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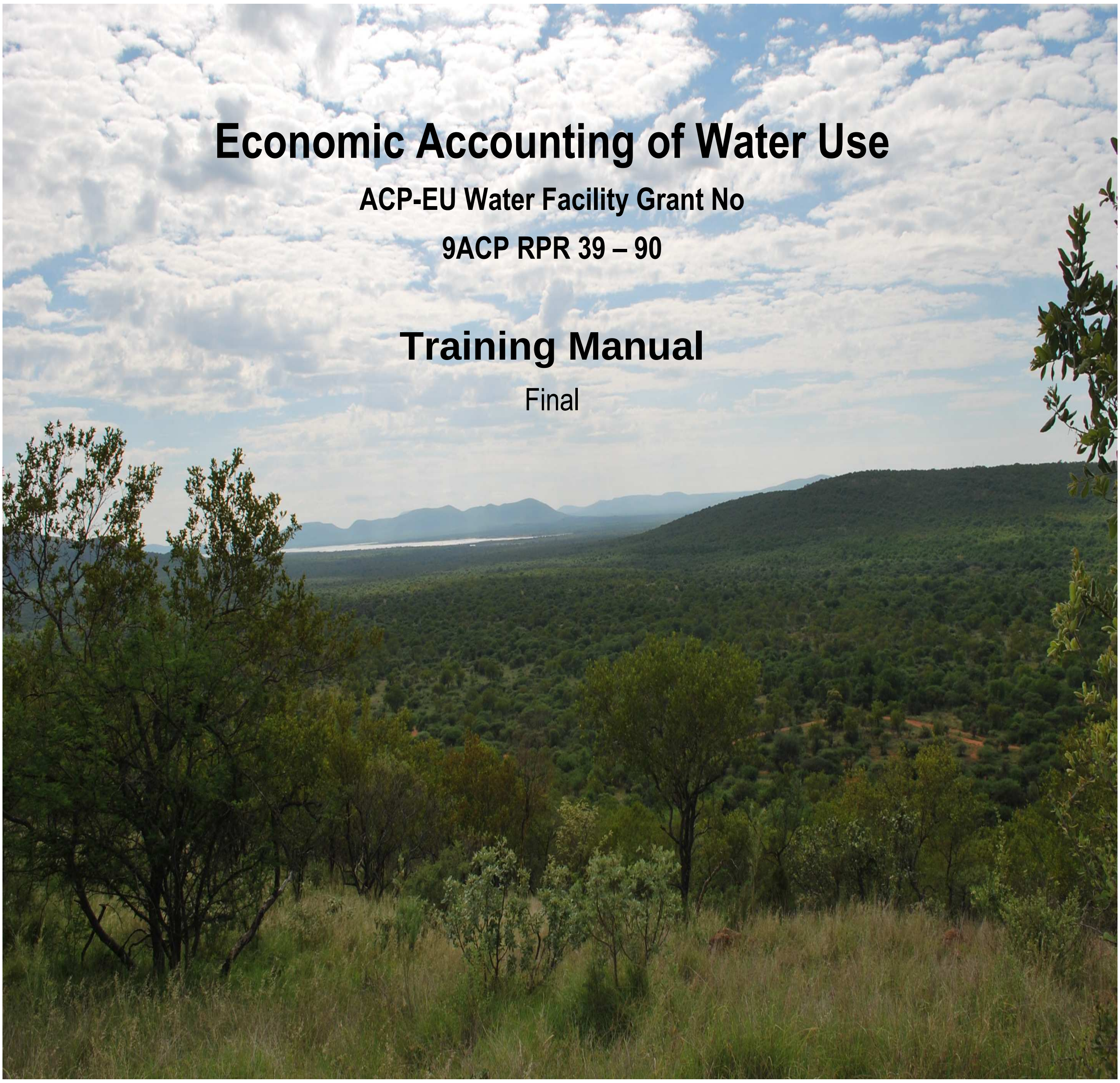

Economic Accounting of Water Use

ACP-EU Water Facility Grant No

9ACP RPR 39 – 90

Training Manual

Final

September 2010

SADC Economic Accounting of Water Use Project

Project Report

Produced by the project consultant Egis Bceom International

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SOUTHERN AFRICAN DEVELOPMENT COMMUNITY

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ECONOMIC ACCOUNTING OF WATER USE PROJECT

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TRAINING MANUAL
FINAL

Prepared For SADC

by

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Preface

Manual Origin

This training manual is part of the SADC Economic Accounting of Water Use (EAWU) project. The project is part of the Regional Strategic Action Plan (RSAP) on Integrated Water Resources Management and Development. It is being implemented under the framework of the Regional Water Policy (RWP) and Regional Water Strategy (RWS), both of which are aimed at facilitating the implementation of the Regional Indicative Strategic Development Plan (RISDP). The RISDP is the blue print of the SADC's development initiatives. The EAWU project is a component of project number RWR 4 (Support for Strategic and Integrated Water Resources planning), as classified in the revised RSAP which was approved by the Integrated Committee of Ministers (ICM) in 2005.

The project is financed by the ACP-EU Water Facility. The European Commission (EC) undertook to finance a maximum of 75% of the estimated total eligible costs. The German and British Governments, through GTZ, agreed to provide 25% contribution, to specifically fund activities of a capacity building nature, regional stakeholder workshops and Project Steering Committee (PSC) meetings. This is in the context of GTZ's role in the SADC water sector and its work with the SADC Water Division under the "Transboundary Water Management in SADC Programme", which is aimed at strengthening the human and institutional capacities for sustainable management of water resources in accordance with the Regional Strategic Action Plan (RSAP) in the SADC region and its transboundary river basins.

The main objectives of the project are to:

- Develop and pilot standardized methodologies for the construction of water use accounts
- Develop capacity of the SADC Member States and River Basin Organizations(RBO) in the use of the developed methodologies to enable them to construct their water accounts
- Develop short- and long-term training programmes in EAWU to benefit water resources management institutions.

EGIS Bceom International was awarded the contract to implement the project over a period of 11 months.

Purpose of the Manual

Methodologies for constructing water accounts have been developed as part of this project and this manual is aimed at building the capacity of Member States and River Basin Organizations in the use of these methodologies. In essence, the manual is aimed at operationalising the developed methodologies. The manual is primarily for training operational- and middle-level managers in the departments of water, statistics, environment and RBOs who are responsible for collecting data that feeds into water accounts, actual construction of water accounts or are responsible for developing benefit sharing strategies. However, with some minor adaption the material can also be used for sensitization and advocacy for high level manager, and policy makers.

The goal of the manual is to address the short term training needs of the region to develop water accounts. The initial short-course training for water practitioners and capacity building institutions will be conducted as part of this project. There will also be a Training- of- Trainers targeted at capacity building institutions in the region in the hope that they will use this manual to roll out training in the region.

Target Audience

As alluded to earlier, the manual is primarily for training operational- and middle-level managers in the departments of water, statistics, environment and RBOs who are responsible for collecting data that feeds into water accounts, actual construction of water accounts or are responsible for developing benefit sharing strategies. However, the training can also benefit policy and decision makers and other stakeholders such as NGOs and researchers who are interested in the subject of economic accounting for water use.

Because of the powerful insights that economics bring to water management, the manual is designed to reach beyond an audience of economists. Most water managers in the SADC region come from engineering, hydrological or science disciplines with limited exposure to economic fundamentals. For these people it is rarely practical to study natural resource economics before attempting to construct water accounts. For this reason, the manual is simplified to reach economists, engineers, hydrologists, statisticians etc. The manual is also useful to university students studying environmental economics or water accounting since it gives them information on the practical application of economic concepts such as valuation to water management in the SADC region.

The manual takes an economic approach to water resources management. Therefore, it will be interesting to contrast ideas about water to your usual thinking as you proceed through this manual.

Expected Impact and Outcome of the Manual

IMPACT: It is expected that the manual will contribute to improved decision-making in the sustainable utilization and management of water resources.

OUTCOME: It is expected that the manual will provide readily available training material for public practitioners and other stakeholders that can increase their knowledge in economic accounting of water use.

Contents

List of Acronyms

EAW	Economic Accounts for Water
EAWU	Economic Accounting for Water Use
EC	European Commission
RE	Economic Rent
GDP	Gross Domestic Product
GWPSA	Global Water Partnership Southern Africa
ISIC	International Standard Industrial Classification
IWRM	Integrated Water Resources Management
MGDs	Millennium Development Goals
MOC	Marginal Opportunity Costs
RISDP	Regional Indicative Strategic Development Plan
RSAP	Regional Strategic Action Plan
RSWIDP	Regional Strategic Water Infrastructure Development Program
RWP	Regional Water Policy
RWS	Regional Water Strategy
SEEAW	System of Integrated Environmental and Economic Accounting for Water
SEEA	System of Integrated Environmental and Economic Accounting
SNA	System of National Accounts
TEV	Total Economic Value
WA	Water Accounts
WDM	Water Demand Management
WMAs	Water Management Agencies

Introduction

This training manual serves as resource material to be used by capacity builders involved in conducting short courses of Economic Accounting of Water (EAW). The main target audience of the manual is professionals responsible for developing the accounts. The manual can also be used for water related educational programs, sensitization and awareness creation among policy/decision makers and other water stakeholders with minor modification. The manual can be adapted to country and regional levels.

The manual is organized in 9 modules as follows:

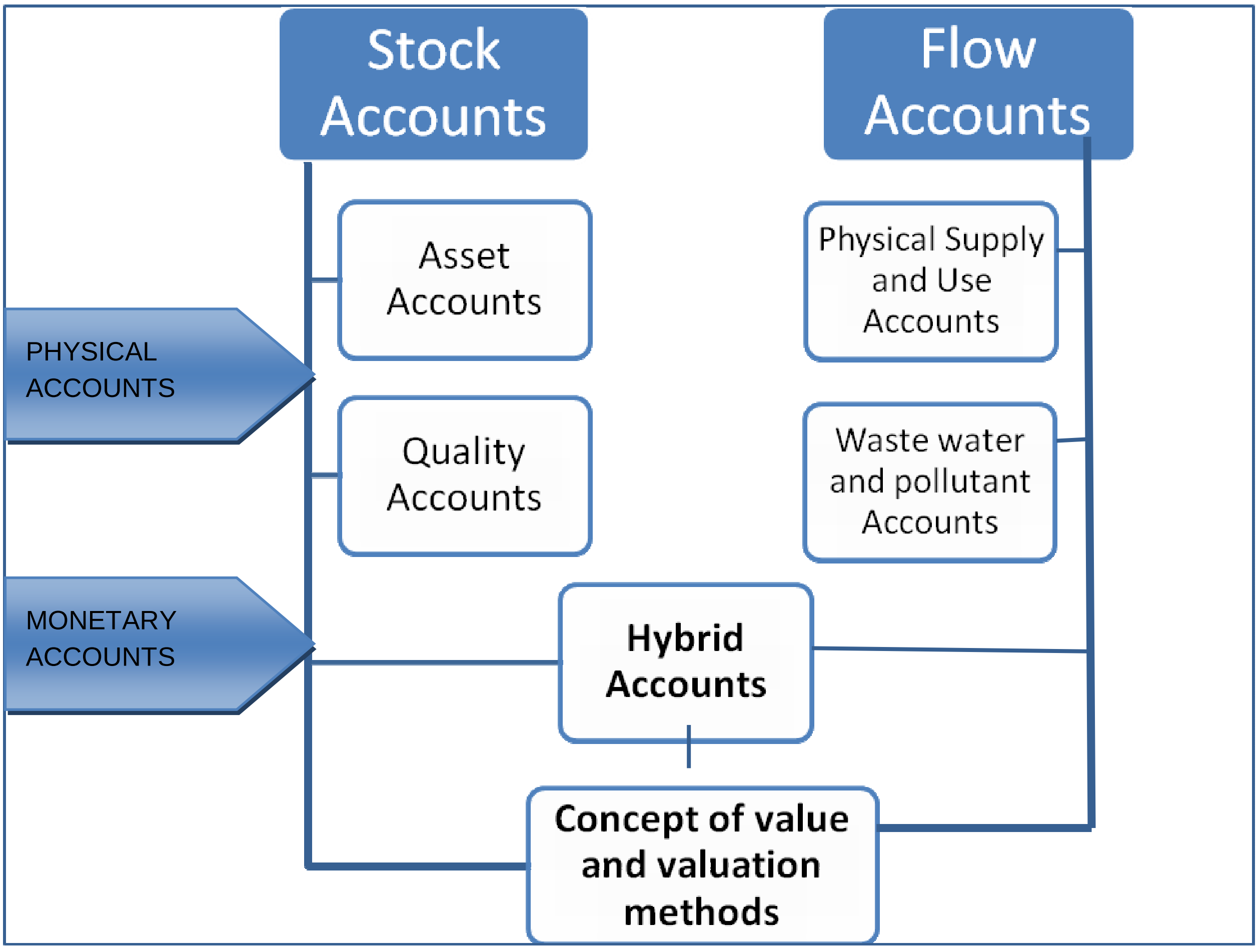
- Module 1: Introduction to EAW
- Module 2: Asset Accounts
- Module 3: Quality Accounts
- Module 4: Physical Supply and Use Accounts
- Module 5: Wastewater and Pollutant Accounts
- Module 6: Hybrid Accounts
- Module 7: Concept of Value and Valuation Methods
- Module 8: EAW and IWRM
- Module 9: EAW and Policy Application

