIA and SEA requirements need to be met ▪ Impacts of climate change on water resources needs to be incorporated
Adverse impacts on other WC countries	▪ Determine as part of EIAs and SEAs ▪ Countries need to be compensated for negative cross border effects ▪ No country should be worse off because of a new water abstraction project
Stakeholder participation and decentralisation	▪ RBOs and WC countries need to ensure that local stakeholders actively participate in shared water management ▪ Benefits of the regional approach and costs need to be equitably and evenly distributed over population groups and sectors

SWC countries and RBOs have to compromise in two areas. First, standard environmental policy principles such as the user and polluter pays principles advocate that the project initiator takes full responsibility for the costs of resource use and pollution. The implementation of these principles would mostly affect upstream SWC countries and could lead to a situation where these countries do not benefit from SWC management. In order to ensure benefits to all countries, contributions from downstream countries to upstream countries may be required. Second, water allocations and use prior to the Protocol may be unjust, inequitable and unreasonable. SWC countries and RBOs need to find a way of creating a more equitable and reasonable use of SWC, but such an approach must be based on compromise and be implemented gradually. This also applies to addressing water use of the agricultural sector.

Each RBO needs to guide future projects. An example of a project checklist to be used in evaluating proposed projects is presented in Box 5.2.

Box 5.2: RBO project checklist

	Questions and Issues	Action:
1	Does the project contribute to the development of the proposing country and the region at large (e.g. jobs, income and poverty reduction)?	▪ If not: adjust the project ▪ Projects should seek to 'broaden the basket of potential benefits' for all basin members
2	Are possible negative project impacts (development and environment) on other countries identified and remedied?	▪ If not: identify and compensate/ mitigate ▪ Compensation and mitigation should be sustained and agreed to by all parties
3	Does the water abstraction leave sufficient water for the environment and subsistence needs?	If not: reject or propose to compete with other projects
4	Does the water abstraction of the project fall within the country's resource allocation?	If not: reject or reconsider other projects
5	Is the project justified within the context of a country's water allocation strategy and plan?	If not: develop such a plan
6	Is an EIA carried out and are the results and the EMP	

	clearly articulated?	
7	Does the proposing country use the SW Course efficiently and are other water sources used efficiently?	If not: increase water use efficiency and modify the project
8	Does the project create economic benefits to the initiating country and southern Africa? Are there economically more beneficial alternatives?	If not: reconsider and redesign or propose the alternative

Moreover, each RBO needs to develop a management position regarding the following issues:

- Whether it allocates resources quotas to SWC countries or whether it restricts itself to basin wide quota;
- Merits of inter-basin transfers, which divert water to another river basin within other countries;
- Merits of water allocations to agriculture in view of the history, its low productivity and growing competition from other sectors;
- Past and existing resource use patterns in view of the Protocol's concept of equitable and fair water utilisation. In other words, how does the RBO deal with water rights and uses that were established prior to the Protocol? Water rights and benefit sharing may need to be treated jointly to provide negotiating space for those riparian states that feel they have an unjust share because of past allocations.
- Dealing with upstream and downstream countries. The former will experience development constraints due to the Protocol while the latter are likely to benefit because of reduced adverse impacts or compensation. There may be need to provide incentives for upstream countries to fully participate and comply with shared water course management; and
- Identification of benefit sharing options through joint projects.

Each RBO needs to clearly articulate the baseline situation in terms of water supplies, domestic needs, environmental requirements, and water abstractions. This requires data collection and sharing. Benefits and costs need to be identified in economic terms:

- Costs include user costs, externalities and foregone benefits; and
- Benefits include user benefits, external benefits and avoided future costs.

Economic analysis is useful and the techniques for estimating both use and non-use values and costs are available. They can be incorporated into multi-objective river basin optimisation models, with the ability to change the weights attributed to the various objectives.

The requirements for cooperative shared water course management are summarised in Box 5.3.

Table 5.3: Cooperative SWC management requirements

Topic	Variables	Implication
Institutional	▪ Growing trust among countries ▪ Evolutionary, time consuming process	▪ Build on previous bilateral water agreements and cooperation in other areas ▪ (e.g. agriculture, energy and trade) ▪ Requires capacity to analyse

		and inform policy positions and decisions ▪ Communication at technical level can assist in establishing an environment that is conducive to further engagement
Political	▪ Political will and willingness to cede some sovereignty ▪ Stable political and effective governance systems in countries	▪ Mobilisation of political support ▪ Promote stable and transparent governance and management
Economic	▪ Generation of additional benefits through higher water use efficiency and SWCM ▪ Additional benefits need to exceed the costs of SWCM ▪ All countries should be better off	▪ Encourage higher value uses ▪ Link with water efficiency plans, consideration for water re-allocation, especially agriculture ▪ Fair and equitable benefit and cost sharing ▪ Broaden the basket' of potential benefits
Social	▪ Prioritisation of basic human and subsistence needs ▪ Benefits should trickle down to the local level ▪ Participation of civil society	▪ Countries to develop national benefit sharing strategy
Environment	▪ Safeguarding environmental water requirements ▪ Minimising risks of floods and flood control ▪ Water quality control	▪ EIAs and EMPs should be an inherent aspect of management tools developed by each RBO whether there are water development projects or not. ▪ Basin dynamics must be fully understood and reflected in agreements.

The main factors that facilitate and constrain cooperative shared water course management are summarised in Box 5.4.

Table 5.4: Constraints and opportunities for cooperative SWC management.

Factors	Policy implications
Emergency events and hazards (e.g. floods, droughts, water stress)	Emergencies and natural disasters can be used as catalysts for cooperative management
Number of countries	▪ A small number of water course countries facilitates cooperative management ▪ All water course countries need to fully participate as unilateral action by one country concerning international basins is often ineffective or inefficient.
Nature of countries	▪ *Homogeneity* and stability among countries facilitates cooperative management. Key factors include: level of economic development, governance, population density,

	economic structure. ▪ Avoid that big/ powerful countries bully smaller, less powerful countries ▪ *Stability* of national economies ▪ Essential that upstream and down stream countries participate
Benefits and costs	High net benefits offer an incentive for cooperative management Requirements: 1. benefits need to be clearly identified and secure; 2. benefits should be quantified and presented in order to be easily understood by all stakeholders
Distribution of benefits	Cooperative management will be facilitated if all countries benefit and there are no losers in terms of sectors and population groups.
Relationships between countries	▪ Build on bilateral shared water management and collaboration in other spheres ▪ Invest in developing trust and mutual respect and to harmonise policy and governance systems ▪ Regional and national stability promote cooperative shared water course management
Data and information	▪ Identification of national data requirements, gaps and collection methods ▪ Need for data sharing and verification (e.g. water course data base?) ▪ this is often easier to start at the technical level (where a healthy level of trust might already exist), but can later be institutionalised at RBO level

These factors and their implications need to be recognised during negotiations at the river basin level.

5.2.3 General framework for resource allocations

Three components are critical for resource allocation: *the mechanism of allocations, demand prioritisation and the spatial level and detail of allocations*. Each component is elaborated below.

Resource allocation mechanisms
Resources can be allocated through public regulations or through the market. The former is most commonly used. Experiences with the latter are mostly limited to individual countries and to other environmental issues such as fisheries and carbon trading. The third approach would be to combine regulated water allocations with market forces, for example through the introduction of commercial water rights that can be traded. The advantages and disadvantages of each approach are summarised in Box 5.5.

Table 5.5: Advantages and disadvantages of different resource allocation mechanisms

Approach	Advantages	Disadvantages
Regulated resource allocation	Can deal with social and environmental needs	▪ Un-economic water use and wastage ▪ Static: does not promote innovation and does not adapt to changing needs
Market allocations	Highest economic gains Transfer from low to high value uses Stimulates WDM	▪ Social, basic needs might be neglected without government regulations ▪ Environment- risk that too much water is allocated to

		other uses than the environment ▪ Limited practical experience ▪ Risk of lack of competition ▪ Lack of data and high transaction costs
Mixed regulations with market forces	Market forces to promote highest use value for commercial activities Regulations for basic needs and subsistence use serve social and environmental needs	Need state regulation for law enforcement or control of environmental externalities

The mixed approach seems to be most advantageous but each RBO needs to determine its preferred approach.

Demand prioritisation and allocation
Resource allocation must be based on demand or use priorities. There seems to be widespread consensus about the following demand priorities: *first priority: basic human needs and subsistence; second priority: environmental requirements; and third priority: productive resource use*. Each RBO should confirm this prioritisation or formulate a modified position.

Different allocation techniques need to be applied for each demand category. Basic needs can be allocated based on the population size and subsistence needs in each country. This will lead to water amounts allocated to each country. Environmental requirements need to be determined by environmental flow analysis or environmental indicators. This will lead to estimated water requirements for the environment in each country. The choice in resource allocation methods is highest for productive uses and luxury domestic use. The following choices exist:

- Determination of resource quotas and allocations to individual countries OR only a regional resource quota with regional allocations based on the criteria of Art. 7 and 8 of the Protocol. The former requires that individual countries develop further allocation mechanisms for their own countries; or
- Resource allocations can be determined through public sector decision-making or through the market. The former is most common; the latter requires the issuing of water rights or credits within the overall quotas for productive use.

Regional and/or national water quotas
RBOs may opt to issue national water quotas or restrict themselves to one aggregate abstraction quota for the entire basin. RBOs such as Incomati issue national quotas and presently no RBO uses regional quotas only. The advantages and disadvantages of national quotas versus one regional quota are summarised in Box 5.6.

Table 5.6: Advantages and disadvantages of regional and national quotas for water abstractions

	Advantages	Disadvantages
Regional and national quotas for productive abstraction	<u>National level:</u> ▪ Security ▪ Planning for basic needs and environmental needs ▪ Commodification of the	<u>National level:</u> Depends on countries' policies for quota distribution

	rights ▪ Develops competition for shared SWC within countries ▪ Protection of future options for countries <u>Regional:</u> ▪ Easier to conclude politically ▪ Promotes regional integration and cooperation for other resources.	<u>Regional:</u> Under utilisation of quota and economic growth opportunities
Regional quota for abstraction without national quotas	<u>National level:</u> Winners and losers <u>Regional level:</u> Enhance economic growth	<u>National level</u> Growing disparity in resource use without compensation <u>Regional level</u> ▪ Loss of sovereignty ▪ Risk of growing polarisation

Resource allocations need to be based on allocation mechanisms such as:

- Resource allocation formula (e.g. Nkomati);
- Negotiated distribution (e.g. Senegal); and
- RBO specific interpretation of determinants of fair and equitable utilisation.

RBOs that operate in underutilised water courses should encourage greater resource use and allocation, while RBOs in basins that are already heavily used would focus more on protection of environmental water requirements, shifts in water uses among countries or sectors (towards higher value use) and benefit sharing.

Fixed amount of water allocations (in m^3) do not work well due to highly variable natural conditions and their inflexibility to respond to socioeconomic changes; percentage allocations (e.g. 1-2% of the river flow) are better.

Past water allocations may be unjust and they often favour the more developed and powerful countries. However, changes are likely to be difficult, and the most pragmatic solution is to incorporate such 'injustices' in considering future resource allocations. The involvement of a third party and a 'broadening of basket of potential benefits', could balance the injustices of the past with the current and future needs of all basin members. While third parties cannot alone create a conducive, political environment, they can provide incentives to cooperate through: (i) providing technical competence and examples of best practices; (ii) assisting in negotiation and mediation skills, including the provision of legal and other water experts; and (iii) facilitating investments in transboundary settings (Phillips *et al*, 2006).

Inter-basin transfers (IBT) need special consideration by each RBO as water is withdrawn from one SWC and moved to another national or shared water course. The implications for downstream countries require special consideration and therefore all IBTs should become a concern of the RBO. There need to be guidelines at the SADC level to regulate large water development projects such as dams and IBTs.

5.2.4 General framework for benefit generation and sharing

Terms and concepts	Description
Gross benefits	Revenues or outputs from a project or activity Financial revenues refer to revenues to the project initiator Economic revenues refer to all benefits
Costs	Inputs and requirements for production, including mitigation and compensation measures External costs refer to costs not incurred by the project initiator
Net benefits	Gross revenues minus the costs
Foregone benefits	Benefits that can no longer be realised because of the project implementation

Benefit identification and generation
Prior to the issue of benefit sharing, the benefits of shared water course management need to be identified and appreciated by the water course countries and all stakeholders (public, private and civil society). The gross benefits include the following:

- Benefits from the river;
- Benefits to the river;
- Cost reductions due to SWCM; and
- Benefits beyond the river.

Benefits of shared water course management include environmental benefits, economic benefits, lower costs of river maintenance and other benefits that are associated with regional integration, replicability or use in other development areas (e.g. transboundary wildlife management) etc.

In order to assess the net benefits two cost categories need to be deducted:

- Costs of SWC management; and
- Costs of mitigation and compensation.

The costs of shared water course management are often overlooked but need to be identified and allocated.

The remainder is the net benefit of the project and the water abstraction to the SWC.

Benefit distribution and sharing
The benefits are distributed among countries, economic sectors and population groups. Benefit sharing needs to extend to the local level to promote compliance and local understanding. This should be part of national strategies for resource allocation and benefit sharing. National strategies for resource allocation and benefit sharing should explicitly state how the benefits will be shared at all levels of society and economy, especially by those groups that need to be compensated for losses introduced by projects such as IBTs and dams.

A fundamental requirement for SWCM is that ***all*** countries benefit. Therefore, there is need for mitigation, compensation and sharing of net benefits. Possible ways of benefit sharing include:

- Water credits (applied in South America at national level);

- Fund for incentives and compensation;
- Inter-country and sector compensation payment;
- In-kind benefit transfers (e.g. skills and technology transfer); and
- Benefits to other sector (non-water dependent).

The advantages and disadvantages of each method are summarised in Table 5.7.

Table 5.7: Advantages and disadvantages of benefit sharing mechanisms.

	Advantages	Disadvantages
Water credits	▪ Minimise under utilisation through transfer of quota ▪ Stimulates efficient use of technology	▪ Depends mostly on market forces ▪ Requires technology and skills
Fund	▪ Mitigates and compensates against foregone benefits ▪ Provides incentives to withhold certain projects	▪ Needs clear and transparent regulations for use of the fund ▪ Fund management institution required
Payments	▪ Encourages high value uses	▪ Cumbersome and needs a detailed administration strategy
In kind benefit transfer	▪ Skills transfer develops human resource base ▪ Encourages cooperation on other resources ▪ Saves costs ▪ Stimulates regional integration ▪ Improvement of livelihoods	▪ Depends on willingness to share skills and technology
Benefits to non-water dependent sectors	▪ Spreading of benefits beyond water-dependent sectors of the economy	▪ Depends on mutual trust ▪ Difficult to implement

Currently, inter-country payments and benefit transfers are most common. Water credits and the benefit sharing fund for SWC are not yet used by any country in southern Africa. In addition to direct payment for benefits and compensation for costs, other mechanisms exist, including direct payment for water itself, power purchase agreements, and financing and ownership arrangements. These have been adopted independently and jointly, with most cases centred of dam construction designed to generate and use hydropower. See boxes below.

The Lesotho Highlands Water Project on the Orange/e River utilises a number of mechanisms, including direct payments for water, purchase agreements and financing agreements.

Benefit sharing of the LHWD project

Benefit identification:
The driving force was that the IBT was cheaper for South Africa than other supply options. The LHWS was therefore driven by cost savings. Additional benefits: power generation for Lesotho and additional revenues.

Downstream countries have not been compensated nor mitigated (Namibia and Botswana).

Benefit sharing:
The benefits of the costs savings for South Africa are split between Lesotho and South Africa through royalty payments. Power benefits accrue to Lesotho. Infrastructure jointly owned??

Comment: further IBTs need to involve Orange RBO and Namibia and Botswana. The mmodel can be extended into a shared SWC arrangement for the Orange River. This implies that affected downstream SWC countries need to be compensated, for example by sharing in the benefits.

On the Senegal River, Senegal, Mali and Mauritania agreed to share the development costs and benefits of jointly-operated common infrastructure using a burden-sharing formula.

Senegal River; benefit sharing through joint infrastructure development and ownership

The under-utilised Senegal River offers a good model for resource allocation and benefit sharing through joint ownership of dams and hydropower schemes.

Benefit identification: the benefits of dams and hydro schemes are identified and 'allocated to countries. Based on the approach towards common development, the contribution to the development costs are proportional to the expected benefits.

Resource allocations are derived from the benefit sharing arrangements

Comments on the model:
This can be useful for shared WC, which are not yet heavily used for abstractive use (e.g. Okavango). Arrangements need to be made to include the costs of environmental externalities and foregone benefits in the (net) benefit calculation.

5.2 Part Two: RBO specific mechanisms for resource allocation and benefit sharing

This section recommends specific steps in achieving resource allocation and benefits sharing. These steps include steps required to develop collaborative management approaches for SWC management prior to addressing resource allocation and benefits sharing. As SWCs are economically, geographically, socially and environmentally unique, the guidelines are flexible and need to be further developed by each individual RBO.

The main points of the following guidelines have been illustrated with a hypothetical example of a three-country shared water course (SWC) in southern Africa. It is assumed that the member states are in the process of forming an RBO and looking forward to developing resource allocation and benefit sharing mechanisms.

The implementation of the ideas for individual RBOs will generate much needed hands-on experiences that need to be incorporated into the evolving guidelines. In this way, the guidelines become dynamic and more relevant to RBOs.

Step 1: Basic agreement towards cooperation – Establishment of an RBO

Countries need to reach an agreement about the definition of the SWC area and the water course countries. In addition, the management priorities and key resource issues need to be identified and agreed upon. Countries need to realise that SWC management is an evolutionary long term process that is best implemented in stages and with a focus on activities that are critical and beneficial to the region and individual countries. Finally, there is need to identify the main stakeholders and their roles.

Some of the above can be done through a comprehensive resource analysis that involves the conducting of Transboundary Diagnostic Analysis (TDA) that other RBOs have already conducted or are in the process of conducting (e.g. ORASECOM and OKACOM)

A SWC institution must be established and agreement needs to be reached about the RBO tasks, responsibilities of the RBO and national governments and sovereignty of SWC states. Two models exist:

- Mostly advisory RBO where strategic decisions are made and implemented by the SWC countries (e.g. Mekong, Rhine and Elbe); and
- SWC-countries cede some power and responsibilities to the RBO.

The former model is easier to accept and ceding sovereignty to an RBO requires mutual trust and a sufficiently common purpose in SWC management and governance. This usually requires time to establish. Care must also be taken that the RBO is efficient and effective.

Agreements need to be drawn up and signed, which establish the institutional structure and procedures, including:

- Degree of participation and appropriate level *(constitutional rules)*
- The transparency of these processes and who is included *(decision rules)*
- The principles by which resources and benefits should be apportioned *(operational rules)*

Step 2: Development of a common understanding and agreement about fair and equitable resource use

The key questions at this stage are:

1. What is the relevant interpretation of the factors that determine equitable and fair use for the particular SWC?
2. Are there ***other*** factors than those mentioned in the treaty that need to be considered? For example: the Helsinki rules are explicit about avoiding water wastage prior to the use of shared water resources.
3. Which weights should be attached to each factor?

The discussion of these questions should include stakeholders from the private sector and civil society too and cross cutting issues such as gender, poverty and HIV/AIDs need to be considered.

Box 5.8 provides a hypothetical example of possible determinants and their weights. The data and their weights could lead to the identification of water use quota for each of the three countries. The criteria cover three categories; supply, including natural factors and water infrastructure, demand and management.

Once the variables are agreed upon, data need to be collected to complete countries' score. Next, each criterion needs to be given a weight. In the example, supply, demand and management each carry equal weight (one third) and within each category weights are attached to each individual criterion. The country score and the weight give a country score for each variable. After each variable has been scored and weighed, aggregate country scores emerge. In the example, country 1 (C1) would have the highest use quota for productive use (44%).

Table 5.8: Determination of equitable and reasonable use

Equitable and reasonable use								
Supply		**Variables**	**Unit**	**C1**	**C2**	**C3**	**All**	**Weight**
	Natural factors and infra-structure	Annual and seasonal run-off		9,000	1,000	1,000	11,000	15
		Groundwater recharge						
		Min-max temperatures						
		Rainfall amount and variability	Mm	900	7590	600	2,250	
		River length (in km)	Km	1,000	500	500	2,500	
		Tributaries (no and length)						
		Basin area	Km^2	250,000	50,000	100,000	400,000	15
		Available species and their 'threatened species' status					0	
	Infra-structure	No. and capacity of dams	Mm^3	100,000	50,000	50,000	200,000	
		Available treated effluent in basin area	Mm^3	2,500	2,500	2,500	7,500	
		Existing bilateral agreements on water sharing and Management					0	
Demand	**Needs**	Subsistence activities and water consumption	Mm^3	26	12	6	44	
		Commercial water abstraction	Mm^3	250	175	50	475	10
		Environmental flows	Mm^3	7,200	600	400	8,200	

	Energy consumptions and generation					0	
Population dependent on SWC	Population living in the river basin	In 000	250	100	50	400	5
	Population directly dependent on the river	In 000	100	50	40	190	
Uses	Water abstraction for agriculture	Mm^3	100	100	25	225	
	Water abstraction for industry	Mm^3	0	25	5	30	
	Water abstraction for mining	Mm^3	100	0	10	110	
	IBT	Mm^3	0	0	0	0	
	Other uses	Mm^3	50	50	10	110	
	Use for non-consumptive purposes	Mm^3	100	100	500	700	10
	Value added and empl. .creation per unit of water consumption		75	50	80	205	5
	Planned possible water abstraction						
External cross border Effects							
Alternatives	Overall water use efficiency of country		60	80	100	240	5
	Water use efficiency in agriculture						
	Water use efficiency in water providers						
	Water use efficiency in						

		public sector						
		Water use efficiency in industry and service sector						
		%of re-use and recycling of treated effluent		10	40	20	70	5
		No and costs of alternative water sources		5	1	1	7	
SWC management	**Conservation and protection**	River dependent ecosystems and species		15	10	25	50	10
	Economic growth and development	Link with transfrontier conservation areas		1	1	1	3	
	Improved living conditions and human development	Water quality levels		2	2	3	7	10
		Control water quality		2	2	1	5	
		Population with access to safe potable water		75	75	90	240	5
		Population with adequate sanitation infrastructure		70	60	70	200	5
	Poverty reduction	P.C. income		4,000	4,000	5,000	13,000	
		Human Development Index						
		Poverty levels and trends						
		National quotas for		**44.4**	**23.3**	**32.3**		

	water abstraction for (productive use as %)						

Each RBO needs to design and complete its own spreadsheet with determinants and their weights based on the above considerations.

The following must be noted. The variables need to be as much as possible supported by objective scientific data and statistics. Weights can be adjusted during negotiations, making it an iterative process. A sensitivity analysis can be carried out with different weights.

Step 3: Identify key aspects of sustainable water use and protection of the water course.

The following aspects need to be considered at this stage:

- Existence of different national water quality standards and the development of common water quality standards;
- Determination of the environmental flow requirements or alternatively agreement about key environmental quality indicators;
- The impact of climate change on the SWC (supply and demand).
- Differences in national EIA and SEA procedures and development of a common procedure in the SWC.

The above should lead to the general guidelines and conditions for all projects that abstract water from the SWC. This would be an elaborated version of the checklist of the common framework (Box 5.2).

This step will show how much water is required for the environment and environmental needs should be considered prior to the allocation of productive water uses.

Step 4: Collection of baseline information for the determination of water supply, needs and uses

A large amount of data is required for SWC management. It is unlikely that all data exist at the start of the RBO operations. It is advisable to have a reasonable reliable minimum set of key data for SWC management and start SWC management without waiting for the 'ideal' data base.

Ideally, the basic data should reveal how much of the supplied water is being used, how much is needed for basic and subsistence needs, what are the ecological requirements, and how much water can still be allocated for productive purposes. In addition, country specific data need to be collected for the determinants of equitable and fair use (see step 2). An example of productive use estimates is given in Box 5.9. This assumes that the subsistence and ecological requirements are known and protected.

Table 5.9: Example of productive use of SWC

III	**Water abstraction in Mm^3**	**C 1**	**C 2**	**C 3**	**Total**
III.1	**consumptive use**				
	for agriculture	100	100	25	**225**
	for industrial use		25	5	**30**
	for mining	100	0	10	**110**
	Inter-basin transfers	0	0	0	**0**
	other uses	50	50	10	**110**
	total water abstraction	**250**	**175**	**50**	**475**
III.2	**non-consumptive uses**				
	Hydropower	25	25	0	**50**

Navigation	100	100	50	**250**
recreation and tourism	50	100	500	**650**
total non-consumptive use	**100**	**100**	**500**	**700**

It is important to include consumptive and non-consumptive water uses. The latter refer to navigation, hydropower, and tourism. Furthermore, it is important to identify water abstraction for other river basins and to include groundwater into the analysis. The level of water that can still be allocated for productive use is an indication of the level of (under-) utilisation of the SWC. Already heavily used SWCs have little resources left for productive use. Under-utilised SWCs have scope for significant growth in water allocations and benefit generation.

Step 5: Development of a SWC vision about and strategy towards resource use, benefits and development based on equitable, fair, sustainable and optimal use of the water resources

The vision would offer a long term perspective and direction for SWC management, which is not constrained by current water allocations and uses. It links the implementation of the SWC Protocol and RBO plan to regional integration and specialisation, economic growth as well as to other Protocols and environmental issues such as biodiversity, transboundary wildlife and fisheries management and tourism.