Module 1 sets the stage of the manual by providing motivation for the EAW, the framework for developing the accounts, possible indicators produced by the accounts and how they can be used for policy decisions. Modules 2 – 6 comprise the key components of the water accounts and Figure 1 shows how these components are linked. The water accounts have two key components: **Stock** and **Flow** Accounts, both of which are presented in **physical** and **monetary** terms. Module 2 discusses the physical stock of water and changes in this stock overtime, while Module 3 discusses the quality of this stock and changes thereof. In Module 4 the physical flows of water from the environment to the economy, within the economy and back to the environment are discussed. The pollutants that end up in water during the flow process are discussed in Module 5. In Module 6 all the information presented in modules 2 – 5 is presented in monetary terms to show the contribution of water to the economy and the impact of the economy on water resources.

Valuation of water resources is key to compiling the water accounts. Module 7 discusses the concept of value and how water values are derived. The concept of IWRM is critically important in the management of SADC water resources. Module 8 discusses how the water accounts can help monitor and evaluate the IWRM process. Lastly, Module 9 summarizes how information produced by the key 5 components of the water accounts can be used for policy application.

In terms of outline, each Module begins by setting out the goal and learning objectives and reflection statements and questions are provided throughout the document. Each chapter ends with an exercise and note to facilitator that explains how the material in the chapter can be used in facilitation.

Figure 1: Schematic of components of the Economic Accounts of Water



Module 1
Introduction to Economic Accounting of Water

Goal

The goal of this module is to introduce the Economic Accounts of Water (EAW), their rationale and how they are compiled.

Learning Objectives

At the end of the module participants are expected to

- Define and provide motivation for EAW
- Understand EAW framework
- Know the relationship between EWA and System of National Accounts (SNA)
- Know key evaluation and monitoring indicators derived from EAW
- Appreciate transboundary issues of EAW

Module Structure

The module is structured as follows:

1. Introduction, which provides motivation to EAW
2. Definition of EAW
3. Link between EAW, SEEA, SEEAW and SNA
4. Framework for developing EAW
5. Indicators generated by EAW
6. Transboundary issues of EAW
7. Examples of EAW
8. Note to facilitator

1.1 Module Summary

Economic Accounting for Water can be simply defined as accounting of the value of water in human activities (consumption and production) and the impact of human activities on water resources. The purpose of this Module is to introduce the concept of Economic Accounting for Water (EAW). To set the stage, the Module starts with key water management and planning challenges in the SADC region that necessitate development of the Economic Accounts for Water (EAW) in Section 1.2. In Section 1.3 the Module defines EAW and links it to the System of Integrated Environmental and Economic Accounting (SEEA), System of Integrated Environmental and Economic Accounting for Water (SEEAW) and the conventional economic accounting system, i.e., the System of National Accounts (SNA). The framework for developing the EAW is presented in Section 1.4. Important indicators for policy decisions generated by the EAW are presented in Section 1.5 and their examples at national level are provided in Section 1.6. Regional/river basin accounts and their examples are presented in Sections 1.7 and 1.8, respectively. The module concludes with notes to facilitators in Section 1.9.

1.2 Introduction

Water is vital for human life, economic development and ecosystems sustenance. However, the availability and quality of the resource is increasingly becoming a challenge in most SADC countries. These challenges can be ascribed to a number of factors summarized below:

- There is great variability of water resources between different parts of the region in terms of space and time, especially in southernmost, drier parts.
- The region is characterized by years of drought broken by large scale of floods, with very few years receiving the supposed average rainfall, which makes planning of water resources difficult and has direct impact on livelihood security for the population of the region
- The population and industrial growth in the region is predicted to put some of the countries in the region in a water stressed situation by 2025
- Almost all the countries in the region are underdeveloped and characterized by low GDP and increasing population levels, low levels of coverage of basic water supply services and reliance on agricultural sector
- Research has shown strong correlation between water development and economic development and ability to withstand water shocks
- This means for the region to realize significant economic growth and development and be able to realize commitment towards MDGs, there is need to increase and accelerate access to adequate and safe/clean water

In an attempt to reverse this bleak situation and secure water supply in the region, SADC has embraced the concept of IWRM and embarked on a number of programs and development initiatives and/or strategies, notably RSAP 1 in 1998, RSAP 2 in 2005, RISDP in 2003 and RSWIDP. Despite these attempts, challenges still remain, such as:

- Mismatch between water availability and demand
- High variability of available water resources
- Shared watercourses and sharing benefits of water allocation between riparian states
- Widespread poverty in the region
- Weak inter-sectoral linkages and coordination, which hampers comprehensive and integrated development
- Low access to safe drinking water and adequate sanitation, primarily as a result of inadequate infrastructure, and poor operation and maintenance of facilities
- Weak policy linkages at regional and national levels, particularly weak implementation mechanisms at national level, such that plans at regional level do not have an effective impact at national level
- planning and understanding of resource availability and utilization
- Poorly developed formal dispute resolution mechanisms
- The prevalence of HIV/AIDS
- Limited financial and human to develop water resources (SADC, 2006)

Box 1.1: Water management and decision making challenges

- The SADC region has the challenge of meeting the MDG related to water and sanitation by 2015 (Goal 7(3))
- Investment in requisite infrastructure required
- Water sector competes for the same public funds as other sectors – how can the water sector negotiate better for a bigger pie to meet the MDGs and other water requirement? What information is required and how best can it be packaged to appeal to those who allocate public funds (i.e. finance ministers)?
- How to assess the economic performance of the water sector, i.e. how to quantify benefits or values generated by water
- How to distribute these values and outlays associated with water provision to the right sectors?
- Most SADC water courses are shared by two or more countries
- SADC is promoting benefit sharing where this exists – how can countries negotiate for benefits and what information is required?
- SADC has embraced the concept of IWRM and some countries have started implementing the concept – how to evaluate and monitor progress?

The above highlighted factors affecting sustainable water supply in the region make water management and allocation decisions in the region a daunting task. Challenges associated with water management and allocation decisions are summarized in Box 1.1. For these challenges to be addressed, critical information on myriad indicators to make informed decisions is required. Examples of such indicators include:

- Economic contribution of water /water benefits
  - GDP generated by water in general
  - Value generated by water in different economic activities, e.g. agriculture, industry

- Water expenditure
  - Investments in water infrastructure
  - Investments in water conservation
  - Cost of distributing water
- IWRM indicators
  - How much water is available
  - How is such water allocated among competing uses: households, economic activities, ecological and international requirements

- What is the relative access to water services by different social groups, which is important for equity evaluation and monitoring
- What is the efficiency in water use among economic sectors
- How much value is added by water in different economic activities, important for evaluating and monitoring economic efficiency
- What water tariffs and fees are charged and whether they are adequate for financing water services
- What sectors pollute water and what water pollution treatments exists, which helps in monitoring environmental sustainability
- Investment in water-related infrastructure and finance mechanisms
- Costs of maintaining the water infrastructure
- How to plan for future water requirements and how to manage water demand (Matete, 2010).

Box 1.2: SNA shortcomings concerning the treatment of the environment

- The Gross Domestic Product (GDP), as measured conventionally, does not adequately represent true, sustainable income because it does not account for the depletion of natural resources (e.g., minerals, fisheries, forests) and environmental degradation (pollution affecting health).
- The SNA also does not include a number of non-market goods and does not adequately treat many non-market services provided by natural resources.
- Some services are wrongly attributed to other sectors, e.g., value of water and soil protection by forests attributed to agriculture.
- Some services are completely omitted from GDP, e.g., biodiversity protection and carbon storage.
- Where environmental values are accounted for, for example, expenditure on water infrastructure, conservation, supply and use, incomes generated from water, these values are not explicitly allocated to the water sector, which makes IWRM planning difficult.

Producing these indicators is based, in part, on a solid understating of how much water is available in an economy, how it is used, what costs are associated with its use and what values are generated from its use. Economic Accounting for Water is a tool that can provide this information by integrating water use information into national economic accounts which are best understood by ministries of Finance and Planning for critical economic and budget allocation decisions.

The economic value of water, the role water plays in economic growth and social development, and the direct and indirect costs related to inaction need to be imparted to policy makers so that water is elevated in policy at all levels; district, national, basin and SADC.

1.3 What is Economic Accounting for Water?

Economic water accounting is part of the broad Natural Resources Accounting proposed in the Integrated Environmental and Economic Accounting (SEEA) handbook of National accounting (UNSD, 2003). The main objective of the SEEA is to

- Augment the System of National Accounts (SNA) by explicitly accounting for natural resources and the environment, for example
  - Depletion of natural resources
  - Degradation of environment – pollution
  - Accounting of unpriced natural resources

The SNA is an integrated accounting of economic performance and is particularly important because it constitutes the primary source of information about the economy and is widely used for analysis and decision-making in all countries. It provides indicators to evaluate economic performance (e.g., GDP, GNI, and NDP) and provides requisite statistics for economic planning (see [illegible] explanation of SNA).

However, the SNA has several shortcomings regarding the treatment of the environment summarized in Box 1.2 These shortcomings present a serious flaw from an accounting point of view. The SEEA was then developed to address these gaps in the SNA.

Think about it:

- ❖ How are water values accounted for in your country's national accounts?

The Integrated Environmental and Economic Accounting (SEEA)

The SEEA has several supportive manuals for accounting of different resources. For water, a specific manual for economic water accounting, i.e., the Integrated Environmental and Economic Accounting for Water Resources (SEEAW), was developed by the UNSD in 2006 with the objectives of augmenting the SNA by explicitly accounting for:

- Supply and use of water resources in an economy and allocating expenditures and incomes from water to right sectors
- Effects of human and economic activities on quantity and quality of water
- Expenditures on water infrastructure and treatment
- Benefits from water including income generated from water
- Water policies like taxes, subsidies and charges

The economic accounts of water (EAW) can be compiled at any level of spatial disaggregation - a river basin, catchment or city. However, it is important to note that economic accounts are generally not compiled at the river basin level, thus making the link between hydrological and economic information difficult. The framework for developing the accounts is presented in Section 1.4 below.

Generally, EAW is an approach that integrates water accounts and economic accounts and provides information on available water resources and its uses. The accounts increase knowledge about the interaction between water and human activity and provide a tool for improved water management.

Integrated Environmental and Economic Accounting for Water Resources (SEEAW)

The System of Environmental - Economic Accounting for Water (SEEAW) is satellite accounting aimed at augmenting the SNA with water information. The SEEAW helps water managers present water information in a manner consistent with the SNA.