The following issues need to be considered as part of the vision and strategy: demand prioritisation, sovereignty, use of regional and/or national quotas, resource investment and capital development and finally the identification, packaging and prioritisation of future projects. This could include the adoption of a shared water resources infrastructure development plan.

Based on the previous steps, each vision and strategy may choose between two different river basin scenarios:

- *Sustainable expansion scenario* when the utilisation level is low as compared to the available water for productive use. The strategic emphasis would be on the identification and implementation of productive projects and water infrastructure projects. The projects need to meet environmental sustainable requirements;
- *Conservation and re-allocation scenario* when the utilisation is already high and leaves little space for additional productive resource allocations. The strategic emphasis lies on ensuring that environmental flow requirements are met, water quality is maintained and that additional water abstractions are set off against reductions in abstractions in other (lower value) sectors. Economic growth and poverty reduction are brought about by resource use switches between economic sectors.

This should be done alongside capacity development and skill-strengthening of all member states, especially those with less capacity to put them on a similar position to analyse and inform policy positions and decisions.

Step 6: Resource allocation and benefit sharing

Resource allocation and benefit sharing are closely intertwined and hence their determination is an iterative process. The benefits of allocated resources and proposed projects are estimated, leading to the need for compensation, mitigation, sharing of benefits and also reconsideration of proposed resource allocations.

Compensation measures need to be ***sustainable,*** i.e. offer affected parties the opportunity to maintain their livelihoods at the same level as before the implementation of the project/ programme.

6a: Resource allocation

Resource allocation and benefit sharing are closely intertwined. Over the long run, benefits can be obtained from a switch towards higher use value of water resources. In the short term, countries are likely to focus on overcoming water scarcity by country specific water allocations from shared water courses.

Each RBO needs to consider prioritisation of water allocations along the following lines:

- Priority 1: Basic and subsistence needs;
- Priority 2: Environmental needs;
- Priority 3: Productive needs, which contribute to economic growth, employment generation and poverty reduction. Therefore, the allocation would be determined by economic factors.

The maximum abstractable amount is determined by the total run-off minus the environmental requirements and the basic needs/ subsistence requirements.

Issues to be considered for resource allocations are:

1. Views differ on the need for general water allocation quotas to SWC countries. Such quotas are intuitively appealing as they create clarity and security among SWC countries, but the risk exists that the link with benefits receives less attention and that the SWC-wide results are sub-optimal (each country goes it alone). Earlier, we gave an example as to how national quotas can be established in a transparent, verifiable and negotiated process (Box 5.8).

2. With or without national quotas, countries need to compensate each other for adverse cross border impacts (externalities). This applies mostly to up-stream states that have to compensate downstream states for reduced river flow and/or pollution. This means that for project proposals, the cross border impacts need to be identified and mitigation and compensation measures proposed.

3. If an RBO opts for country specific water abstraction quotas, new projects may exceed or fall within the allocated quotas. If it falls within the quota, the country should meet general guidelines for SWC abstractions that are developed by the RBO. In addition, the country must ensure that this project makes the desired contribution to its national development; if the project exceeds the country's quota, the project can only proceed if the country restructures its total water use from the SWC (ensuring that total demand does not exceeds its quota) or if the country purchases unused water rights from other countries.

4. It is generally recognised that existing water abstractions tend to be biased in favour of more developed countries and sectors. This is a sensitive issue and cannot easily and quickly be changed. Possible ways of handling the issue include:

    - Water allocation reforms to make water use equitable and fair. It may be difficult to achieve this for current uses merely through cooperation, as it will often negatively affect the powerful sectors and countries. Other potential benefits needs to be identified to create incentives and political will for allocative reforms;

- Gradual redistribution of water allocations for *new* projects taking into account historical injustices. This compromise has fewer negative impacts and is more likely to be accepted and succeed.

5. The agricultural sector is particularly prone to water redistribution claims as its value added per m^3 is relatively low and its water abstraction is usually high. The answer requires a SWC specific analysis, taking into account the following factors:

   - Importance of agriculture for rural development, livelihoods and food security;
   - The opportunity costs of agricultural water consumption. For example, the opportunity costs of irrigation may be high as the water can be used for other purposes. In contrast, opportunity costs of water consumption by livestock are low where it concerns the use of widely scattered boreholes.

6. Fixed amounts of water allocations do not work because of the significant variations in run-off and rainfall conditions. During droughts, abstraction must be reduced while during high rainfall periods, abstraction can increase. Therefore, if resources are allocated to countries, it should be as percentages of the river flow rather than absolute amounts.

6B: Benefit sharing

This includes the following (sub-)steps.

<u>1: Identification of the current benefits associated with the shared WC in terms of subsistence and commercial benefits.</u>

The benefits are the gross benefits (see above) minus the costs associated with SWC management.

1	Gross benefits	▪ Categorisation into basic needs, subsistence benefits and commercial/productive benefits ▪ Categorisation in benefits for and from the river, benefits beyond the river and cost reductions
2	Costs	▪ Associated with SWC management ▪ Associated with the project (financial costs, compensation and mitigation costs, externalities and foregone benefits)
3	Net benefits	Gross Benefits minus Costs (1minus 2 = 3)

Subsistence benefits are critical in the short term to contain poverty and improve livelihoods. In the longer term, shifts towards efficient commercial use will accelerate development. An example of the gross benefits of a project is given in Box 5.10.

Table 5.10: Gross benefits of a SWC project

		C 1	C 2	C 3	Total
1	**BENEFITS FROM THE RIVER**	**Dollars (Thousands)**			
1.1	**Water abstraction**				
	Agriculture	75,000	50,000	35,000	160,000
	Mining	0	0	0	0
	Industry	60,000	15,000	0	75,000
	Interbasin transfers	0	0	0	0
	Other uses	0	0	0	0

		135,000	***65,000***	***35,000***	***235,000***
I.2	**Non consumptive river use**				
	Hydropower	0	0	0	0
	Recreation and tourism	10,000	100,000	450,000	560,000
	Transport and navigation	0	0	0	0
	Other non consumptive uses	0	0	0	0
		10,000	***100,000***	***450,000***	***560,000***
II	**COST REDUCTION DUE TO RIVER**				
	Avoided costs of conflict resolution	??	??	??	??
	Avoided costs of water insecurity	??	??	??	??
	Avoided costs of conflicts	??	??	??	??
III	**BENEFITS BEYOND THE RIVER**				
	Increase regional cooperation and integration	??	??	??	??
	???	??	??	??	??
IV.	**BENEFITS TO THE RIVER**	***250,000***	***50,000***	***250,000***	***550,000***
V	**TOTAL BENEFITS**	***395,000***	***215,000***	***735,000***	***1,345,000***

The benefits beyond the river and the benefits of cost reductions are often difficult to quantify (so-called intangibles) but should not be forgotten. They can play an important role in regional cooperation that can have positive spill-over effects in other non-water related aspects of development in the region, e.g. improved regional security. For convenience sake, the RBO could assume that such benefits and reduced costs benefit each country equally and would thus already be evenly shared. At a later stage, efforts can be made to estimate these benefits based on accumulated implementation experiences.

The net benefits are calculated by deducting the costs, which include:

- Cost of SWC management: e.g. average O & M costs of RBO per project;
- Cost of sustainable compensation and mitigation measures (emerging from the EIA);
- Costs of proposed future projects (usually given in the project description); and
- Cost of other environmental externalities and foregone benefits (often forgotten and yet important; e.g. emerging from a social cost-benefit analysis)

Level of utilisation and increasing the benefits from SWC

Some water resources are already heavily used (e.g. Inkomati and Orange-Senqu) while others are under-utilised (e.g. Senegal and Okavango). For heavily used rivers, the RBO emphasis will be on water efficiency and re-distribution of water rights in order to increase development benefits. In under-utilised basins, the emphasis will fall on developing projects and infrastructure to support development and economic growth (see step 5).

The RBO needs to consider the following:

- Which higher use values can be promoted in the SWC? Generally, industry and the tertiary sector generate more jobs and income than agriculture.

- Which opportunities exist for multiple uses, e.g. combination of non-consumptive and consumptive use? For example, recreation and tourism may be boosted without adversely affecting consumptive uses.
- Which other potential benefits may emerge from cooperative SWC management and how can they be achieved? This includes shifts in water consumption between countries, and lower policy, conflict control and enforcement costs because of cooperative efforts.

Table 5.11 presents the results of a resource allocation and benefit generation/sharing analysis of three common types of new projects:

- Irrigation;
- Hydropower; and
- Inter basin transfers.

Below, the management implications of different variants of each project are summarized. In some cases, compensation and mitigation is required, in other cases the project may proceed or is better scaled down. This approach is transparent and can be further developed and refined in time.

	Project implications
A	**Three variants of irrigation (in country 1)**
A1	No need for cross border compensation
	Contributes to national and region growth
	Enough water for environmental flows and subsistence needs
	Carry out the project
A2	Need for compensation of Country 2 and 3
	Contributes to regional and country 1 growth
	Enough water for environmental flows and subsistence needs
	Exceeds nat. Quota
	Carry out project subject to compensation and meeting national quota requirements
A3	Same as A2; however lower regional benefits
	A2 is preferred from regional perspective.
B	**Three variants of hydropower schemes (in country 1; upstream)**
B1	Contributes to growth in country 1 and region
	No need for cross border compensation
	Enough water for environmental flows and subsistence needs
	Carry out the project
B2	Contributes to growth in C1 and slight growth in region
	Need for compensation of Country 2 and 3
	Enough water for environmental flows and subsistence needs
	Carry out the project
B3	Growth in Country 1 but decline in region
	Do not carry out the project
C	**Three variants of inter-basin transfers (in country 2)**
C1	No need for cross border compensation
	Contributes to national and region growth
	Enough water for EF and subsistence needs
	Carry out the project
C2	Growth in Country 2 and region
	Adverse impacts on Country 3
	Enough water for environmental flows and subsistence needs
	Carry out project with compensation

C3	Growth in country 2 and region
	Less benefits than under variant C 2.
	Prefer to carry out variant C 2.

Benefit distribution and sharing

The protocol emphasises benefit distribution between countries. It is essential that benefits are also equitably and fairly distributed within countries. Local communities must experience the benefits of shared WC management in order to support such efforts. This can be done by prioritising water demand for domestic and subsistence use and promoting CBNRM approaches towards tourism, recreation and other areas such as fishing.

There are different methods of benefit distribution, which are closely associated with the resource allocation methods:

- Market forces such as water credits that link water rights to payments and transfers of benefits;
- Regulated benefit distribution through the RBO and/or national countries. These include: cross country payments for benefit transfers, joint ownership of infrastructure and projects, establishment of a benefit sharing fund, benefits sharing beyond the SWC and/or in kind benefits.

Table 5.11: Gross benefits of different types of projects

		Resource Allocations (Mm^3)				Benefits (Dollars)					
		C 1	**C 2**	**C 3**	**Total**	**C 1**	**C 2**	**C 3**	**Total**	**Net benefits**	**Inter country compensation required**
O	**Baseline situation**										
	Water use	250	175	50	475	395,000	215,000	735,000	1,345,000		
	Available after subsistence needs and environmental flows	1,774	388	594	2,756						
	Requirement for non-consumptive use	100	100	500							
	National quota for productive use	1,013	531	737	2,281						
A	**Upstream irrigation project in country 1**										
A.1	S 1 Irrigation project within margin and no effects on other countries in underutilised basin	1,000	175	50	1,225	970,000	215,000	735,000	1,920,000	575,000	0
A.2	S 2: Large scale up-stream irrigation project with downstream negative impacts but within the available margin	1,400	175	50	1,625	1,320,000	140,000	460,000	1,920,000	575,000	350,000
A.3	S 3: Large scale up-stream irrigation project with significant downstream negative impacts	1,650	175	50	1,875	1,445,000	115,000	285,000	1,845,000	500,000	550,000
B	**Upstream hydropower project and dam in country 1**				0						
B.1	S1Hydropower project within margin and no effects on other countries in underutilised basin	250	175	50	475	695,000	215,000	735,000	1,645,000	300,000	0
B.2	S2:Hydropower project with some adverse impacts on down stream countries	250	175	50	475	697,500	202,500	475,000	1,375,000	30,000	272,500

B.3	S3: large scale upstream hydropower project with significant downstream impacts	250	175	50	475	897,500	160,000	175,000	1,232,500	-112,500	615,000
C	**Inter-basin water transfer in country 2**										
C.1	S1: IBT within margin and no effects on other countries	250	375	50	675	395,000	415,000	735,000	1,545,000	200,000	0
C.2	S2: IBT within margin and modest adverse down stream effects	250	425	50	725	395,000	440,000	625,000	1,460,000	115,000	-110,000
C.3	S3: IBT with major adverse down stream impacts	250	475	50	775	395,000	505,000	470,000	1,370,000	25,000	-265,000

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Annex 1: List of consulted persons

Name	Organisation	Questionnaire	Interview
Dr A. R. Tombale	Diamond Hub, Coordinator, Botswana		✓
Mr. G. Gabaake	MMEWR, P.S., Botswana		✓
Mr. B. Paya	Mmaabula Energy Project, Coordinator. Okacom and LIMCOM, Commisssioner. Botswana		✓
Mr. C. Schaan	USAID, Regional NRM Programme Manager		✓
Ms P. Segomelo	DEA, Deputy Director, Botswana Okacom OBSC, Chairperson		✓
Ms T. Molefi-Mbui	DWA, Coordinator of International Waters Unit, Botswana		✓
Mr. F. Monggae	KCS, CEO, Botswana		✓
Ms B. Mosepele	HOORC, BIOKAVANGO Project, Botswana		✓
Dr N. Moleele	BIOKAVANGO Project, Coordinator, Botswana		✓
Dr S. Keitumetse	HOORC, Research Fellow, Cultural Tourism, Botswana		✓
Dr N. Kurugundla	DWA, Principal Water Resources officer, Botswana		✓
Prof D. Kgathi	HOORC, Livelihoods Unit, Botswana		✓
Dr Mmopelwa	HOORC, Livelihoods Unit, Botswana		✓
Dr L. Magole	HOORC, Research Fellow, Governance Unit, Botswana		✓
Dr E. Chonguica	OKACOM Secretariat, Executive Secretary		✓
Dr D. Mazvimavi	HOORC, Research Fellow, Hydrology Unit, Botswana		✓
Mr. I. Magole	BIOKAVANGO Project, Tourism Specialist, Botswana		✓
Mr. L. Thamae	ORASECOM, Executive Secretary, South Africa	✓	
Ms C. Roberts (and group of Namibian resource persons)	ERB-SADC Project, Coordinator, Namibia	✓	
Ms C. Machava	ARA-ZAMBEZI, Director General, Mozambique	✓	
Mr L. de Almeida	SADC Secretariat, Project Manager	✓	
Mr. E. M. Dlamini	KOBWA, Swaziland	✓	
Dr P. Wolski	HOORC, Research Fellow, Hydrology Unit, Botswana	✓	
Mr. M. Ives	Okavango Wilderness Safari Group	✓	
Mr P. Ramoeli	SADC-Water Division, SADC headquarters		✓
*Dr T. Magnusson	Swedish Embassy, Regional Coordinator, Mozambique	✓	
*Dr H. Vogel	GTZ	✓	
Mr. K. Msibi	SADC-Water Division, SADC headquarters	✓	✓
*Mr. C. Andrade	Ministry of Water and Energy, Angola	✓	
*Mr. C. Reeve	European Commission in South Africa, Attaché	✓	
*Mr. A.M. Gomes Da Silva	Water Affairs, Angola	✓	
*Mr. I Pinheiro	Ministry of Energy and Water, Angola	✓	
*Dr. A. Yamamoto	UNDP/GEF, South Africa	✓	

Note: *did not respond

Annex 2: Checklist and guide for interviews and discussions

A. Classification of SWC and scarcity

1. SWCs find themselves in different situations in terms of implementing resource allocation and benefit sharing arrangements of the Protocol. Which factors primarily determines these differences (and rank priority with 1 being the highest)?
    - Number of SWC countries: ………………………………………………………
    - Degree of water scarcity (e.g. acute, stress, no immediate shortage) ……
    - Other factors such as:
        - o ……………………………………………………………………………
        - o ……………………………………………………………………………
        - o ……………………………………………………………………………

2. Which data are required to characterise the differences between SWC water resources?
    a. Minimum (starting) set:

    b. Ideal set of data:

B. Understanding and operationalising key terms

2 What factors determine ***reasonable*** and ***equitable*** use?

Factor	Comment	Weight (out of 100)
Natural factors, incl. geography, hydrographical, climatic, ecological and other 'natural factors'		
Social, economic and environmental needs of the SWC States		
Population dependent on SWC in each SWC state		
Effects of water use from SWC in a state on other states		
Existing and potential uses of SWC		
Conservation, development, protection and economy of use of SWC		
Availability of alternatives of comparable value to a planned or existing use		
Other factors (specify)		

2 Which factors need to be taken into account to determine ***sustainable*** use and environmental protection (section 2 of the Protocol)?

Factor	Comment	Weight (out of 100)
Environmental flow requirements		
Environmental Reserve (e.g. South Africa)		
EIA and SEA requirements will take care of the ecological requirements		
Control of alien species		
Joint water quality objectives and standards		
Listing of banned subsistence		
Incorporation of internationally accepted rules and standards		
Other factors (specify)		

5. Which factors determine ***optimal*** use and what weight should be given to each?

Factor	Comment	Weight (out of 100)
Maximising economic production and benefits		
Maximising livelihood improvements		
Other factors (specify)		

6. What are ***alternative water sources of comparable value***?

Factor	Comment	Weight (out of 100)
Water demand management measures		
Re-use and recycling of treated effluent		
Greater use of groundwater		
Other measures		

7. Which data are needed for negotiating resource allocations and benefit sharing?

   a. minimum (starting) set:

   b. Ideal data set:

C. Resource allocation models and mechanisms

1. How important are 'rights' in determining water resource allocations? What about needs? How would you deal with prior rights?

2 Is there need for water re-allocation in the river basin?

Factor	Comment	Priority (1 = highest)
Between countries		

Between sectors		
Between the environment and society		
Between subsistence and commercial use		
Others ………		

4 How can resource allocation be improved?

Factor	Comment	Priority (1= highest)
Public allocation (licensing and permits)		
Demand prioritisation, including water reserve for basic human needs and ecological requirements)		
Trading in water rights		
Other mechanisms		
Use of tools such as:		
- water accounting		
- virtual water		
- water allocation formula		

5. Which data are needed to achieve equitable, reasonable, sustainable and optimal resource allocation?

8. Do you know good examples of successful resource allocation models? Please provide details and/or references.

9. What would be your preferred operational model for resource allocation?

D. Benefit sharing models and mechanisms

1. How are mitigation and compensation requirements in SWCs dealt with at present?

2. Which experiences of benefit sharing measures exist in the region? What are the lessons?

3. Which lessons can be learned from other parts of the world?

4. Which benefit sharing models can be taken to encourage benefit sharing for the following situations?

Factor	Comment	Priority (1= highest)
From one country to another		
From low value to		

high value uses (e.g. agriculture to tourism or industry);		
From subsistence to commercial users		
Other: ………		

5. Which data are needed to achieve reasonable, equitable, sustainable and optimal benefit sharing?

- Minimum (starting) set:
- Ideal data set:

6. What role should the RBO, national and local authorities play in implementing resource allocation and benefit sharing?

7. How should national policy and legislation provide for benefit sharing in order to ensure equitable allocation of benefits? How should harmonisation of national policies and legislation be achieved?

8. Is there a clear understanding of the benefits and costs of resource allocation and benefit sharing at the regional level? Do the perceptions of benefits change over time? And should benefit sharing mechanisms reflect these (e.g. in agreements)? For instance, the current power crisis might have in impact on how countries share resources and for what uses.

E. Environmental water requirements

1. Are there any empirical examples or benchmarks on ecological water requirements?

2. Which data are needed to in order to estimate and safeguard the environmental flow requirements (EFR)?

3. Which data are required to estimate ecological water requirements and/or EFR?

- Minimum (starting) set of data:
- Ideal data set:

Annex 3: Views on major concepts of the Protocol

Terms from the Protocol	Views from interviews and questionnaires
Reasonable and equitable use	All factors mentioned in art. 7 and 8 are important. Two different types of prioritisations emerged: 1. Priorities for needs and the environment; 2. Priority for natural factors that determine countries' contribution to the river flow Some argued that joint developments should be given priority (e.g. joint ownerships of dams or irrigation schemes)
Environmental needs	Environmental flows need to guide environmental needs. Environmental needs need to be addressed at the RB level. EIA, alien species and water quality management are considered to be critical issues too. While environmental needs may be relatively constant, social and economic needs put growing pressure on the SWC and these needs extend beyond the boundaries of the specific SWC.
Optimal use	Support for greater economic emphasis to boost development and regional integration through attracting investments
Cross border impact	Effect on water use in other states may be negative or positive. For negative ones, compensation and mitigation is required. Positive ones need to be boosted. Harnessing of water and responsible regulation can improve availability and mitigate the effects of droughts and floods.
Alternative water sources of comparable costs	Strong emphasis on implementing water demand management. Less emphasis on re-use of treated effluent, use of groundwater and use of other water sources (e.g. other rivers). Caution that WDM must be realistic and some scepticism about its potential.

Annex 4: Summary of Kilgour and Dinar's 'Flexible Water Allocation Rule'.

Kilgour and Dinar (2001) introduce the 'Flexible water allocation rule' as a new approach to the economic understanding of the allocation of total river water flows which enable the development of principles guaranteeing efficient (Pareto-optimal) allocations. They also assess the possibility of achieving efficient water allocations in practice, using flexible agreements. Kilgour and Dinar's formal model of water use and other transfers among countries within a river basin depends only on hydrological, geographic, and economic factors. They posit that analysis of the model leads to a characterisation of efficient allocations and to algorithms for finding them and determining the associated bargaining problem. One consequence is the concept of 'efficient schedule' of river allocation for every possible level of flow volumes.

The River Basin Model

This model focuses on the utilisation of river water and the transfer of other resources among the countries within a river basin. For instance, it allows a downstream country that needs more water to obtain it from an upstream country by compensating that country for using less water.

This model considers a number of aspects including; *water demand* (a country's water demand function, which treats the country as if it were a single decision maker, is an idealised way to measure its economic value for water). The demand function is assumed to be continuous, strictly increasing, and strictly positive. (The later assumption implies that additional water always has a positive value, which may be very small if consumption is very large.) The only information the model requires about a country's value for water is its water demand function. Note that different country's water consumption amounts, and water demand prices, must be measured in identical units. (Sometimes, countries have the option to meet their water demand by purchasing out-of-basin water.

A second component of a country's description is its *water contribution*. Assume that country *i*'s contribution to river flow volume is $Q_i$units per year. Note that one option available to country *i* is to consume $qi=Q_i$ units of water per year. If every country did this, then all river water would be consumed in the country that contributed it, and none would be transferred to other countries. The interest of this model lies in the possibility that some countries may consume less than their flow contributions, and other may consume more.

The third descriptor represents relevant geographical facts about the river basin. For each country, *i*, we require the list of countries, *up* (*i*), that are upstream from *i.* To analyse the most general river basin model, the logical structure of the up (·) lists must be utilised. E avoid this problem by considering only linear river, for which country 1 is the source country, any outflow from country 1 passes to country 2, then country 3, and so on to the outlet country. The identification of upstream countries is important because each country's maximum consumption equals its own flow contribution plus the flow contributions not consumed by upstream countries.

To complete the model of the interrelation of countries in the river basin, we now describe all transfers among them other than water. We model these as simple money transfers. Specifically, each country, *i*, receives an amount *xi,* from the pool, then country *i* is a net beneficiary of non-water transfers, and if *xi*< 0, then country *i* is a net beneficiary of non-water transfers. Viewing transfers as payment for foregone consumption of water, we require that all transfers balance, i.e.

$$\sum_h x_h = x_1+x_2+\ldots+x_n=0$$

The purpose of the model of money transfers is to allow a country to compensate upstream countries for passing water on to it. Note that pairs of countries may make individual deals- the quantity x_1 is simply the net amount, counting receipts as positive and payments as negative, that *i* receives from all other riparian countries.

Annex 5: Example of water accounts: Botswana water accounts and water accounts for the Orange River

The text in this annex is heavily based on one of the case studies contained in Department of Environmental Affairs (2008). The case study book was prepared by the Centre for Applied Research (www.car.org.bw) and the Department of Environmental Affairs (www.envirobotswana.gov.bw).

This annex discusses Botswana's water accounts in details but also refers to findings of a draft report of water accounts for the Orange River (section 5.2).

1. Introduction

Natural resources accounting (NRA) is a system that emerged in the 1970s and expands the national accounts by incorporating environmental concerns into macroeconomic planning and hence providing a better measure of sustainable development. Botswana along most countries uses a standard United Nations system of National Accounts (NA) to record and monitor economic performance. However, this system has several environmental shortcomings that the natural resources accounts try to correct and these are outlined below. National accounts:

- Do not recognise natural resources as capital or development assets
- Pay little attention to the possibilities of natural resources scarcities;
- Do not reflect the impacts of environmental degradation and natural resources depletion;
- Add pollution abatement costs as income while it should be deducted as the cost of mitigation measures to retain welfare levels.

Natural resources accounts record the stocks, changes in stocks of natural resources as well as the annual use of these resources. The ultimate goals of NRA are therefore to develop a system of accounts that can reflect more changes in the status, uses and roles of natural resources and the environment in terms of their possible effect on economic planning and sustainable development. NRA further provides a set of aggregate indicators for monitoring changes in wealth and welfare status of an economy.