As a satellite account of national accounts, SEEAW has a similar structure to the SNA as it uses concepts, definitions and classifications consistent with the SNA while not violating the fundamental concepts and laws of hydrology. The SEEAW expands the national accounting framework by:-

- Expanding the national economic accounts asset boundary to include all water assets and their quality and explicitly identifying infrastructure (produced assets) for mobilising water resources.
    - **Asset accounts** for infrastructure (e.g dams, pumps etc.) related to water and sanitation are already included in the national economic accounts, however they are often not separately identified from other produced assets.
    - SEEAW allows for the explicitly identification of those assets related to water and sanitation. **This type of information has great analytical value as it provides an indication of the ability of a country to mobilize water**
- Expanding the system of national accounts by juxtaposing physical information to the monetary accounts. SEEAW allows for the compilation of the accounts in physical and monetary terms.
- Introducing information on the relationship between the economy and the environment in terms of abstractions, returns and pollution thus allowing for the analysis of the impact in terms of quantity and quality on natural assets caused by production and consumption activities of economic units.
- Separately indentifying expenditures for the protection and management of water resources including taxes, subsidies and the financing mechanisms.

The system of National Accounts (SNA)

Closely linking economic accounting for water with the System of National Accounts has a number of advantages.

- First, SNA is an internationally accepted standard for compiling economic accounts and has been adopted by SADC member states.
    - It provides a set of internationally agreed concepts, definitions and classification thus allowing for international comparison.
    - Fitting economic accounting for water into this framework improves the analysis of the interrelations between water and the economy.

- Second, the system of national accounts has a number of identities which can be used to check for consistency of data.
- Third, the accounting structure also allows for the calculation of a number of indicators which are precisely defined, consistent and interlinked with each other because they are derived from a fully consistent data system. Lastly, it allows evaluation of environmental-economic tradeoffs not by analysing sectoral policies in isolation but in a comprehensive economic and environmental context (see Annex 1 for details).

1.4 Framework for developing the Economic accounts of water

The SEEAW provides a framework for incorporating the role of water in the economy through a system of satellite accounts to the national accounts using common and standardised definitions and classifications which make them comparable to the national accounts.

This standardisation is important as the national accounts language is understood by decision makers worldwide and the accounts are used for decision making in all countries. This means that, for water challenges to receive the requisite attention from decision makers, the language used in the water accounts must match that used in national accounts.

Think about it

- What important indicators from the SNA are used for economic planning decisions in your country
- Can presenting water information in the same format improve economic decisions concerning water? How?

The SEEAW describes most of hydrological cycle, from precipitation and soil water to the abstraction and use of water for economic and human activities, and the returns of wastewater, treated or untreated, back to the environment. According to the SEEAW the water accounts consist of two broad categories: (i) **Stock** and (ii) **Flow** Accounts, both of which are presented in physical and monetary terms, i.e., **physical** and **monetary** accounts – see the schematic in Figure 1 in the Introduction Section (UNSD, 2005). The components are described as follows:

A. Water stock accounts consist of **asset and quality** accounts**.**

(i) **The Asset accounts** – record the amount of total resource and changes in the resource over the accounting period, which is usually a year **(Module 2)**.

(ii) **Quality accounts** – record stocks of water in terms of its quality **(Module 3)**

B. Water flow accounts – record the flows of water between the economy and the environment, including the supply, use and returns of water by industries and households **(see Figure 1.1)**.

- Figure 1 shows that raw water flows from the environment to national economies, where the water is further distributed within the national economies between different economic sectors including households, or to other economies where transboundary transfers exist (i.e. the Rest of the World). After use, the water is returned back to the environment, most of the times in different quality (e.g. polluted) and quantity.
- The flow accounts se are usually organised in the format of **Supply and Use Tables (SUT)** that is similar to the SUT compiled for national income accounts. The main tables include:

(iii) **Physical water flow accounts -** record the volume of water supplied by an agent either for own use or for delivery to another user (like in the case of water utilities) and the volume used by economic and domestic sectors (i.e. industry and households) – **Module 4**

(iv) **Monetary flow accounts** – record the cost of delivering water to users and tariff charged for that water, where the difference between the two is effective water subsidy. This components of the accounts is presented as part of the hybrid accounts in **Module 6**

(v) **Wastewater and Pollutant accounts** – records the volume of waste water or pollution discharged or emitted to raw water/water body after use **(Module 5).** The monetary accounts record the cost of treating wastewater and the user charge for wastewater treatment and they are included in the **Hybrid Accounts** covered in **Module 6**

C. Hybrid and economic accounts – show interface between physical amounts of water supplied/used by different activities and value generated by water in these uses. The objective is to show economic value of water in different uses. The accounts also include the value of water assets, changes in these values and costs associated with provision of water services.

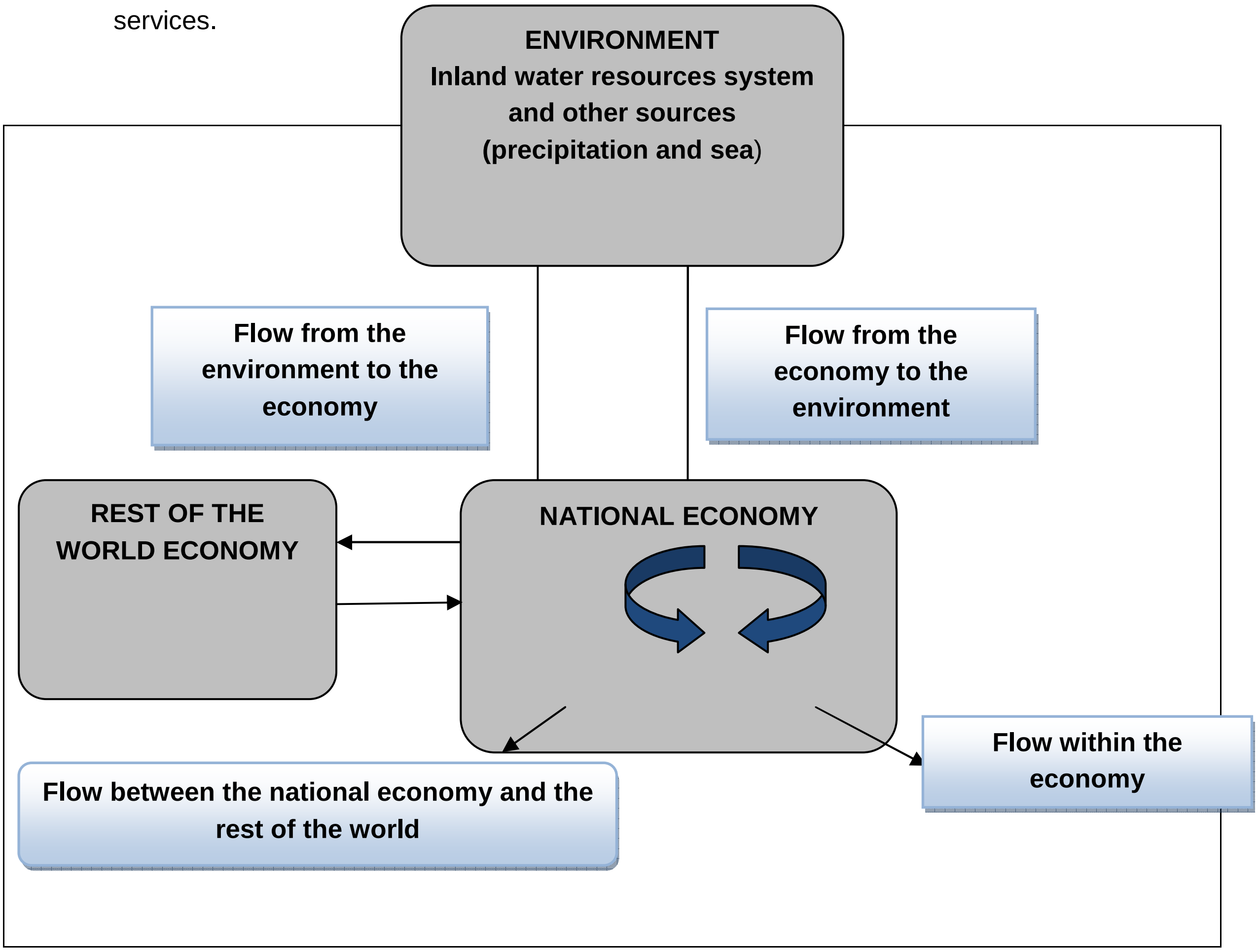


Figure 1: flow of water between the environment and economy

Source: Adapted from UN Statistics Division, 2005

From these accounts it is clear that economic accounts for water are data intensive and that most of the required data is not ordinarily generated and compiled by countries. As a consequence, in most cases only asset, supply and use and hybrid accounts are constructed.

THINK ABOUT IT

- Is the data required for the accounts readily available in your country
- If not, how can such data be generated?

1.5 Indicators generated by economic accounts of water and policy application

Economic water accounts provide a unique tool for

- Evaluating and monitoring IWRM
- Any economic analysis of water issues including
  - progress towards attaining water and sanitation related MDG,
  - water use efficiency,
  - contribution of water to economic growth
  - economic effect of water policies (e.g. pricing, subsidies)
  - cost and benefit analysis of water projects

Think about it:

- Does your country has an IWRM plan?
- Is it implemented?
- How is the implementation process evaluated and monitored?

- This is because EAW integrates data about both the environmental and economic aspects of water in a framework that supports quantitative analysis.
- Usually, available information to water managers is on water use by broad groups of end-users. However, this data cannot be easily used for economic analysis as the end users rarely correspond to the detailed classification of economic activities used for national income accounts, which is the primary source of information about a country's economy.
- The EAW link water statistics (i.e. water use, supply, resources, discharge of pollutants etc) directly to National Income Accounts (NIA). This is achieved by sharing structure, definitions and classifications with the NIA. Water suppliers and end-users are classified by the same system for the NIA.

EWA as a monitoring tool for IWRM

Water accounts are useful in developing indicators that can, among other things, be used to monitor and evaluate application of IWRM principles and attainment of its objectives by identifying:

- Water distribution, scarcity **(Asset Accounts)**
- Allocation of water, water infrastructure among competing uses and relative access to water services by different social groups, which is important for equity monitoring **(SUT)**
  - Household users
  - economic users
  - ecological requirements
  - international requirements
- Efficiency in water use between economic sectors **(SUT)**
- Value addition and employment generation by water in different economic activities **(Hybrid Accounts)**
- Water pricing and economic instruments:
  - Variation of water costs/scarcity by region
  - Impact of water tariffs on different industries and different social groups, especially the poor
- Polluting sectors and existing pollution treatments, which helps in monitoring environmental sustainability **(Quality and Waste Water Accounts)**
- Costs of maintaining the infrastructure **(Monetary Asset Accounts)**
- Investment in water-related infrastructure **(Monetary Asset Accounts)**
- Planning for future water requirements, water demand management **(SUT and Asset Accounts)**
- Water financing mechanisms **(Monetary flow accounts (SUT)**
- Fees paid by users for water-related services **(Monetary flow accounts – Wastewater accounts)**
- Policy in related sectors: agriculture, rural development, tourism, etc. **(Flow accounts –SUT)**

In general EWAs help design policies of cost-recovery and equitable, environmentally sustainable and efficient water allocation as required by IWRM which are pertinent to water managers and decision makers adopting the IWRM concept.

EWA as a Tool for Economic Analysis

- Contribution of water to economic growth
  - Information from the SUT and Hybrid accounts can be used to estimate contribution of water to GDP
- Efficiency of water use in economic production
  - Information from SUT can be used to determine technical and allocative efficiency of water use
- Costs and benefits of water
  - Information from the monetary accounts (Hybrid) can be used to identify and estimate costs associated with provision of water as well as benefits/value generated by water in different uses. This information is critical for benefit sharing negotiations

- Progress on attainment of MDGs
    - SUT provide information on the number of people, according to different income groups and other classification, have access to clean water. This information can be compared with the MDG target for a country to determine the outstanding gap and plan for bridging the gap accordingly.

In summary: Economic water accounts provide aggregate, often national level, indicators that provide 'warning' signs of a trend that may be unsustainable or socially undesirable, as well as more detailed sectoral indicators that shed light on sources of pressure on water resources, opportunities for reducing the pressure, and contribution of economic incentives to the problem and possible solutions. Because they are linked to national income accounts, they can also be used for more complex economic analysis and modeling to project future water demands and evaluate different policy options for meeting those demands such as pricing reform, water efficiency improvements, wastewater reuse and recycling and demand management.

1.6 Examples of EWAs from the SADC Region

In Southern Africa economic water accounting started with a program on Natural Resource Accounting (NRA) initiated in East and Southern Africa to assess the economic value of natural resources and their use for economic activities. The major focus of this program has been on constructing water accounts (for details refer to Lange et al., 2003).

Currently there are three countries in the SADC region that develop the water accounts on a continuous basis:

- Botswana
- Namibia
- South Africa

The accounts were initially developed as a component of the regional initiative started in 1995 to construct environmental accounts in this region (Lange, Hassan and Hamilton, 2003). The first accounts were built for Namibia as a demonstration site during the first phase of the project (1995 – 1997).

The main objective was to test the feasibility of constructing the accounts and their usefulness for policy makers. In the second phase (1998 – 2001), the accounts were extended to Botswana and South Africa and the three countries have since updated their original accounts. The existing accounts of the three countries are compiled in Lange and Hassan (2006). Mozambique and Tanzania have engaged in pilot projects towards the developments of water accounts.

Because of data challenges, not all on the five main components of EWAs were compiled in the accounts of Botswana, Namibia and South Africa. Only asset, supply and use and hybrid accounts were compiled and to certain extend, depending on availability of information in each country. Some of the important results from these accounts are reported in Tables 1.1 – 1.3 to provide examples of types of information generated by the accounts.

Table 1.1: Water use by sector in Botswana, Namibia, and South Africa, 2000

	Botswana	Namibia	South Africa
Total water use (million m^3)	169	266	12872
Per capita water use (m^3 per person)	193	149	295
Per capita water use excluding agriculture (m^3 per person)	59	39	96

Source: Lange and Hassan (2006)

Table 1.1 provides information on per capita use of water in each country, including and excluding agriculture, which reflects the huge amount of water consumed by agriculture in each country.

Table 1.2 further disaggregates use according to different activities, which is important for monitoring allocation against requirements in different activities.

Table 1.2: Water use by sector in Botswana, Namibia and South Africa, 2000

	Botswana		Namibia		South Africa	
	Million m3	%	Million m3	%	Million m3	%
Agriculture and Forestry	73	43	198	74	8665	65
Irrigation	19	11	139	52	7921	62
Livestock	54	32	59	22	313	2
Forestry	0	0	0	0	431	3
Mining	27	16	7	3	388	3
Manufacturing	4	2	7	3	700	5
Food processing	NA	NA	4	1	123	1
Other	NA	NA	4	1	577	4
Electric power generation	NA	NA	<1	<1	297	2
Utilities and construction	1	1	<1	<1	NA	NA
Services except government	16	9	22	8	865	7
Services except government	4	3	7	3	713	6
Government	11	7	15	6	152	1
Households	49	29	31	12	1958	15
Urban	26	15	23	9	1697	13
Rural	23	14	8	3	261	2
Total	169	100	266	100	12873	100

Source: Lange and Hassan (2006)

The information in this table is critically important for monitoring the objective of equity as it can be used against information on water access requirements by different socio-economic groups of households to determine the number of household's who still require access against those who have it.

Table 1.3 provides information on value generated by different economic sectors measured in terms of GDP and employment generated, respectively.

Table 1.3: Water productivity in Botswana, Namibia and South Africa, 2000 (Rands of value added per cubic meter of water used)

	Botswana	Namibia	South Africa
GDP per m^3 of water input	236	93	65
GDP per m^3 of water input (excluding agriculture)	405	340	193
Agriculture	14	7	3
Mining	513	389	142
Manufacturing	1000	455	215
Services excluding government	2962	1113	606
Government	553	338	876

Source: Lange and Hassan, 2006

These are used as proxies for value generated by water in each use. This information is important to the economic efficiency objective in IWRM as it provides information on uses that are more efficient in water use. Where information on water charges, tariffs and subsidies exist, cost recovery and water financing capability can be determined.

1.7 Regional/River Basin Water Accounts

Water accounting at a regional level brings an economic perspective to water management at a regional level. The accounts still consist of the five components discussed earlier. The information contained by the accounts at a regional/river basin level is summarized in Box 1.3.

Data required to compile regional accounts is even more difficult to obtain than that required to compile national accounts.

Nevertheless, if compiled the EWAs at a regional or transboundary level can provide useful information for planning and managing water resources and help generate useful indicators for sustainable management of water at transboundary/regional level.

By providing a clear economic perspective on water supply and use at the regional/basin level, EWA can contribute to better management that benefits all riparian states promoting sound water allocation, water conservation and pollution prevention measures (Lange et al., 2007).

The challenge is that the river basin does not always correspond neatly to geographic areas fro which economic and other relevant data are compiled

Box 1.3: The EAW at a regional/river basin level

- Supply and use accounts are used to compare contribution to water supply from each riparian state to the amount used
- These are linked to economic data of each country to derive hybrid accounts which calculate water use productivity by industry and country
- This helps in determining comparative advantage of different countries in a basin in terms of water use
- This knowledge can facilitate negotiations on benefit sharing among countries – a concept being promoted as a progressive tool for negotiating water use in a transboundary nature compared to the one focused on sovereignty issues
- The Asset accounts show amount of water contributed by each country to the shared basin, while the Quality accounts record the quality of this water
- The Wastewater and pollutant Accounts record amounts of pollution, and cost thereof, contributed by different activities of each country to the shared basin

1.8 Examples of Regional Accounts drawn from the SADC Region

There are not many examples of regional EAW in the region. However, some attempts have been made by the Centre for Environmental Economics and Policy in Africa (CEEPA) to develop accounts for the Orange Senqu River Basin (OSRB). These comprise

- The regional comparative advantage of water use in the ORB. The study was done by Conningarth Economists (2001) as part of the Natural Resource Accounting Programme of Southern Africa (NRASA) under CEEPA
- Water accounting for the Orange River Basin: An economic perspective on managing a transboundary resource (Lange et al, 2006), which in a way also updated Conningarth's study of 2001.

These accounts included stock and flow accounts only due to data constraints (i.e. monetary accounts were not developed). Nevertheless, the use accounts were linked to national income accounts to calculate water productivity. Tables 1.4 and 1.5 show examples of the SUT derived at a regional level.

Table 1.4: Water Supply in the Orange Senqu River Basin

	Lesotho	South Africa	Namibia	Botswana
Water supply (million m^3)	4768	8975	294	56
%	34%	64%	2%	0.4%
Water use (million m^3)	43.27	6941	100.69	1.12
%	1%	98%	1%	0.02%

Source: Lange et al. (2006)

Table 1.4 shows quantity of water contributed by each riparian country in the OSRB and how the water in the basin is used by each riparian country.

Table1.5 : Water use by country and industry, 2000 (million m3)

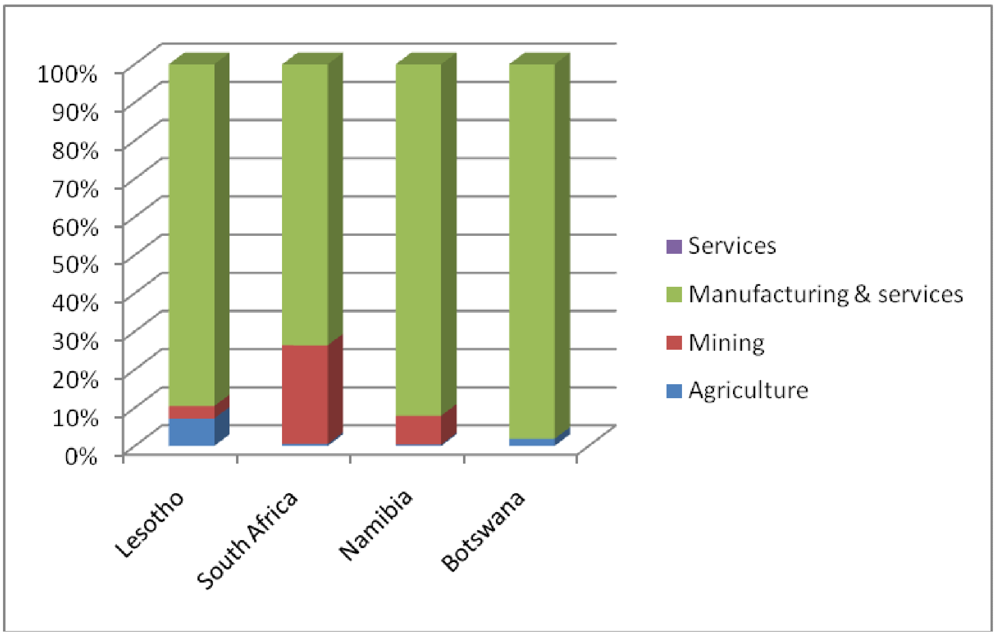
ACTIVITIES	LESOTHO	SOUTH AFRICA			NAMIBIA				BOTSWANA	TOTAL
		Total	Upper Orange	Lower Orange	Total	Ground	Surface: Dam	Surface: Orange River		0
Agriculture	**19.29**	**1828**	**835**	**993**	**96.07**	**12**	**41.3**	**42.78**	**0.51**	**1943.87**
Crop irrigation	**0.4**	**1757**	**780**	**977**	**90.95**	**6.92**	**41.26**	**42.78**	**0**	**1848.35**
Grapes	-	-			31.69	0	0	31.69	0	
Other horticulture	-	-			13.51	3.34	3.67	6.49	0	
Lucerne	-	-			2.95	1.91	0	1.04	0	
Cereals and other crops	-	-			42.8	1.66	37.59	3.56	0	
Livestock	**18.87**	**71**	**55**	**16**	**5.12**	**5.08**	**0.04**	**0**	**0.51**	**95.5**
Commercial		-			**5.02**	**4.98**	**0.04**	**0**	**0**	
Traditional	**18.87**	-			**1**	**1**	**0**	**0**	**0**	
Mining	**1.00**	**9**	**0**	**9**	**1.44**	**0.01**	**0**	**1.43**	**0**	**11.44**
Manufacturing and services	**21.00**	**54**	**46**	**8**	**1.71**	**0.91**	**0.8**	**0**	**0.11**	**76.82**
Manufacturing	-	-			**0.2**	**0.09**	**0.11**	**0**	**0**	
Food processing	-	-			**0.16**	**0.07**	**0.09**	**0**	**0**	

ACTIVITIES	LESOTHO	SOUTH AFRICA			NAMIBIA				BOTSWANA	TOTAL
		Total	Upper Orange	Lower Orange	Total	Ground	Surface: Dam	Surface: Orange River		0
Other manufacturing, utilities, construction	-	-			**0.03**	**0.02**	**0.02**	**0**	**0**	
Services	-	-			**1.52**	**0.82**	**0.7**	**0**	**0.11**	
Trade, transport, business, other services	-	-			0.53	0.28	0.25	0	0.08	
Hospitals and schools	-	-			0.99	0.54	0.45		0.03	
Households	**24.00**	**106**	**87**	**19**	**1.46**	**0.89**	**0.57**	**0**	**0.51**	**131.97**
Urban	-	100	82	18	1.33	0.76	0.57		0	
Rural	-	6	5	1	0.13	0.13	0	0	0.51	
Subtotal economic uses within ORB	**64.29**	**1997.00**	**968.00**	**1029.00**	**100.68**	**13.81**	**42.67**	**44.22**	**1.13**	**2163.1**
Transfers out to other WMA		**3202**	**3148**	**54**	**0**	**0**	**0**	**0**	**0**	**3202**
Subtotal, all economic uses	**64.29**	**5199.00**	**4116.00**	**1083.00**	**100.68**	**13.81**	**42.67**	**44.22**	**1.13**	**5365.1**
Distribution of water for economic uses	**1%**	**97%**	**77%**	**20%**	**2%**	**0.3%**	**0.8%**	**0.8%**	**0.02%**	**100%**
Ecological requirements		**1743**	**1682**	**61**	**-**	**-**	**-**	**-**	**-**	**1743**
Total water use	**64.29**	**6942.00**	**5798.00**	**1143.00**	**100.68**	**13.81**	**42.67**	**44.22**	**1.13**	**7108.1**
Distribution of total uses	**1%**	**98%**	**82%**	**16%**	**1%**	**0.2%**	**0.6%**	**0.6%**	**0.02%**	**100%**

Source: Lange et al. (2000)

Figure 1.2 shows productivity of water in the basin for the main four productive sectors: agriculture, mining, manufacturing and services. This is a measure of technical efficiency in water use and from the figure it can be clearly seen which country is more efficient in using water in what activity.