NRA can be developed for a variety of natural resources including, water, forests, wildlife, minerals and livestock among others. NRA has been adopted in several countries globally. In southern Africa, countries are also moving towards the NRA direction (Table 1).

Table 1: Countries that have constructed natural resources accounts

	Minerals	Fisheries	Water	Wastewater	Land/land degradation	Forests
South Africa	X	X	X			X
Namibia	X	X	X		partial	partial
Swaziland						partial
Tanzania	X	X	X			X
Botswana	X		X	X		

Water accounts are increasingly being recognised as an integrated water resources management (IWRM) planning tool. The accounts recognise the economic value of water and capture the stocks, uses and efficiency the resource use. Moreover, this is a tool that can help contribute to the attainment of several global agenda such as the 2002 World Summit on Sustainable Development which recognises water as a vital resource for environmental, economic and social concerns hence emphasis on efficiency in the use of water.

2 Botswana background

Botswana is a semi arid country with limited water resources. Surface water resources are mostly found in the north and the perennial rivers are shared with neighbouring countries hence their utilisation and management are subject to the Southern African Development Community (SADC) Protocol on Shared Water Courses. The western part of the country does not have surface water and mostly rely on groundwater which is very scarce. The total annual runoff of surface water is about 696 million $m^{3.}$ There is high variability of runoff and the rate of evaporation is also high. There are about ninety-four reservoirs/ dams of which ninety-four percent of them are used for agricultural purposes. Five large dams are operated by the Water Utilities Corporation (WUC) and these supply urban and peri-urban areas. The storage capacity of these dams is about 354 million m^3 and account for more than 90% of the total dam storage capacity. The Department of Water Affairs operates one medium sized reservoir with highly variable yields and water levels. Evaporation rates are high and exceed the consumption of water and this poses a lot of problems for the sustainability of water utilisation. Information about the five major dams in the country is presented in Table 2.

Table 2: Botswana's major dams

Dam	Capacity Mm^3	Hydrologically sustainable yields (Mm^3) BNWMP	Sustainable Yields (Mm^3) WUC estimates	Mean annual runoff (Mm^3)
Gaborone	144.2	7	10	31
Letsibogo	104	16	20	57
Nywane	2.3	0.3	0.3	1.9
Bokaa	18.5	0.1	1.1	9
Shashe	85.3	22	40	84
Total	354.3	45.3	70.3	173.9

Sources: SMEC *et al,* 1991; WUC Annual Reports and WUC files

Groundwater resources are very limited in quantity and quality and the distribution of these resources is highly uneven. Most groundwater resources are found in eastern parts of the country and they are very limited in western and northern Botswana. In the latter areas, the water is often saline. Groundwater sources supply most rural areas as well as the mining and the livestock sectors. There have been concerns about the depletion of the resources in mining areas and around settlements.

Wastewater is mostly produced in urban areas. In 2002, the inflow into and outflow from the WWTWs was about 24.5Mm^3 and 12.3Mm^3 respectively. Currently, only twenty percent of the outflow is being re-used mostly for irrigation purposes and a significant amount is lost in the treatment system due to evaporation.

3 Framework of the accounts

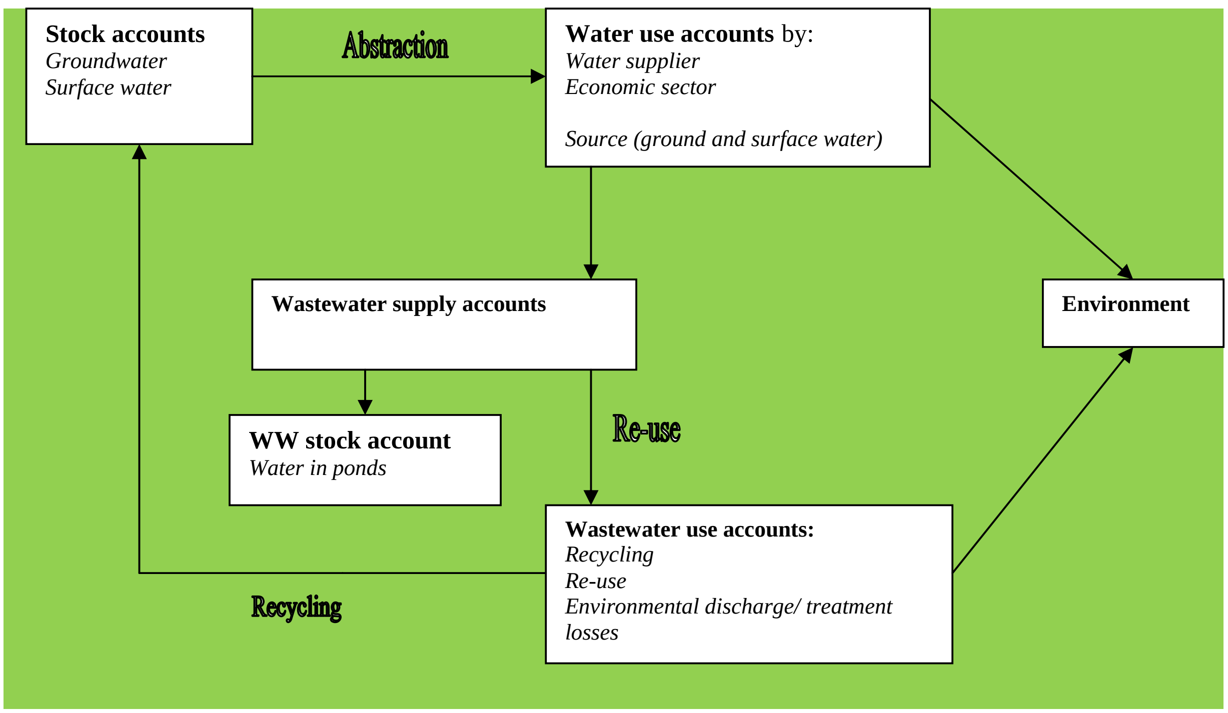
The water accounts adopt a model of the UN System of Integrated Environmental and Economic Accounting (SEEA). The SEEA has the following objectives:

- To mainstream resource issues into economic decision making;
- Evaluation of resource impacts of development on the environment; and
- Evaluation of impacts of environmental policies on the economy.

The system of SEEA accounts distinguishes stocks, flow and water quality accounts. The Botswana accounts have been developed for stocks, use and wastewater. These are expressed in mostly in physical terms. The accounts cover period 1990 to 2003.

The freshwater and wastewater accounts are interlinked as shown in Figure 1. Firstly, water is abstracted from the stocks and used in different sectors (use account). The water uses generate wastewater which is collected in WWTWs or discharged into the environment. Secondly, outflows from the WWTWs is reused, recycled or discharged into the environment.

Figure 1: Linkages of the accounts



3.1 Freshwater accounts

Stock accounts

These indicate the amount of water available at the beginning of the year, inflows and outflows during the year and the end stock. The accounts refer to water stored in reservoirs/dams (Environmental Asset -EA. 1311), water in lakes (EA.1312)' water in rivers and streams (EA.1313) and EA 132 for groundwater resources. The accounts were constructed for the country's main reservoirs. A typical stock account framework is outlined as in Table 3.

Table 3: Framework of the surface water stock account

	1990	1991	1992…….
Opening volume	…..	…...	…...
Inflows(+)	……	…...	…...
Abstraction(-)	…...	…...	…...
Evaporation(-)	…...	…...	…...
Closing volume	…...	…...	…...

Sub-accounts have not been finalised for groundwater resources due to data limitations and consequently the incomplete accounts are less informative for policy makers than the surface water accounts. The opening and closing volumes of well fields are not known as well as the amounts of groundwater that can be economically abstracted. Moreover, the recharge rates are not adequately known. However, incomplete groundwater stock accounts were presented. The accounts are restricted to developed groundwater resources such as well fields and individual boreholes.

Use or flow accounts
The use or flow accounts measure the flow of water between the economy and the environment, and within the economy between water suppliers and end users. The former involves the abstraction of water from natural resources and the return of the water after use to the environment. Water use within the economy indicates the supply of water from one economic sector to the other. These are shown by institutional source of water used by each sector.

3.2 Wastewater accounts

Three types of accounts have been constructed: wastewater stock account, wastewater supply account and wastewater use account:

a. The wastewater stock account indicates the amount of wastewater stored in WWTWs. The account shows how much wastewater is stored at the beginning and the end of each year, and the inflows and outflows that have occurred.
b. The wastewater supply account indicates the sources of wastewater, that is, domestic use, business, and government. Disposal of wastewater may take place onsite, off-site or through the sewerage system. The account is restricted to wastewater treated in the WWTWs.
c. Wastewater use account shows how wastewater is being used. Four uses have been distinguished: 1. treatment losses; 2. discharge in the environment; 3. re-use and 4. recycling. Re-use is the productive or consumptive use of wastewater while recycling involves upgrading treated wastewater to potable water. Total wastewater use is equal to wastewater supply.

3.3 Monetary accounts

Monetary accounts are incomplete primarily due to data constraints. Portions of relevant economic aspects of water management are discussed and these include: water supply costs, pricing, wastewater treatment costs, efficiency of water allocation and efficiency of water use by sector as well as the benefits of reuse and recycling of treated wastewater.

4 Method and structure

4.1 Stock accounts

4.1.1 Surface water stock account

WUC records the volume of water stored in dams as well as abstraction. However, the aggregate inflows are not recorded. Evaporation rates are also available for each dam.

- The annual evaporation was estimated as the evaporation rate for each dam multiplied by the (opening + *closing volume)*.
- Inflow was estimated as *(closing volume + abstraction + evaporation – opening volume).*Ideally, inflow should be separated into natural inflow and inflow from other dams (transfers) including inflow from treated wastewater that is recycled.
- Abstraction should be divided into abstraction for treatment and distribution and transfers into other dams.

Aggregate stock accounts (simplified version) could only be compiled for 2001 to 2003. The accounts are incomplete for most of the years in the stipulated period of 1990-2003 due to data constraints. For the dams managed by DWA, a stock account was constructed for one dam for the period 1990 to 2003.

4.1.2 Groundwater stock accounts

The groundwater stock accounts should cover the opening stock of aquifers, add the annual recharge and subtract the annual abstraction which leads to the closing stock at the end of the year. However, a sub account was constructed for each well field using DWA WELLMON data recharge estimates. The aggregate of all well fields was then used on the overall groundwater stock account. Estimates for the aggregate abstraction of individual borehole are also contained in the account but are also incomplete.

4.2 Use accounts

The use accounts cover a period of 1990-2003. Data was obtained from the WUC, DWA, DCs and self providers. The accounts are constructed by institution, source and sector. Due to data insufficiencies and inconsistencies, averages and scaling up/down factors were used. Intermediate consumption could not be separated from final consumption.

For the agricultural sector, water use was estimated by multiplying the number of livestock by the daily water use of cattle, goats and sheep (45, 4.5 and 4.5 litres per day respectively). Table 4 indicates the daily and annual water requirements per head of livestock. It was assumed that, since the irrigation sector is small and stagnant, consumption was constant for the last twenty years; therefore the 1991 water consumption for irrigation provided by the National Water Master Plan of 1991 was used for the accounts' period.

Table 4: Water requirements per head of livestock

	Daily (litres)	Annual (m^3)
Cattle	50	18.25
Goats	5	1.825
Sheep	5	1.825
Donkeys	20	7.3

Source: NCSA and CSO, 2001 in Lange and Hassan, 2006

4.3 Wastewater accounts

For the stock account, only a fraction of wastewater is stored mainly in ponds and temporarily pending maturation and discharge. The stock is therefore negligible hence the wastewater stock account is less important than the supply account.

4.3.1 Wastewater supply accounts

The inflows and wastewater losses are measured from the supply accounts. It is also assumed that wastewater storage is the same at the beginning of the year and at the end of the year and this is determined by the capacity of the ponds. Capacity data was obtained from WWTWs files.
As already indicated, wastewater may be disposed on-site, off-site or through the sewerage system.

Onsite wastewater disposal should not be included in the accounts (this is a recommendation of the SEEA). The account is restricted to wastewater that is returned to WWTW as these flows can be re-used or recycled and can be transferred between economic sectors. Off-site wastewater disposal should be included but, this could not be done due to lack of data. The account is constructed for individual WWTW and then for the whole country by aggregating the individual WWTWs.

The amount of wastewater received at the WWTWs is estimated based on the water consumption of the categories mentioned earlier and the effluent generation fraction (EGF) or return percentages used in the NMPWWS:

- Households: 80% of the water consumption of those connected to the sewerage system enters the sewerage system (EGF is 0.8);
- Business: 55% (0.55) enters the sewerage system; and
- Government: 65% (0.65) enters the sewerage.

Wastewater supply is estimated by multiplying the actual water consumption (derived from WUC and DWA) by the EGF indicated above.