Figure 1.2: Water productivity by country and industry



Source: Lange et al. (2007)

1.9 Notes to the Facilitator

About this Module

The module is designed for face-to-face facilitation. The duration is **approximately 1.5 hours.** This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator needs to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver the module.

The module has some reflection/discussion questions aimed at helping participants appreciate the rationale for EAW. These questions could be asked in the plenary or participants could be asked to discuss them in small groups and share feedback in plenary. The discussion questions are aimed at giving participants the opportunity to maximize interaction amongst each other and learn from each other through sharing knowledge and experiences.

It is important to structure the presentation and Questions and Answers (Q&A) period carefully in order to allow sufficient time for a productive discussion. It is recommended that the module be presented in three sessions, each lasting 20 minutes. This will allow 10 minutes discussion time after every session. It is advised that the Q&A period per session should not exceed 15 minutes to have a balance between the three sessions.

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. In addition, study the other modules to appreciate the role of water accounting in water decision making.

Participant Evaluation

An evaluation questionnaire should be provided to allow participants assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your Feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to mateteme@yahoo.co.uk

1.10 References

Conningarth Consultants. 2001. Regional comparative advantage of water use: the Orange River case study. Report submitted to the Natural Resource Accounting Programme of Southern Africa. CEEPA, University of Pretoria.

Global Water Partnership (GWP). 2004. Catalysing change: a handbook for developing Integrated Water Resources Management (IWRM) and water efficiency strategies. GWP. Stockholm.

Global Water Partnership Southern Africa. 2009. IWRM Survey and Status Report: Summary. GWPSA, Pretoria, South Africa.

Lange, L.; Hassan, R.M. and Hamilton, K. 2003. *Environmental Accounting in Action*: *Case studies from Southern Africa*. Edward Elgar Publishers: Cheltenham, UK.

Lange, G. And Hassan, R.M. 2006. The Economics of Water Management in Southern Africa: An Environmental Accounting Approach. Edward Elgar: Cheltenham, UK.

Lange, G.; Mungatana, E. And Hassan, R.M. 2007. Water accounting for the Orange River Basin: An economic perspective on managing a transboundary resource. *Ecological Economics*: 61 (4), 660-670.

Matete, M. 2010. IWRM and Economic Accounts of Water. Thematic paper presented in the Regional Project Stakeholder workshop, Gaborone Sun, Gaborone, Botswana, 24 – 25 February, 2010.

UN. 2003. Handbook of national accounting: Integrated environmental and economic accounting. Final draft circulated for information prior to official editing: UN, EC, IMF, OECD and the World Bank.

UNSD (in cooperation with the Subgroup of the London Group on Water Accounting). 2005. Integrated Environmental and Economic Accounting for Water Resources (August Draft). UN.

World Resources Institute (WRI). 2005. *World Resources.* Washington: WRI

Useful Websites

*un**stats**.un.org/**unsd**/environment/qindicators.htm*

http://www.ceepa.co.za/publications.html

Annex 1: System of National Accounts

The System of National Accounts (SNA) is an internationally agreed set of guidelines, which gives a comprehensive and consistent description of economic activity in each country. This helps monitor the behaviour of the economy, and assists with macroeconomic analysis, economic policy and decision making.

Because the standards are internationally accepted and implemented, comparisons of economic performance can be made between countries. The SNA consists of a variety of accounts including; current accounts, capital accounts, production accounts, accumulation accounts, balance sheets, and satellite accounts.

Generally the national accounts are intended to record economic transactions that have been observed and can be expressed in monetary terms. This approach has the disadvantage of failing to identify either the scale of environmental damage or the extent of the resource depletion caused by these transactions.

Satellite accounts were introduced to address these perceived limitations within the SNA. In the satellite accounts; the national accounts aggregates are amended to treat natural resources as capital in the production of goods and services. They also record the cost of use (depletion or degradation). Many of the cost and capital items needed to account for natural resources are already identified separately. Others will need to be disaggregated further and reclassified, while others will need to be added. In the SNA only produced assets are included explicitly within net value added.

This introduction took sometimes due to the difficulty to segregate the accounts which can be used by a simple sharing into produced and non-produced accounts from those which necessitate a specific treatment.

Whatever be these difficulties, nonetheless the fact remains that the major identities of the SNA are still available and constitute the main accounting identities for the SEEA. This means that the concepts and items which form these identities must be under control in order to setting-up any water use accounts.

The basis of SNA as well as SEEA is to present under an equation the equality between what has been produced and how it has been used.

This means that during the SNA or/and SEEA process of construction, it must keep in mind that the sum of supply's components is balanced with the sum of use's components.

These items and concepts are also depending on key data. If there is no relevant data (which means having a clear definition), none construction of any accounts is possible. What are the products available for the national economy?

OUTPUT	=	USE
PRODUCTION	=	CONSUMPTION
SUPPLY	=	DEMAND

needs an exchange process in a place (the MARKET)
under the form of :

merchandise → merchandise
merchandise → money → merchandise
money → merchandise → money
money → money

Take into consideration that PRODUCTION precedes CONSUMPTION
and, in a certain extent, that SUPPLY creates DEMAND
then process of production MUST BE COMPARABLE WITH process of use

OUTPUT		
OUTPUT	production of goods & services coming from:	
products	- the national econommy	**P**
importation	- abroad	**M**
OUTPUT =	production + importation	
OUTPUT =	**P + M**	

category 1: must be reclasssified as a product, so as a part of production (P)

category 2: can be considered as partially consumed therefore as to be a particular component of production

category 3: is partially consumed but is considered as a capital for future production, as an investement

category 4: is entirely consumed

category 5: can be considered as consumed even if it has not been done within the territory

USE	
categories of CONSUMPTION	
1. from own production, which is not a real consumption	included in **P**
2. good or service only used for making a good or a service ready to be consumed	intermediate consumption **= IC**
3. good or service used for making a set of goods or services which can be <u>reused</u> in the process of production	fixed capital **= FK**
4. good or service entirely consumed during NA exercise	final consumption **= FC**
5. good or service used or consumed outside the national territory	exportation **= X**

P + M	=	**IC + FK + FC + X**
	OR	
P - IC	=	**FC + FK + X - M**

P – IC	FC + FK + X – M
This identity represents what the country has really produced, this is the VALUE ADDED or the Gross Domestic Product	This identity represents the elements of use expressing how the components of the VALUE ADDED have been used.

These key elements need to be detailed but they express the fundamental basis of a system of national accounts.

Production (output) + Importation

Output

Is the value of goods and services from domestic production activities and from abroad (importation).

Details:

The outputs are from market production, production for own final use, and non-market production in general government and in NGOs. Output of goods and services is not the same as sale of goods and services. Output is published in basic prices, i.e. subsidies on products are included, but not VAT or other taxes on products.

Details:

Total supply

= Output (in basic prices) + Taxes on products - Subsidies on products + Imports

= Output (in producers' prices) + Taxes on imported products + Value added tax + Customs duties + Imports

Intermediate consumption

Value of the goods and services consumed as inputs in the production process, excluding fixed assets whose consumption is recorded as consumption of fixed capital.

Details:

There are more precise definitions in SNA, especially on the borderlines against gross fixed capital formation and compensation of employees. Intermediate consumption refers to goods and services that are used, not purchased goods and services.

Value added (more details)

Values added and gross income generated from domestic production in an industry or sector (or in total for all industries/sectors), derived and defined as output less intermediate consumption. Value added is published in basic prices, i.e. subsidies on products are included, whereas VAT and other taxes on products are not (see basic price).In general government and other non-market activities, value added is compiled as sum of compensation of employees, net taxes on production (taxes on production less subsidies on production) and consumption of fixed capital.

Total uses

= Final consumption expenditure + Gross fixed capital formation + Changes in inventories + Exports + Intermediate consumption

= Total final uses + Intermediate consumption

= Total domestic uses + Exports

= Total final domestic uses + Intermediate consumption + Exports

These productions and importations can be used either for getting on the making of another product or for being consumed. This differentiation is fundamental because it allows to distinguishing the use of product: either as an intermediary consumption or definitively used.

In the same manner, the use of output must be shared into different categories:

- What has been consumed definitively
- What has been invested
- What has left the territory
- **Fixed assets (element of FK)**
- These are produced assets used repeatedly, or continuously, in processes of production for more than one year.
- *Details:*
- *They consist of both tangible fixed assets (dwellings, other buildings and structures, transport equipment, other machinery and equipment, cultivated assets like part of livestock and orchards etc.), and intangible fixed assets (mineral exploration, computer software, originals in art etc.).*
- *Inventories and valuables that are not used repeatedly in production are not recorded as fixed assets. The same is the case for tangible and intangible non-produced assets.*
- **Consumption of fixed capital (element of FK)**
- It is the decline in the current value of the stocks of fixed capital as a result of physical deterioration, normal obsolescence and normal accidental damage.
- **Gross fixed capital formation (element of FK)**
- It is the value of acquisitions less disposals of new or existing fixed assets.
- *Details:*
- *Fixed assets consist of both tangible fixed assets (dwellings, other buildings and structures, other structures, transport equipment, other machinery and equipment, livestock for breeding etc., vineyards, orchards etc.) and intangible fixed assets (mineral exploration including oil and gas, computer software, entertainment, literary or artistic originals, etc.).*
- **Final consumption expenditure of households**
- Expenditure incurred by resident households on consumption of goods and services.
- *Details:*
- *Household durables and semi-durables - except expenditure on dwellings and valuables - are recorded as household consumption expenditure in the period they are acquired (purchased). Expenditure on dwellings by households constitutes gross fixed capital formation, while dwelling services (rentals) are recorded annually over the period of service lives of the dwellings as part of the household consumption expenditure. Acquisitions by households of valuables (antiques, art objects etc.) are recorded as gross fixed capital formation.*

Final consumption expenditure of NPISHs

Expenditure incurred by non-profit institutions serving households on consumption goods and services.

Details:

These expenditures are equal to output and measured as total production costs, i.e. as the sum of intermediate consumption (goods and services that the NPISHs dispose for their production purposes), compensation of employees (use of own labour), consumption of fixed capital (use of own production capital) and any other taxes on production, net, but less income from sale to other sectors. Final consumption expenditure of NPISHs is by convention all individual and used by households as actual final consumption. Final consumption expenditure of NPISHs is mainly financed through government budgets.

Local government final consumption expenditure

Expenditure incurred by local government on consumption goods and services.

Details:

This expenditure is recorded as total costs of production, i.e. intermediate consumption (goods and services that local government disposes for its production purpose), compensation of employees (use of own labour force), *consumption of fixed capital (use of own production assets), any other taxes on production, net, while deducting receipts from sales. In addition, expenditures on consumption goods and services purchased from market producers and supplied directly to households. Grants paid by local government to private day-care institutions for children are considered social transfers to households since local government finances part of these household services.*

Local government final consumption expenditure consists of two main parts, i.e. collective (actual) final consumption of central government, and individual consumption expenditure of central government, which is also part of actual final consumption of households.

Central government final consumption expenditure

Expenditure incurred by central government on consumption goods and services.

Details:

This expenditure is recorded as total costs of production, i.e. intermediate consumption (goods and services that central government disposes for its production purpose), compensation of employees (use of own labour force), consumption of fixed capital (use of own production assets), any other taxes on production, net, while deducting receipts from sales. In addition, expenditures on consumption goods and services purchased from market producers and supplied directly to households, e.g. refunds related to purchases of pharmaceuticals, fees to physicians etc.

Central government final consumption expenditure consists of two main parts, i.e. collective (actual) final consumption of central government, and individual consumption expenditure of central government, which is also part of actual final consumption of households.

Final use categories

Include final consumption expenditure (of households, non-profit institutions serving households (NPISHs) and general government), gross fixed capital formation, changes in inventories and exports.

Gross domestic product (GDP)

GDP is an indicator for total value added in a country, and also an expression for gross income generated from domestic production. GDP is measured in market prices, and is defined and compiled from three different main approaches: for the production approach, the expenditure approach and the income approach.

Production approach =

- Output (basic price) - Intermediate consumption (purchaser price) + Taxes on products - Subsidies on products, *or*
- Output (producer price) - Intermediate consumption (purchaser price) + Taxes on imports + VAT + Customs duties, *or*
- Total value added (basic price) + Taxes on products - Subsidies on products, *or*
- Total value added (producer price) + Taxes on imports + VAT + Customs duties

Expenditure approach =

- Final consumption expenditure + Gross fixed capital formation + Changes in inventories + Exports – Imports, *or*
- Final uses – Imports, *or*
- Final domestic uses + Exports - Imports

Income approach =

- Compensation of employees + Operating surplus + Consumption of fixed capital + Taxes on production - Subsidies on production

Complementary definition of some elements entering in the calculation of components of supply ad use

Taxes on products

Transfers from domestic producers to general government of taxes or excises that are payable per unit of some good or service produced or transacted. The most important taxes on products are the value added tax, excises on motor vehicles, tax on petrol and special taxes on alcoholic beverages.

Accruals basis

This is a principle for recording flows in the accounts. Accrual basis means that output is recorded at the time when being created, not when paid by a purchaser, and assets recorded when change in ownership occurs, not when paid. Interests, taxes and excises are recorded in the time period when accrued, regardless whether paid in this period or not. Transactions in national accounts are basically recorded at accruals basis, although in some cases information available is only related to period when paid, and not when change in ownership of assets occur. This is particularly a problem for some taxes. In these cases, the national accounts introduce certain conventions or methods in order to calculate when taxes are accrued.

Valuation

Supply of products is valued in basic prices, while use of products is valued in purchasers' prices. Purchaser's price is the amount actually paid by the purchaser, including any taxes on products less taxes on subsidies, and including any transport costs. Deductible ingoing value added tax is not included in the purchaser's price. Exports are valued fob, and imports valued CIF on detailed flows (for international reporting, total imports are fob).

Basic value

The value of products is in basic prices. Basic price is amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable to government, and plus any subsidy receivable from government, on that unit as a consequence of its production or sale. Output is recorded in basic prices in accordance with SNA. Intermediate consumption is recorded in purchasers' prices. Value added by industry is recorded in basic prices, as a difference between output in basic prices and intermediate consumption in purchasers' prices.

Market value

Gross domestic product (GDP) is measured in market value, defined as total of value added in all industries in basic prices, adding to it total taxes on products and subtracting total subsidies on products.

Changes in inventories

Value of entries into inventories less the value of withdrawals and the value of any recurrent losses of goods held in inventories. Work-in-progress is included in changes in inventories, as well as work-in-progress on cultivated assets (single-use plants or livestock, and young fish, for later slaughtering). Building of oil platform modules and building of ships are however not recorded as changes in inventories, but as gross fixed capital formation while the construction project is in progress (at accruals value).

Work-in-progress

Goods and services that are partially completed, but that are not usually turned over to other units without further processing or that are not mature and whose production process will be continued in a subsequent period by the same producer.

Subsidies on products

Transfers from general government to domestic producers of subsidies that are payable per unit of a good or service produced. The most important subsidies on products are subsidies on research and development services, on agricultural products and subsidies on private education services.

Market production, production for own final use and other non-market production

Market production covers output sold at prices that are economically significant or otherwise disposed of on the market, i.e. receipts exceeding production costs. Non-market production covers output where products are supplied free or at prices that are not economically significant. It covers also output produced for own final use.

The definitions of market and non-market production are clarified on basis of certain criteria. Non-market production includes production in general government (except water supply and sewage and refuse disposal etc. in local government), production in NPISHs and production for own final use. Production for own final use is distinguished, specifying separate industries, such as agriculture, hunting, fishing and owner-occupied dwelling services. Production in general government and production in NPISHs are also broken down by industries.

The coverage of the assets under the two systems differs significantly. Under the SNA, the asset boundary is used to define the types of goods that can be classified as 'economic assets'. To be defined as an economic asset, it must be of "economic value and be under the ownership or control of an economic agent". As such, natural assets are only included if they provide economic benefits to the owner and have effective ownership or property rights associated with them. This is usually as a result of being controlled by an institutional unit, often via explicit ownership, and having a market price available.

Included within the SNA boundary are environmental assets such as proven subsoil assets, land and water over which ownership rights are enforced, farmed fish stocks and managed forests. Natural fish stocks over which ownership rights are enforced are also included.

Outside the SNA asset boundary are assets such as probable or possible subsoil assets, and land, water, naturally occurring forests, and natural fish stocks over which ownership rights are not enforced. Probable and possible subsoil assets are excluded as they are not of ‘definite’ economic value. There is no guarantee that they will provide economic benefit to the owner. As with natural fish stocks, naturally occurring forests are excluded only if ownership rights are not enforced. Examples of natural fish stocks that will be excluded from SNA are those in protected areas such as marine parks, and proven subsoil reserves in national parks.

Environmental assets such as air are also excluded from SNA, despite the fact that economic activities could not exist without them. They are excluded because no ownership rights are associated with them, and they do not produce economic benefits ‘directly’. Similarly, the SNA excludes environmental assets that produce noneconomic benefits. Services provided by ecosystems such as the cleaning of fouled air and water are excluded from the SNA for this reason (but are included in the scope of the SEEA).

Not only does the SNA exclude assets that are not producing direct economic benefit, or non-economic benefits, the SNA also excludes items that are not of economic benefit to current individuals, such as unproven sub-soil assets.

The SEEA therefore has a wider coverage than SNA and in principle includes all natural assets. It also allows for the measurement of non-use benefits of assets – those that may eventually be of benefit to those currently living, or currently not born. "The inclusion of option, bequest and existence benefits effectively broadens the scope of the SEEA asset boundary to include all land and natural resources. In addition, ecosystems are included in the SEEA asset boundary on the grounds that they provide a variety of services that bring indirect use benefits to humans."9

The SEEA includes those assets that contribute to production activities directly, and those that are simply affected by the environmental impacts of economic activities. The SEEA includes economic assets and noneconomic assets (also referred to as environmental assets) as the focus is on environmental impacts. The details of ownership and control are irrelevant.

The System of Integrated Environmental and Economic Accounting (SEEA)

The three main approaches that have been advanced in physical accounting may be described as follows:

(a) Natural resource accounts describe the stocks and use of different natural resources during the accounting period in a fairly aggregate fashion. Natural Resources Accounts are measured in different units (weight, volume, energy equivalent, area) and are largely consistent with the SNA asset accounts. They can be expressed in monetary units, too, and have thus been developed as an integral part of the SEEA;

(b) Physical input-output tables can be extended to include material flows from, and back into, the environment, presenting these flows in great sectoral detail. Providing a balance of total material inputs and outputs, these tabulations can also be interpreted as material/energy balances;

(c) Material flow accounts attempt to measure the material through the economy as a measure of the sustainability of economic activity in non-monetary terms (usually weight). Material flow accounts describe the extraction, production, transformation, consumption and accumulation of chemical elements, raw materials or products. They may include ecological rucksacks of hidden material flows that are not physically incorporated in a particular output but are required for the production of goods, their use, and the recycling and disposal of wastes.

Environmentally adjusted accounting indicators

The aggregates can be presented as the sum total and elements of conventional accounting identities. These accounting identities are maintained in the SEEA.

(a) Supply-use identity:

$$P + M = IC + C + CF + X$$

Indicating that the supply of goods and services produced (P) and imported (M) equals their use in intermediate (IC) and final consumption (FC), capital formation (KF) and export (X);

(b) Value-added (environmentally adjusted) identity for industry i:

$$EVAi = Oi - ICi - CCi - ECi = NVAi - ECi$$

Describing value added generated by an industry (EVAi) as the difference of output and cost, including fixed capital consumption (CC) and environmental depletion and degradation costs (ECi) or equivalently as the difference of net value added (NVAi) and environmental costs (ECi);

(c) Domestic product identity (environmentally adjusted) for the whole economy:

$$EDP = \sum EVAi - ECh = NDP - EC = C + CF - CC - EC + X - M$$

Defining environmentally adjusted net domestic product (EDP) as the sum of environmentally adjusted value added of industries (EVAi) with a further deduction of environmental costs generated by households (ECh).

Depending on the different valuations described above and their scope and coverage, alternative indicators, adjusted for natural resource depletion or both depletion and environmental degradation, can be compiled. Further adjustment of EDP by deducting factor incomes and current transfers, paid to less received from abroad, and further deducting the costs of transnational environmental impacts would yield an environmentally adjusted national income (ENI) figure. Methodological and data problems have so far precluded such estimates which are therefore not further discussed here. As also discussed in chapter I, the deduction of natural capital consumption (EC), in addition to fixed capital consumption (CC), from gross capital formation, yields environmentally adjusted net capital formation (ECF), an indicator that can be used for demonstrating the non-sustainability of economic performance.

The incorporation of asset accounts in figures II and VI adds another set of identities that explain the difference between opening and closing stocks during the accounting period. They do so in terms of gross capital formation (CF), produced and natural capital consumption (CC and EC), other volume changes, and monetary holding gains and losses measured as revaluation. For non-produced economic natural assets, those stocks reflect the natural resource part of the environmental capacities. They are measures of wealth, which reflect the endowment of a country with economic assets, including natural resources, at the beginning and end of the accounting period. Their use is in the analysis of wealth generation and distribution.

Compilation of produced natural asset accounts

1. Identify the industries for which produced asset accounts are to be compiled, focusing on cultivated natural assets (agriculture, forestry, fishery and so forth).
2. Estimate the value of the fixed asset/inventory stocks at the beginning of the accounting period in current prices (from wealth surveys or research studies).
3. Incorporate national accounts data on gross fixed capital formation, changes in inventories and capital consumption.
4. Assess the value of other volume changes due to natural disasters or other destruction (for example, loss of livestock in floods), uncompensated seizures by authorities, unforeseen obsolescence and changes in asset classifications.
5. Calculate the value of revaluation of assets, that is to say, holding gains and losses resulting from changes in the prices of the assets.
6. Estimate the value of the fixed asset/inventory stocks at the end of the accounting period in current prices.

Examples of indicators from SNA

A simplified presentation of national accounts can take various forms. You will find hereafter a presentation focuses on the key identity by which we started in this document. This presentation can be adapted in function of specific demands, for instance more focused on demand side, or on supply side. These various presentations start from the 3 modes of approach presented with the generic definition of GDP (underlined in blue). The actual presentation is applied for 6 Member's State.