- For *domestic use*: wastewater supply is estimated by multiplying the domestic water consumption from standpipes, yard and house connections by the EGF. It is assumed that no water from standpipes and yard connections enters the sewerage system and WWTWs.
- For the government, wastewater supply is water consumption by government multiplied by EGF of 0.65.It is assumed that all government departments are connected to the sewerage system and WWTWs. For 1998-2002, it was assumed that government consumption in Gaborone is the average share for 1990-1997 (0.9153).
- For industries/business, wastewater supply equals water consumption of the sector multiplied by EGF of 0.55. The assumptions are the same as for the government sector.

4.3.2 Wastewater use account

Four main destinations of wastewater are distinguished. Data on inflows, outflows, quality, re-use and recycling were incomplete. Therefore, some data from the National Asset Register (NAR) have been used for 2001/02 and fieldwork was carried out at five WWTWs (Gaborone, Jwaneng, Selebi-Phikwe, Francistown and Lobatse).

4.4 Monetary accounts

For the monetary aspects of the water accounts, the physical units are multiplied by monetary units to get insights into the value associated with water. Ideally, the accounts require the assessment of economic rent of water or the water supply costs. The water suppliers' data on the costs was incomplete and this prevented the development of full monetary accounts. Economic aspects of water use and management were assessed. This included water use efficiency, allocative efficiency and benefits of wastewater reuse and recycling. Two indicators are used to estimate use efficiency being value added per m^3 and employment per $m^{3.}$

5 Results of water accounts

5.1 Botswana water accounts

5.1.1 Stock accounts

Surface water sub account

The amount of water stored in reservoirs is limited due to the shallow nature of the resources and consequent high evaporation. The aggregate storage capacity of the major dams is $354Mm^3$ but their sustainable yield is only twenty percent of the capacity. The stock account shows that the abstraction is more than the sustainable yields for the period 2001 to 2003 (Table 5). The account indicates that the major dams are under high pressure as shown by the decrease in the amount of water stored in 2003.

Table 5: Fresh water (reservoir) stock account for the all WUC dams (Mm^3)

	2001	2002	2003
Opening volume	289	319	235
Inflows	277	142	149
Abstraction	174	159	79
Evaporation	72	66	60
Closing volume	320	236	245

Source: DEA and CAR, 2006

Groundwater sub accounts

The accounts are incomplete due to data imitations. The account is presented below for 1992, 1995 and 2001 (Table 6). In most well fields, abstraction exceeds recharge rates, indicative of non-sustainable use of a renewable resource. However, without the opening volumes, it is not possible to state the lifetime of the resource. This will cause problems in future as most rural areas and the mining sector rely heavily on these resources.

Table 6: Ground water stock account (Mm^3)

		1992	1995	2001
I.	**Opening volume well fields**	Unknown	Unknown	Unknown
	Abstraction	46.3	49.8	55.7
	Recharge	15.5	15.5	15.5
	Other changes to volume of reserves	Unknown	Unknown	Unknown
	Closing volume	Unknown	Unknown	Unknown
II.	**Opening volume individual boreholes**	Unknown	Unknown	Unknown

	Abstraction	42.1	42.6	39.7
	Recharge	Likely to exceed abstraction	Likely to exceed abstraction	Likely to exceed abstraction
	Other changes to volume of reserves	Unknown	Unknown	Unknown
	Closing volume	Unknown	Unknown	Unknown
III.	**Opening volume total developed groundwater**	Unknown	Unknown	Unknown
	Abstraction	88.4	92.4	95.4
	Recharge	At least 57.6	At least 58.1	At least 55.2
	Other changes to volume of reserves	Unknown	Unknown	Unknown
	Closing volume	Unknown	Unknown	Unknown

Note: I plus II equals III.

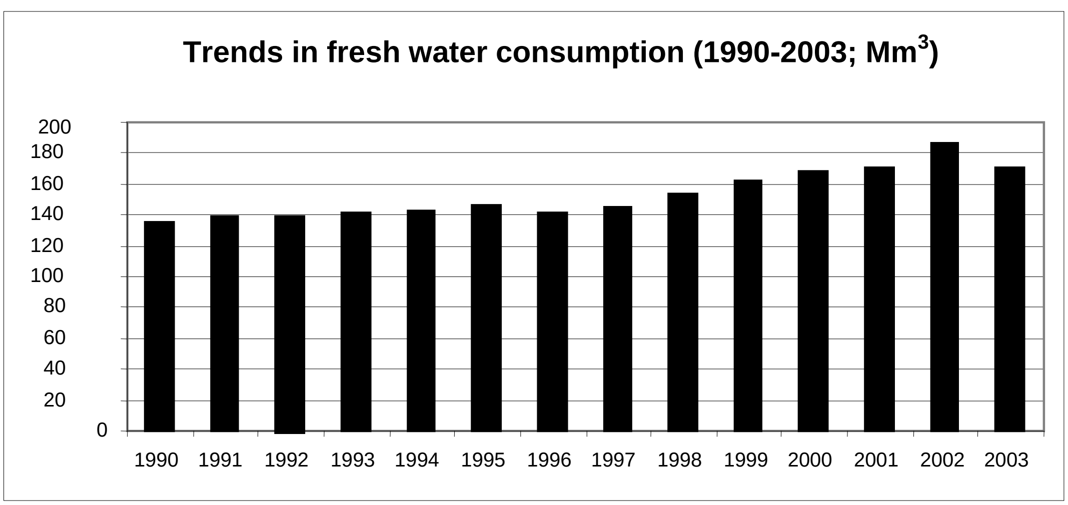
Wastewater sub account

Wastewater stocks are relatively small as only a portion is stored mostly in ponds and this makes the accounts far less important than the wastewater supply accounts. Gaborone and Lobatse ponds had a capacity of 1.5 Mm³. Assuming that this is the same for the other WWTWs, the total amount of stored waste water could be around 3Mm³, a figure that is far less than the amount of stored surface water and groundwater resources.

5.1.2 Water use accounts

The general trend in the consumption of water is illustrated in Figure 2. The figure shows that aggregate water consumption has increased from 140Mm³ in 1990 to 170Mm³ in 2003.However, this is lower than what the BNWMP of 1991 predicted. In the 1990s consumption had increased mainly due to the mining boom but this however levelled off in the early 2000s. By category of institutions, self providers account for the largest share in the consumption of water followed by WUC, DCs and DWA.

Figure 2: Trends in water consumption in Mm³ (1990-2003)



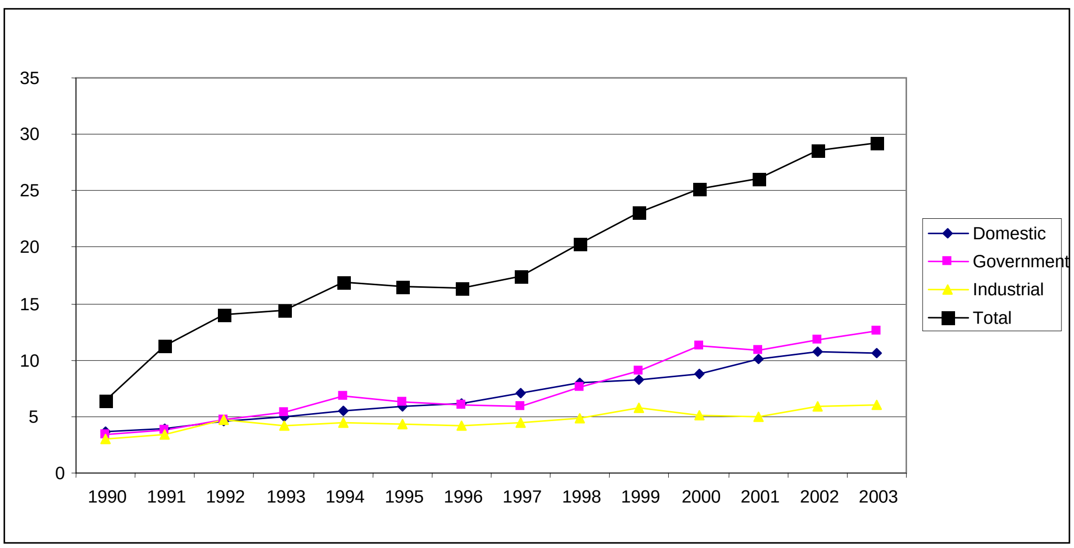
The accounts indicate that water consumption has increased much faster in urban areas than in rural areas. Agricultural and household sectors are the largest water users accounting for 63.4Mm³ and 56.9Mm³ respectively. This is illustrated in Table 7. The mining sector has the fastest growth in water consumption followed by households and government.

Table 7: Water use by economic sector (Mm³) for selected years

User category	1992	1996	2000	2003
Agriculture	72.9	70.6	76	63.4
Mining	12.8	14.4	24.1	26.8
Manufacturing	3.9	2.1	4	5.1
Water + electricity	0	0.8	0.5	0.7
Construction	0	0.4	0.4	0.4
Trade	0.2	0.7	1	1.2
Hotels and restaurants	0.2	0.5	0.8	0.8
Transport and communication	0	0.2	0.2	0.3
Insurance, banking, business	0	0.5	0.7	0.8
Social and personal services	0	1.2	1.7	2.4
Government	8.7	8.8	11.1	11.5
Household use	36.1	41.1	48.1	56.9
WUC private sector	7.7	0	0	0
Total	142.5	141.3	168.6	170.3

Wastewater supply account
The estimated wastewater supply account by main category is presented in Figure 3.

Figure 3: Wastewater supply to WWTWs (1990-2003; Mm³)



The accounts illustrate that the supply of wastewater more than doubled in the period 1990-2003 and thus the 'resource' is growing much faster than water consumption primarily due to improved sewerage systems. The total amount of wastewater received in WWTWs amounted to 14.8 Mm³ compared to 29.2 Mm³ in 2003. This is equivalent to about seventeen percent of total water consumption.

Wastewater use account
Wastewater use covers treatment losses, re-use, recycling and environmental discharges. The use account is equal to the supply account. Table 8 shows the main wastewater

destinations for 1992, 1997 and 2003. Processing losses in WWTWs and discharges into the environment are most significant. These account for about 90% of wastewater supply. Discharges into the environment are important for vegetation and groundwater recharge and downstream economic activities such as agriculture. However, they may be hazardous for the environment and people's health if the discharge is of poor quality. Recycling is zero and re-use is increasing but remains low as percentage of the outflow. Reuse grew from 0.9Mm³ in 1992 to 1.6Mm³ in 2003; an increase of 83.3% in a decade. Irrigation and landscaping are the main destinations of re-use.

Table 8: Main destination of wastewater for selected years (as % of total inflow)

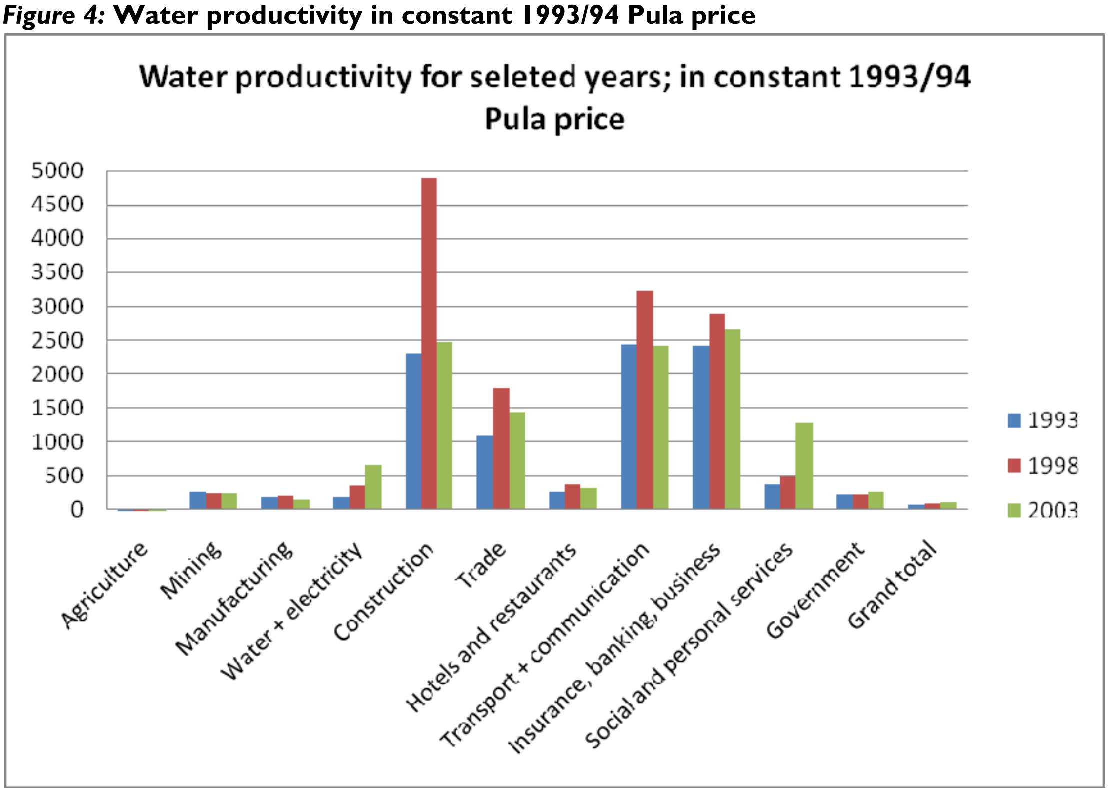
Wastewater destination	1992	1997	2003
Processing losses	43.7	43.0	42.2
Re-use	6.5	6.4	10.8
Recycling	0.0	0.0	0.0
Environmental discharge	49.8	50.6	47.0
Total use of WW	100.0	100.0	100.0

5.1.3 *Monetary accounts*

The monetary accounts could not be developed due to data inadequacies. Instead, results have focused on estimating water use efficiency.

The estimates for value added per m³ are presented in Figure 4. Value added per m³ is highest in the service, construction and transport sectors (over P1000/m³). It is lower in the manufacturing industry, mining and government and by far the lowest in the agricultural sectors. The estimates indicate that water use efficiency has increased in time to an average of P106/m³.

Figure 4: **Water productivity in constant 1993/94 Pula price**



In terms of employment, in 2003, an average of close to 2 800 paid jobs were generated for each Mm^3. The largest number of jobs are created in the service sectors (about 20 to 5 000 per Mm3), while the public sector generates around 25 000 jobs per Mm^3. Paid employment per Mm^3 is lower in the industry, mining and agriculture. The latter mostly creates jobs for self employment of farmers and informal employment. If these were included, water efficiency would be over 1 500 jobs per Mm^3.

Benefits of wastewater re-use
Three types of potential benefits from re-use and recycling are distinguished:

- Postponement of additional supply schemes e.g. 2^{nd} phase of NSWC- deferment by five years would lead to savings of about P500 million over a five year period;
- Benefits derived from the use of saved water ; and
- Lower water tariffs would enhance competitiveness and savings for households e.g. in Namibia, reclamation costs are equal to bulk water supply costs from Namwater (N$2.40).

To derive maximum economic benefits from re-use and recycling, a combination of re-use destinations should be considered. An example is shown in Table 9. The gross benefits total P925million per annum. Employment could be as around 40 000 paid jobs assuming the employment rate is 2 800 per Mm^3.

Table 9: Possible direct gross economic benefits of a composite re-use scenario

Destination	Designated re-use amount Mm^3)	Value added / m^3 (93/94 P/m^3)	Directly associated value added of re-use (M Pula 93/94 prices)	Possible associated paid employment
Irrigated agriculture	8.0	20	160	50 - 500
Construction	0.2	2 468	494	7 000 - 12 000
Government	1.0	271	271	20 000- 25 000
Domestic use	5.3	0	None	
Total	14.5		925	Around 40 000

Source: Arntzen *et al*, 2006

5.2 Regional water accounts for the Orange River

The water accounts for this river basin were constructed in 2001 by Connigarth Economic Consultants. This text is based on their draft report. Data for the accounts was mostly sourced from national water accounts of each country (except Lesotho). The accounts include water supply and use as well as the ecological requirements. Furthermore, water productivity in terms of value added has been estimated. The monetary accounts for the costs of supply could not be constructed because only two out of the four countries had national water accounts encompassing monetary accounts.

Water supply has been calculated as:

Local water management area (WMA) yield which is the sum of (a*nnual runoff + storage+ groundwater yield + return flows) + transfers from other WMAs.*

Water use = *all economic uses+ water requirements for industry and households+ transfers out to other WMAs + ecological uses and losses.*

The water supply account indicates the relative contribution of each country to total supply. The results indicate that South Africa is the largest contributor at 64% of total supply, Lesotho contributes 34% and Namibia and Botswana collectively make a contribution of 2% (Table 10).

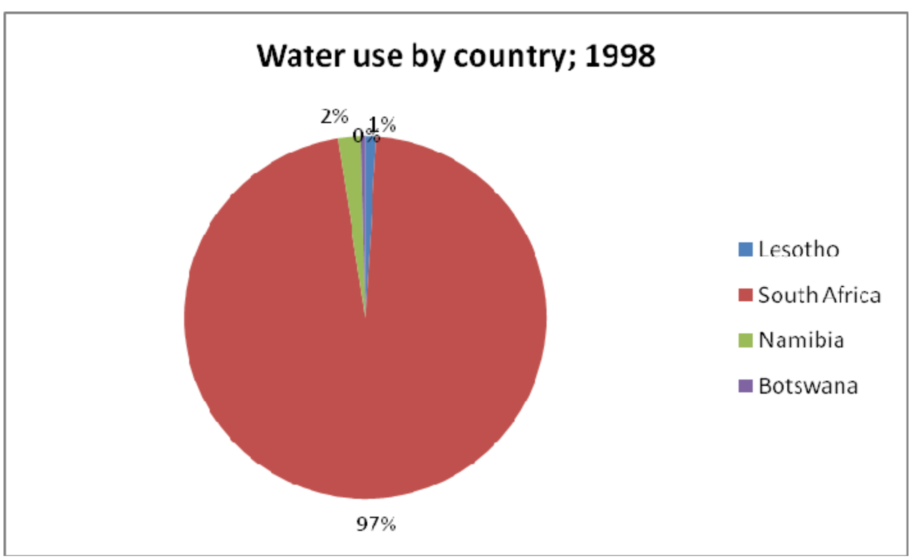
Table 10: Water supply in the Orange River basin, 2000 in Mm³.

	Lesotho	South Africa		Namibia	Botswana	Total
		Upper Orange	Lower Orange			
Water supply=	4768	5798	3177	294	56	14,093
Net annual runoff +storage	4765	5660	1014	281	51	11,771
+Groundwater	1	65	24	13	5	108
+ Usable return flows	2	71	97	N/A	N/A	170
Sub total	4768	5796	1135	294	56	12,049
+ Transfers in from other WMA	0	2	2035	0	0	2,037
Share of total supply by country	34%	41%	23%	2%	Less than 1%	100%

Note: N/A means not available
Source: Lange *et al*, 2007.

In terms of water use, South Africa accounts for the largest amount (97%) of total water use, Lesotho and Namibia use 1% and 2% respectively while Botswana accounts for less than 1% of total use (Figure 5). Lesotho supplies a lot but uses little of total water from the river basin.

Figure 5: Water use by country



Sectorally, agriculture dominates water use in most countries except for Lesotho where the industrial sector and domestic uses account for the largest use of water. Transfers out of the river basin into other WMAs account for a significant share of total water use (56%). For South Africa, in the lower river basin, about 3,148Mm^3 of water is transferred to other WMAs.

In terms of water productivity, the value added per cubic meter of water from the river basin was estimated at around R21million or 2.7% of the countries' GDP. The share of each country is as follows: Botswana – 4%, Namibia – 19.3%, Lesotho – 20.3% and South Africa – 56.4%. Despite agriculture being the main recipient of water, its value added per m^3 is the lowest.

4.1.9 Discussions

The Botswana and orange case studies show that water accounts can be constructed, mostly in an incremental manner. It is most suitable to start with the priority issues and accounts, for which data exist or can be constructed. Later on, accounts can be added such as wastewater accounts in Botswana.

Water accounting is a tool that can be used to enhance the resource use efficiency and reduce resource wastage, thus contributing to the achievement of IWRM objectives. The Botswana National Master Plan recognises that the nations' water resources must be monitored and accounted for hence the need for NRA. The plan highlights that NRA can help counterbalance a number of difficulties on the path to the sustainable utilisation and management of the water resource. "The accounts monitor the levels of the resource, the value of the resource to the country, consumption and investment level and therefore could lead to an evaluation of an agreed definition of sustainability", pp.24 (SMEC, 2006).

It is optimal to construct monetary accounts since they provide a comprehensive economic view on the utilisation and management of water. Current estimates for value added per unit of water as well as employment unit of water are useful for improving the efficiency of water allocations. Value added per m^3 is highest in the service, construction and transport and very low in the agricultural sector despite its high utilisation of the resource. Re-use and recycling of wastewater would lead to deferment of construction of large water schemes, water savings and lower water tariffs which would lead to increased savings for domestic households and also enhance Botswana's competitiveness.

Water accounting is a tool that can be used to enhance the resource use efficiency and reduce resource wastage, thus contributing to the achievement of IWRM objectives. The Botswana National Master Plan recognises that the nations' water resources must be monitored and accounted for hence the need for NRA. The plan highlights that NRA can help counterbalance a number of difficulties on the path to the sustainable utilisation and management of the water resource. "The accounts monitor the levels of the resource, the value of the resource to the country, consumption and investment level and therefore could lead to an evaluation of an agreed definition of sustainability", pp.24 (SMEC, 2006).

Water use efficiency is critical for ensuring sustainability in the utilisation of the water resource. All water users therefore need to treat water as an economic good and use it efficiently. The level of investments into efficient use by the private sector should be substantial given that they utilise considerable amounts of water in their operations.

Several messages for policy are outlined in the box below based on the findings of the accounts:

- Water allocation needs to be based on allocative efficiency and optimal resource allocation;
- Water users need to use water efficiently;
- Water providers need to cut water losses;
- Re-use and recycling have several benefits including deferment of large additional water supply schemes and extra production with saved water;
- Costs of advanced treatment technologies can be earned back by re-using and recycling wastewater;
- The choice of technology used will determine the amount of outflow from the WWTWs, for instance, although the pond system is cheap, the resource is lost through evaporation. Therefore, investments should be put in better technologies.
- There is potential to use NRA for allocation of shared water such as the Okavango River.

Annex 4: River Basins in Southern Africa

Zambezi River Basin

	Angola	Namibia	Botswana	Zimbabwe	Zambia	Malawi	DRC	Tanzania	Mozambique	Total
Baseline data RB	11%	2%	6%	19%	41%	8%		2%	11%	
Basin area (km)	252,600 (18%)	21,000 (2%)	21,400 (2%)	224,000 (16%)	574,000 (41%)	112,100 (8%)		28,000 (2%)	168,000 (12%)	1,570,000
river length (km)										2,650
MAR (Mm3/a)										94,000
Evapotranspiration (km^3)										1,100
Rainfall (km^3)										1,200
Water transfer schemes?										
no of dams				25	5	1			1	
dam capacity (in Mm3)				161,865	167,920				52,000	
dam surface area				5,322	6,274				2,660	
Socioeconomic data										
Population				11,136,000	8,448,000					38,400,000
Agricultural GDP in RB										
Industrial GDP in RB										
Mining GDP in RB										10
Traditional sector GDP in RB										
Commercial sector GDP in RB										
SWC dependent livelihood sources										
SWC dependent commercial activities										
Water abstraction (in m^3)										
for agriculture										1,500,000,000

for domestic use										
for industrial use										
for mining										
For hydro-electric power production										
other uses										
total water abstraction										
Navigational use										
Environmental use										
Institutional set up										
RBO established??	2004									
RB agreement??										
Key national institutions	5	4	3	5	4	3			3	27

Orange- Senqu River Basin

		Lesotho	South Africa	Botswana	Namibia	Total	Notes
I	**Baseline data RB**	4%	60%	25%	11%		
	basin area (km)	30,000	600,000	120,000	250,000	1,000,000	896,368
	river length (km)					2,300	
	MAR (Mm3/a)					11,500	11,500,000,000
	Evapotranspiration					1,100	
	Rainfall					average 330 (50-2000)	Av 325
	Water transfer schemes?						
	no of dams	2	24		5		
	dam capacity (in Mm3)	2,910	17,050		452		
	dam surface area (Km^2)	35.8	2,179		47.4		
II	**Socioeconomic data**						
	Population					19,000,000	
	Agricultural GDP in RB						
	Industrial GDP in RB						
	Mining GDP in RB						
	Traditional sector GDP in RB						
	Commercial sector GDP in RB						
	SWC dependent livelihood sources						
	SWC dependent commercial activities						
III	**Water abstraction (in Mm3)**						
	for agriculture					$4.16km^3/yr$ (64%)	
	for domestic use					$1.89km^3/yr$ (29%)	
	for industrial use						
	for mining					$0.46km^3/yr$ (7%)	
	irrigation potential 390,000ha					3%	
	Irrgation 313, 000ha						
	other uses						
	total water abstraction					$6.5km^3/yr$	
	Navigational use						
	Environmental use						
IV.	**institutional set up**						
	RBO established??					Nov-2000	ORASECOM
	RB agreement??						Yes
	Key national institutions						Departments of Water Affairs