Use side presentation

Year 2008 million of US$	BOTSWANA	SOUTH AFRICA	ZAMBIA	NAMIBIA	MOZAMBIQUE	LESOTHO
final consumption	6 495	223 911	11 741	7 590	8 995	2 135
households	4 142	167 649	8 929	5 805	7 796	1 507
public	2 353	56 262	2 811	1 785	1 199	628
gross capital formation	3 541	62 982	3 818	2 270	1 977	436
gross formation of fixed capital	2 931	64 177	3 629	2 061	2 076	436
changes in inventories	611	- 1 196	189	209	- 99	4
export	5 615	97 771	5 296	3 860	2 443	913
import	4 474	106 338	6 277	4 666	3 481	1 882
net domestic product	11 787	277 129	14 767	9 263	9 834	1 607
gross domestic product	11 734	276 447	14 441	8 825	9 840	1 607

Year 2008 structure in %	BOTSWANA	SOUTH AFRICA	ZAMBIA	NAMIBIA	MOZAMBIQUE	LESOTHO	
final consumption	55,1%	80,8%	79,5%	81,9%	91,5%	132,9%	+
of which households	63,8%	74,9%	76,1%	76,5%	86,7%	70,6%	
of which public	36,2%	25,1%	23,9%	23,5%	13,3%	29,4%	
gross capital formation	30,0%	22,7%	25,9%	24,5%	20,1%	27,1%	+
gross formation of fixed capital	24,9%	23,2%	24,6%	22,2%	21,1%	27,1%	
changes in inventories	5,2%	-0,4%	1,3%	2,3%	-1,0%	0,3%	+
export	47,6%	35,3%	35,9%	41,7%	24,8%	56,8%	+
import	38,0%	38,4%	42,5%	50,4%	35,4%	117,1%	-
net domestic product	100%	100%	100%	100%	100%	100%	=
export minus import in % of NDP	9,7%	-3,1%	-6,6%	-8,7%	-10,6%	-60,2%	

Value Added side presentation

Year 2008 million of US$	BOTSWANA	SOUTH AFRICA	ZAMBIA	NAMIBIA	MOZAMBIQUE	LESOTHO
agriculture	218	8 277	2 915	853	2 508	113
mining manufacture utilities	5 314	76 061	2 472	2 290	2 023	479
manufacturing	427	46 692	1 473	1 206	1 387	273
construction	500	7 717	1 970	261	282	64
wholesale	1 324	31 507	2 845	1 121	1 389	126
transport communication	449	20 073	600	457	902	93
other activities	3 448	104 935	3 272	3 212	2 092	614
Total value added	11 252	248 570	14 074	8 193	9 197	1 489

primary sector = agriculture + mining

secondary sector = manufacturing + construction

tertiary sector = wholesale + transport, communication + other

in % of V.A	Botswana	South Africa	Zambia	Namibia	Mozambique	Lesotho
mining	43,4%	11,8%	7,1%	13,2%	6,9%	13,8%
agriculture	1,9%	3,3%	20,7%	10,4%	27,3%	7,6%
primary	45,4%	15,1%	27,8%	23,6%	34,2%	21,4%
secondary	8,2%	21,9%	24,5%	17,9%	18,1%	22,7%
tertiary	46,4%	63,0%	47,7%	58,5%	47,7%	55,9%

Module 2
Asset Accounts

Goal

To provide an understanding of the aspects of water resources assessment required for the development of asset accounts at various levels.

Learning objectives

At the completion of the module, participants should be able to:-

- Describe the components of the hydrological cycle
- Describe the Water Asset Classification
- Define the stocks for water
- Describe the components of asset accounts
- Prepare Asset Accounts at National Level
- Prepare Asset Accounts at Transboundary Basin Level

Structure of the Module

In this Module we present the approach of compiling a water asset account at national and river basin level; starting by an understanding of the characteristics of the resource, defining the resource stocks and classification of the asset and finally how to prepare information and compile the water asset accounts. The Module is outlined as follows:-

A The Hydrological Cycle and Global Water Balance

B Water Asset Classification and Defining Stocks of Water

C Water Asset Accounts

D Preparing Water Asset Accounts at National and Transboundary levels

2.1 Introduction

Asset accounts describe the stocks of water resources at the beginning and end of an accounting period and the changes in stocks that have occurred during that period. In presenting the understanding of water accounts this module presents (a) A description of the hydrological cycle and the general estimates of global and regional water availability (b) Classification of water accounts and how stocks of water are defined (c) The required information for water asset accounts, its processing and compilation, and finally (d) How to compile the accounts at both national and transboundary levels.

SECTION A

2.2 The Hydrological Cycle and Global Water Balance

The central theme of hydrology is that water moves throughout the Earth through different pathways and at different rates. The most vivid image of this is in the evaporation of water from the ocean, which forms clouds. These clouds drift over the land and produce rain. The rainwater flows into lakes, rivers, or aquifers. The water in lakes, rivers, and aquifers then either evaporates back to the atmosphere or eventually flows back to the ocean, completing a cycle. This cycle is called the water cycle or the hydrological cycle, see Figure 2.1 below.

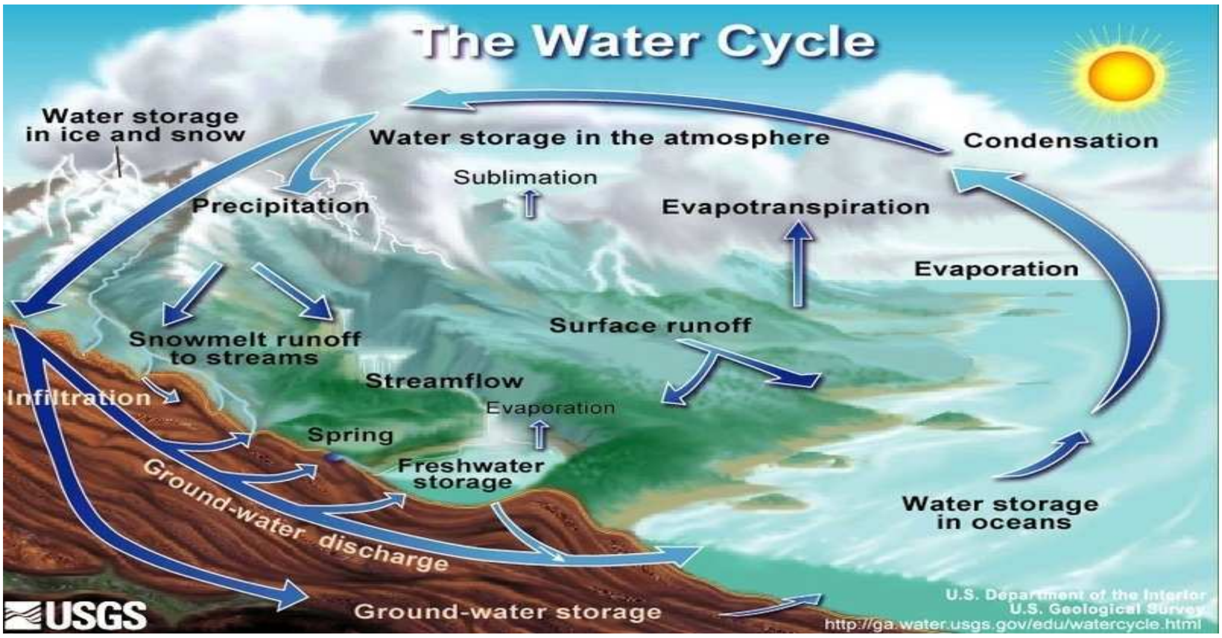


Figure 2.1 Water cycle (source: United States Geological Survey Department)

The understanding of the hydrological cycle is translated to the conservation of the water balance. In whatever pathway the water has moved whether used for plant growth, production, flowed to the ocean, seeped into the ground, this water can be accounted for eventually as it flows to complete and repeat the hydrological cycle over and over again. This understanding forms the basis for water resource accounting. Figure 2.2 below presents the global water balance as seen in the context of the hydrological cycle.

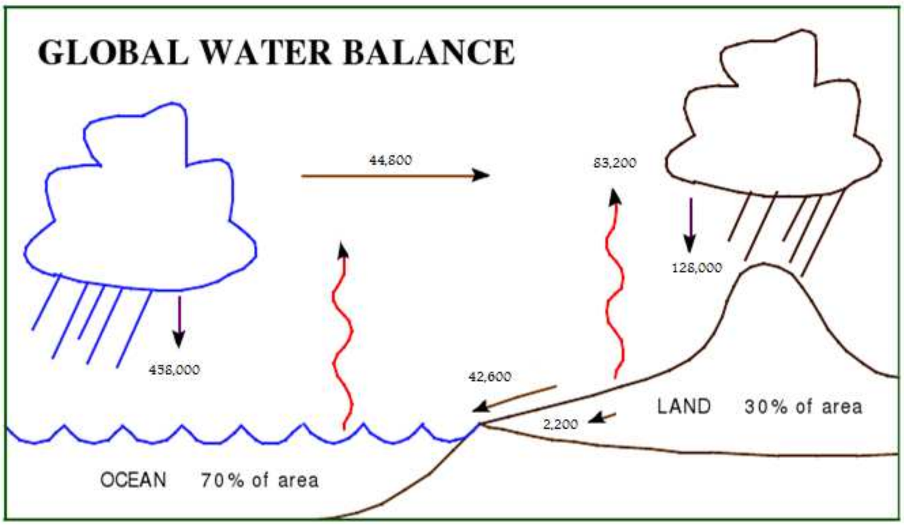


Figure 2.2: Schematic Diagram showing global water balances in the hydrological cycle. Units are km3/yr. Adapted from Hartmann, 1994

2.3 Some Water Resource concepts in water accounting

2.3.1 Integrated water Resources Management (IWRM)

Integrated Water Resources Management (IWRM) is: "*a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*" (Global water Partnership, 2004). This process includes the monitoring and evaluation of progress. As such IWRM takes into account, and requires data at the river basin level on the links between water and the environment, the economy and water, as well as society and water.

2.3.2 Inland water resources

Within the concept of inland water resources are a suite of water resources concepts such as renewable and non-renewable water resources, natural and actual water resources, internal and external renewable water resources, and exploitable water resources (UNSD, 2006). These concepts are used as a basis for many international water indicators regarding inland waters.

2.4 Renewable and non-renewable water resources

Water resources are either renewable or non-renewable. Renewable water resources are represented by the long-term annual average flow of surface water and groundwater. Non-renewable water resources are groundwater bodies (usually contained in deep aquifers) that have a negligible rate of recharge relative to the size of the aquifer (i.e. the storage or stock) (UNSD, 2006).

2.4.1 Internal renewable water resources

Internal renewable water resources (IRWR) are that part of the water resources (surface water and groundwater) generated from endogenous precipitation. The IRWR figures are the only water resources estimates that can be added up for countries to create a regional IRWR figure. By way of contrast, Total Renewable Water Resources (TRWR) cannot be added to create a regional figure since this would result in double counting (the part of the IRWR of a country that flows to a downstream country would be added to the IRWR of the downstream country to estimate its TRWR).

Although the hydrological cycle links all waters, in many instances surface water and groundwater are studied separately and represent different opportunities for use. Surface water flows can contribute to groundwater replenishment through seepage in the river bed. Aquifers can discharge into rivers and contribute their base flow, which is the sole source of river flow during dry periods. In some cases, instead of only calculating surface water runoff and groundwater recharge from precipitation, total surface water flows are added to total groundwater recharge, in which case the "overlap" between surface water and groundwater needs to be removed (UNSD, 2006).

2.4.2 Internal flow

Similar to the concept of IRWR is the concept of internal flow. Internal flow is the total volume of river runoff and groundwater generated, in natural conditions, exclusively by precipitation into a territory, and is calculated as precipitation less evapotranspiration. In many cases internal flow and IRWR are the same, for example in countries where there are no significant inflows of water from other territories and there is relatively insignificant evapotranspiration of water used to irrigate. However, in some cases where there are large inflows of water from neighboring territories and there is evaporation of this water, internal flow can be much lower than IRWR, and may even be negative. In other cases there may be significant evapotranspiration of water used for irrigation. In these cases, the evaporation of inflows and evapotranspiration of irrigation water should not be deducted from precipitation. Only the evaporation of endogenous precipitation should be deducted from precipitation. If these adjustments are made, then internal flow and IRWR will be equal even though they are calculated differently.

2.4.3 External renewable water resources

External renewable water resources are the part of a country's renewable water resources that enter from upstream countries through rivers including a part of the resources of shared lakes or boundary rivers. Most of the inflow from neighboring territories consists of surface water inflows, but it can also consist of groundwater transfers between countries. However, groundwater transfers are rarely known and their assessment requires a good knowledge of the piezometry of the aquifers at the border. In arid areas such as part of Botswana and Namibia, they may be important in comparison with surface flow.

2.4.4 Natural and actual renewable water resources

Natural renewable water resources correspond to a situation without human influence, while actual renewable resources correspond to the current situation taking into account possible reductions in flow resulting from the abstraction of water in upstream countries. Natural renewable water resources are the total of a country's internal renewable water resources (IWRW) and natural external renewable water resources, including both surface water and groundwater generated annually calculated as a long term annual average.