Limpopo River Basin

		Botswana	South Africa	Zimbabwe	Mozambique	Total
I	**Baseline data RB**					
	basin area (km)					415,000
	river length (km)					1,750
	MAR (Mm3/a)					5,500
	Evapotranspiration					
	Rainfall					
	Water transfer schemes?					
	no of dams	4	26	13	1	
	dam capacity (in Mm3)	349	1,891	1,028		
	dam surface area		205.2	123.4		
II	**Socioeconomic data**					
	Population					
	Agricultural GDP in RB					
	Industrial GDP in RB					
	Mining GDP in RB					
	Traditional sector GDP in RB					
	Commercial sector GDP in RB					
	SWC dependent livelihood sources					
	SWC dependent commercial activities					
III	**Water abstraction (in Mm3)**					
	for agriculture					
	for domestic use					
	for industrial use					
	for mining					
	other uses					
	total water abstraction					
	Navigational use					
	Environmental use					
IV.	**institutional set up**					
	RBO established??					
	RB agreement??					
	Key national institutions					

Okavango River Basin

	Angola	Namibia	Zimbabwe	Botswana	Total	Notes
Baseline data RB						
basin area (km)	150,100	176,200	22,600	358,000	706,900	192,500
river length (km)				100	1,900	
MAR (Mm3/a)				11, 650	11,000	11,000,000,000
Evapotranspiration				94		
Rainfall				501mm/a		
Water transfer schemes?						
no of dams	0	0		0		
dam capacity (in Mm3)						
dam surface area						
Socioeconomic data						
Population	350,000 (58%)	163,000 (27%)		88,000 (15%)	600,000	
Agricultural GDP in RB						
Industrial GDP in RB						
Mining GDP in RB						
Traditional sector GDP in RB						
Commercial sector GDP in RB						
SWC dependent livelihood sources						
SWC dependent commercial activities						
Water abstraction (in Mm3)		0.20%		0.10%		
for agriculture						
for domestic use						
for industrial use						
for mining						
other uses						
total water abstraction						
Navigational use						
Environmental use						
Institutional set up						
RBO established??	1994					
RB agreement??	OKACOM					
Key national institutions		DWA		DWA	OKASEC	

Congo River basin

		Angola	Burundi	Rrwanda	CAR	Tanzania	Cameroon	Congo	Zaire	Zambia	Total
I	**Baseline data RB**										
	basin area (km)										3,800,000
	river length (km)										4,700
	MAR (Mm3/a)										1,260,000
	Evapotranspiration										
	Rainfall										
	Water transfer schemes?										
	no of dams										
	dam capacity (in Mm3)										
	dam surface area										
II	**Socioeconomic data**										
	Population										
	Agricultural GDP in RB										
	Industrial GDP in RB										
	Mining GDP in RB										
	Traditional sector GDP in RB										
	Commercial sector GDP in RB										
	SWC dependent livelihood sources										
	SWC dependent commercial activities										
III	**Water abstraction (in Mm3)**										
	for agriculture										
	for domestic use										
	for industrial use										
	for mining										
	other uses										

	total water abstraction										
	Navigational use										
	Environmental use										
IV.	**Institutional set up**										
	RBO established??										
	RB agreement??										
	Key national institutions										

Buzi River Basin

		Zimbabwe	Mozambique	Total
I	**Baseline data RB**			
	basin area (km)			31,000
	river length (km)			250
	MAR (Mm3/a)			2,500
	Evapotranspiration			
	Rainfall			
	Water transfer schemes?			
	no of dams			
	dam capacity (in Mm3)			
	dam surface area			
II	**Socioeconomic data**			
	Population			
	Agricultural GDP in RB			
	Industrial GDP in RB			
	Mining GDP in RB			
	Traditional sector GDP in RB			
	Commercial sector GDP in RB			
	SWC dependent livelihood sources			
	SWC dependent commercial activities			
III	**Water abstraction (in Mm3)**			
	for agriculture			
	for domestic use			
	for industrial use			
	for mining			
	other uses			
	total water abstraction			
	Navigational use			
	Environmental use			
IV.	**institutional set up**			
	RBO established??			
	RB agreement??			
	Key national institutions			

Cunene River Basin

		Angola	Namibia	Total	Notes
I	**Baseline data RB**				
	basin area (km)	95,300 (86.68%)	14,900 (13.32%)	106,500	110,200
	river length (km)			1,050	
	MAR (Mm3/a)			Ephemeral	
	Evapotranspiration				
	Rainfall				
	Water transfer schemes?				
	no of dams				
	dam capacity (in Mm3)				
	dam surface area				
II	**Socioeconomic data**				
	Population			1,988,000	
	Agricultural GDP in RB				
	Industrial GDP in RB				
	Mining GDP in RB				
	Traditional sector GDP in RB				
	Commercial sector GDP in RB				
	SWC dependent livelihood sources				
	SWC dependent commercial activities				
III	**Water abstraction (in Mm3)**				
	for agriculture				
	for domestic use				
	for industrial use				
	for mining				
	other uses				
	total water abstraction				
	Navigational use				
	Environmental use				
IV.	**institutional set up**				
	RBO established??				
	RB agreement??				
	Key national institutions	Permanent Joint Technical Commission			

Cuvelai River Basin

		Angola	Namibia	Total
I	**Baseline data RB**			
	basin area (km)			
	river length (km)			430
	MAR (Mm3/a)			
	Evapotranspiration			
	Rainfall			
	Water transfer schemes?			
	no of dams			
	dam capacity (in Mm3)			
	dam surface area			
II	**Socioeconomic data**			
	Population			
	Agricultural GDP in RB			
	Industrial GDP in RB			
	Mining GDP in RB			
	Traditional sector GDP in RB			
	Commercial sector GDP in RB			
	SWC dependent livelihood sources			
	SWC dependent commercial activities			
III	**Water abstraction (in Mm3)**			
	for agriculture			
	for domestic use			
	for industrial use			
	for mining			
	other uses			
	total water abstraction			
	Navigational use			
	Environmental use			
IV.	**institutional set up**			
	RBO established??			
	RB agreement??			
	Key national institutions			

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Inkomati River Basin

	Swaziland	South Africa	Mozambique	Total	Notes
Baseline data RB					
basin area (km)	6%(2820km^2)	63%(29610km^2)	31%(14570km^2)	50,000	47,000
river length (km)				480	
MAR (Mm3/a)				5,000	
Evapotranspiration				1,900	
Rainfall (mm/a)				740	
Water transfer schemes (Mm^3)	132	135	0	267	
no of dams	2	5	1	8	
dam capacity (in Mm3)	381	691	879	1951	
dam surface area					
Socioeconomic data					
Population				2,000,000	
Agricultural GDP in RB					
Industrial GDP in RB					
Mining GDP in RB					
Traditional sector GDP in RB					
Commercial sector GDP in RB					
SWC dependent livelihood sources					
SWC dependent commercial activities					
Water abstraction (in Mm3)					
for agriculture	94	1143	152	1389	
for domestic use	8	98	4	110	
for industrial use	1	35	11	47	
for mining					
other uses					
total water abstraction					
Navigational use					
Environmental use					
Institutional set up					
RBO established??	2002				
RB agreement??					
Key national institutions	Policy matters- Joint Water Committee % Tripartite Permanent Technical Committee				
	Management matters-Komati Basin Water Committee % Komati Joint Operations Forum				

Maputo River Basin

		South Africa	Swaziland	Mozambique	Total
I	**Baseline data RB**				
	basin area (km)				32,000
	river length (km)				380
	MAR (Mm3/a)				2500
	Evapotranspiration				
	Rainfall				
	Water transfer schemes?				
	no of dams				
	dam capacity (in Mm3)				
	dam surface area				
II	**Socioeconomic data**				
	Population				
	Agricultural GDP in RB				
	Industrial GDP in RB				
	Mining GDP in RB				
	Traditional sector GDP in RB				
	Commercial sector GDP in RB				
	SWC dependent livelihood sources				
	SWC dependent commercial activities				
III	**Water abstraction (in Mm3)**				
	for agriculture				
	for domestic use				
	for industrial use				
	for mining				
	other uses				
	total water abstraction				
	Navigational use				
	Environmental use				
IV.	**institutional set up**				
	RBO established??				
	RB agreement??				
	Key national institutions				

Pungue River Basin

		Zimbabwe	Mozambique	Total	Notes
I	**Baseline data RB**				
	basin area (km)	5%	95%	32,500	31,000
	river length (km)			400	
	MAR (Mm3/a)			3,000	
	Evapotranspiration				
	Rainfall (mm/a)			Av. 1800-2400	
	Water transfer schemes?				
	no of dams				
	dam capacity (in Mm3)				
	dam surface area				
II	**Socioeconomic data**				
	Population				
	Agricultural GDP in RB				
	Industrial GDP in RB				
	Mining GDP in RB				
	Traditional sector GDP in RB				
	Commercial sector GDP in RB				
	SWC dependent livelihood sources				
	SWC dependent commercial activities				
III	**Water abstraction (in Mm3)**				
	for agriculture				
	for domestic use				
	for industrial use				
	for mining				
	other uses				
	total water abstraction				
	Navigational use				
	Environmental use				
IV.	**institutional set up**				
	RBO established??	2000			
	RB agreement??				
	Key national institutions				

Ruvuma River Basin

		Tanzania	Malawi	Mozambique	Total	Notes
I	**Baseline data RB**					
	basin area (km)	52,200 (34.43)	400 (0.3%)	99,000 (65.27%)	155,500	151,700
	river length (km)				800	
	MAR (Mm3/a)				15,000	
	Evapotranspiration					
	Rainfall					
	Water transfer schemes?					
	no of dams					
	dam capacity (in Mm3)					
	dam surface area					
II	**Socioeconomic data**					
	Population				3,200,000	
	Agricultural GDP in RB					
	Industrial GDP in RB					
	Mining GDP in RB					
	Traditional sector GDP in RB					
	Commercial sector GDP in RB					
	SWC dependent livelihood sources					
	SWC dependent commercial activities					
III	**Water abstraction (in Mm3)**					
	for agriculture					
	for domestic use					
	for industrial use					
	for mining					
	other uses					
	total water abstraction					
	Navigational use					
	Environmental use					
IV.	**institutional set up**					
	RBO established??					
	RB agreement??					
	Key national institutions					

Save River Basin

		Zimbabwe	Mozambique	Total
I	**Baseline data RB**			
	basin area (km)			92,500
	river length (km)			740
	MAR (Mm3/a)			7,000
	Evapotranspiration			
	Rainfall			
	Water transfer schemes?			
	no of dams	18	1	
	dam capacity (in Mm3)	2951		
	dam surface area	212.3		
II	**Socioeconomic data**			
	Population			
	Agricultural GDP in RB			
	Industrial GDP in RB			
	Mining GDP in RB			
	Traditional sector GDP in RB			
	Commercial sector GDP in RB			
	SWC dependent livelihood sources			
	SWC dependent commercial activities			
III	**Water abstraction (in Mm3)**			
	for agriculture			
	for domestic use			
	for industrial use			
	for mining			
	other uses			
	total water abstraction			
	Navigational use			
	Environmental use			
IV.	**institutional set up**			
	RBO established??			
	RB agreement??			
	Key national institutions			

Umbeluzi River Basin

		Swaziland	Mozambique	Total
I	**Baseline data RB**			
	basin area (km)			5,500
	river length (km)			200
	MAR (Mm3/a)			600
	Evapotranspiration			
	Rainfall			
	Water transfer schemes?			
	no of dams			
	dam capacity (in Mm3)			
	dam surface area			
II	**Socioeconomic data**			
	Population			
	Agricultural GDP in RB			
	Industrial GDP in RB			
	Mining GDP in RB			
	Traditional sector GDP in RB			
	Commercial sector GDP in RB			
	SWC dependent livelihood sources			
	SWC dependent commercial activities			
III	**Water abstraction (in Mm3)**			
	for agriculture			
	for domestic use			
	for industrial use			
	for mining			
	other uses			
	total water abstraction			
	Navigational use			
	Environmental use			
IV.	**institutional set up**			
	RBO established??			
	RB agreement??			
	Key national institutions			

Nile River Basin

		Tanzania	Burundi	Rwanda	Kenya	Uganda	Zaire	Eritrea	Ethiopia	Sudan	Egypt	Total
I	**Baseline data RB**											
	basin area (km)											2,800,000
	river length (km)											6,700
	MAR (Mm3/a)											86,000
	Evapotranspiration											
	Rainfall											
	Water transfer schemes?											
	no of dams											
	dam capacity (in Mm3)											
	dam surface area											
II	**Socioeconomic data**											
	Population											
	Agricultural GDP in RB											
	Industrial GDP in RB											
	Mining GDP in RB											
	Traditional sector GDP in RB											
	Commercial sector GDP in RB											
	SWC dependent livelihood sources											
	SWC dependent commercial activities											
III	**Water**											

	abstraction (in Mm3)											
	for agriculture											
	for domestic use											
	for industrial use											
	for mining											
	other uses											
	total water abstraction											
	Navigational use											
	Environmental use											
IV.	**institutional set up**											
	RBO established??											
	RB agreement??											
	Key national institutions											