Actual renewable water resources are the sum of internal renewable resources (IRWR) and external renewable resources (ERWR), taking into consideration the quantity of flow reserved to upstream and downstream countries through formal agreements (e.g. treaties) and possible reduction of external flow due to upstream water abstraction. Unlike natural renewable water resources, actual renewable water resources vary with time and water use patterns.

2.4.5 Exploitable water resources

Exploitable water resources are that part of the renewable water resources that is accessible for use (i.e. can be abstracted). These are sometimes referred to as manageable water resources or the water development potential. To determine the quantity of exploitable water resources many factors have to be considered, such as: the economic and environmental feasibility of storing floodwater behind dams or extracting groundwater; the physical possibility of catching water which naturally flows out to the sea; and the minimum flow requirements for navigation, environmental services, aquatic life, etc.

SECTION B: Water Assets and Asset Classification

2.5 Defining Water Assets

Water resource assets are defined as water found in fresh and brackish surface and groundwater bodies within the national territory that provide direct use benefits, now or in the future (option benefits), through the provision of raw material, and may be subject to quantitative depletion through human use.

2.6 Asset classification

The asset classification of water resources consists of the following categories (Based on the SEEAW asset classification):

- EA.13 : Water Resources (measured in cubic meters)
- EA.131: Surface water
- EA.1311: Artificial reservoirs
- EA.1312: Lakes
- EA.1313: Rivers and streams

- EA.1314: Glaciers, snow and ice
- EA.132: Groundwater
- EA.133: Soil water

The explicit inclusion of soil water in the SEEAW asset classification reflects the increasing importance of this resource in terms of stocks and also allows for a clearer representation of water exchanges between water resources. Water in the soil, for example, is a very important resource in SADC (both in terms of stocks and flows) for food production as it sustains rainfed agriculture, pasture, forestry, etc. Water management tends to focus on water in rivers, lakes etc. And neglects soil water management, even though the management of soil water holds significant potential for water savings, increasing water use efficiency and the protection of vital ecosystems.

Surface water comprises all water that flows over or is stored on the ground surface (UNESCO/WMO International Glossary of Hydrology, 1992). Surface water includes *artificial reservoirs,* which are man-made reservoirs used for storage, regulation and control of water resources; *lakes* which are, in general, large bodies of standing water occupying a depression in the earth's surface; *rivers and streams* which are bodies of water flowing continuously or periodically in channels; *snow and ice* which include seasonal layers of snow and ice on the ground surface; and *glaciers* which are defined as an accumulation of ice of atmospheric origin, generally moving slowly on land over a long period.

Groundwater comprises of water which collects in porous layers of underground formations known as aquifers. An aquifer is a geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs. It may be unconfined, that is it has a water table and an unsaturated zone, or may be confined when it is between two layers of impervious or almost impervious formations. Depending on the recharge rate of the aquifer, groundwater can be fossil (or non-renewable) in the sense that water is not replenished by nature in human life spans. Note that the concerns of non-renewable water applies not only to groundwater, but also to other water bodies: for example, lakes may be considered non renewable when the replenishment rate is very small compared to the total volume of water.

Soil water in this manual refers to water that is used for rain-fed agriculture which is critical for agriculture in SASDC. This water is sometimes referred to as green water.

The asset classification can be adapted to specific situations depending on data availability and country priorities. For example, the classification could be further disaggregated to classify artificial reservoirs according to the type of use, e.g. for human, agricultural, hydroelectric power generation and mixed use. Rivers could be further classified on the basis of the regularity of the runoff as perennial rivers, where water flows continuously throughout the year, or ephemeral rivers, when water flows only as a result of precipitation or to the flow of an intermittent spring.

Note that boundaries between the different categories in the asset classification, such as between lakes and artificial reservoirs and rivers and lakes/reservoirs, may not always be precise. This, however, is mostly a hydrological problem and does not affect the accounts. In those cases in which the separation between two categories is not possible, a category combining the two categories could be introduced for ease of compilation in the table.

2.7 Fresh and non-fresh water resources

Water resources include all inland water bodies regardless of their salinity level: they include fresh and brackish inland water. Freshwater is naturally occurring water having a low concentration of salt. Brackish water has salt concentration between that of fresh and marine water. The definition of brackish and freshwater is not clear cut: the salinity levels used in the definition vary between countries. Brackish water is included in the asset boundary on the ground that this water can be (and often is) used, with or without treatment, for some industrial purposes, for example, cooling water or even for irrigation of some crops.

The asset classification of water resources can be further disaggregated to distinguish between fresh and brackish water. This would allow for a more detailed analysis of the stocks of water and their uses according to the salinity level. Quality accounts for water which will be described later in this module can be based on salinity levels.

2.8 Water in oceans, seas and atmosphere

The asset classification of water resources excludes water in oceans, seas and atmosphere because the stocks of these resources are enormous compared to the abstraction. These assets, in general, do not incur depletion. Water in oceans, seas and atmosphere is recorded in the accounts only in terms of abstracted water. In particular:

- the physical supply and use tables (see chapter 5) record: (a) water abstracted from and returned into the sea (in the case, for example, of abstraction of sea water for cooling purposes or for desalination); (b) the precipitation directly used by the economy (in the case, for example, of water harvest); and (c) evaporation and evapotranspiration which occur within the economic sphere (part of water consumption);
- the asset accounts record: (a) water flowing into oceans and sea (outflows from rivers); (b) water vaporized and evapotranspired from water resources; and (c) precipitation into water resources (flow from the atmosphere into the inland water resources).

2.9 Produced versus non-produced assets

All water resource assets described in the previous paragraphs are considered in economic accounting for water as ***non-produced assets***, that is, they are “non-financial assets that come into existence other than through processes of production” (para. 10.6, 1993 SNA). It could be argued however, that water contained in artificial reservoirs comes into existence through a production process: a dam has to be built, and, once the dam is in place, activities of operation and management of the dam that regulate the stock level of the water have to be exercised on a continuous and regular basis. The discussion on whether to consider water in a reservoir as a produced asset has not yet concluded. For this reason, this manual has retained the classification of the SEEA-2003.

2.9.1 Produced Assets

These include infrastructure put in place to abstract, distribute, treat and discharge water. Produced asset for water are already included in the national accounts as fixed assets; hence they are implicitly included as part of the core national accounts. However, this information is generally highly aggregated and at national level – special surveys may be necessary to separately identify those fixed assets that related to water.

Changes in the value of these stock of assets during the accounting period are explained by changes due to transactions in the item in question (acquisitions or disposals of non-financial assets; consumption of fixed capital), changes in the volume of the asset that are not due to transactions (e.g. discoveries of assets or recognition of their value; the unanticipated destruction of assets; changes in classification etc.), and changes in price. Accounts for produced assets for water are very crucial since they provide information on the level of investment in water infrastructure and thus the ability of the country to mobilize and treat water.

2.9.2 Stocks of water and stock of Rivers

The concept of a stock of water is related to the quantity of surface and groundwater in a territory of reference measured at a specific point in time (beginning and end of the accounting period). While for lakes, reservoirs and groundwater the concept of a stock of water is straightforward (even though for groundwater it may be difficult to measure the total volume of water), for rivers it is not always easy to define. Water in a river is in constant movement at a much faster rate than the other water bodies: the estimated residence time of world's water resources is about two weeks for rivers and around ten years for lakes and reservoirs (Shiklomanov, 1999).

To keep consistency with the other water resources, the stock level of a river should be measured as the volume of the active riverbed determined on the basis of the geographic profile of the riverbed and the water level. This quantity is usually very small compared to the total stocks of water resources and the annual flows of rivers. However, the river profile and the water depth are important indicators for environmental and economic considerations. There might be cases, however, in which the stocks of river may not be meaningful either because the rate of the flow is very high or because the profile of riverbed changes constantly due to topographic conditions. In these circumstances, computing the stock of rivers is not realistic and can be omitted from the accounts

2.9.3 Link with Supply and Use tables

Asset accounts in physical units are linked with the supply and use tables that are discussed in Module 4. In particular, changes due to human activities in the asset accounts, namely abstraction and returns, represent the intersection of the supply and use tables with the asset accounts. The abstraction that appears in the asset accounts in Table 2.1 corresponds to the Abstraction from Water Resources by the economy in the physical use table, row 1.i of Table 4.1. Similarly, the returns that appear in Table 2.1 correspond to the Total Returns to Water Resources in the physical supply table, row 5.a of Table 4.2.

The link between physical water asset accounts and physical supply and use tables is analytically important as it provides information on the sources of water for the economy as well as the destination of water discharges by the economy. It allows for the evaluation of the pressure exerted by the economy on the environment in terms of abstraction and returns.

SECTION C: WATER ASSET ACCOUNTS

2.10 Defining Asset Accounts

Asset accounts measure the stock of water resources at the beginning and end of the accounting period as well as changes in stocks that occur during that period (see Figure 2.1).

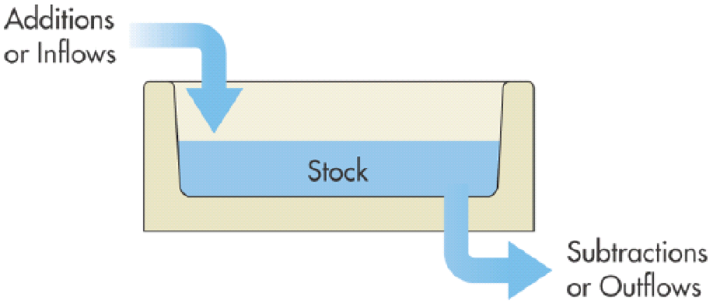


Figure 2.1: Changes in stock of water

These stocks include the stock of natural water resources as well as stock of water infrastructure for storage, treatment and distribution of water.

Asset accounts for water can be divided into two components: produced asset which are man-made infrastructure for storage and distribution of water and natural water resources. Asset accounts present the following:-

- Opening and closing stocks which are the stocks level at the beginning and end of the period of time;
- Increases in stocks which include those due to human activities (i.e. returns) and natural causes (e.g. inflows, precipitation); and
- Decreases in stocks which include those due to human activities (i.e. abstraction) and natural causes (e.g. evaporation/evapotranspiration, outflows etc.).

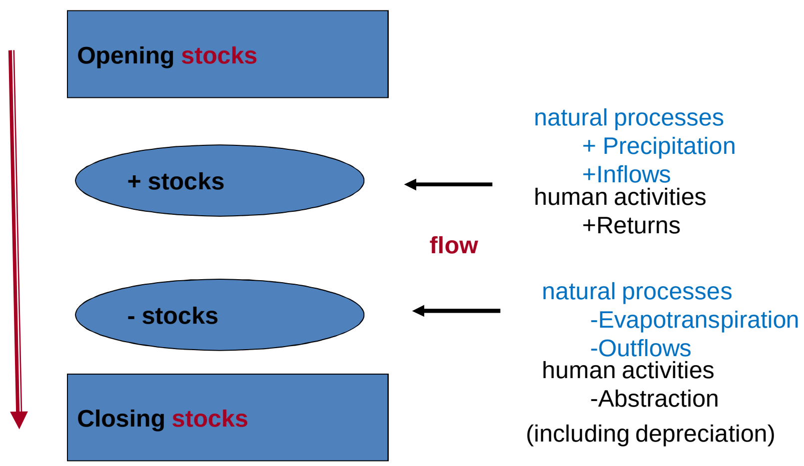


Figure 2.3: Changes in Stock

These accounts are particularly relevant because they link water use by the economy (represented by abstraction and returns) and natural flows of water to the stocks of water in a country. The standard table for asset accounts for water resources is presented in Table 2.1. The columns refer to the water resources as specified in the asset classification, and the rows describe in detail the level of the stocks and the changes therein due to economic activities and natural processes.

The items presented in the table are discussed in detailed below:

Table 2.1: Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.1313 Rivers		EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks	1,500	2,700	5,000		100,000	500	109,700
Increases in stocks							
2. Returns from the economy	300	0	53		315	0	669
3. Precipitation	275	430	230		-	22,500	23,435
4. Inflows	1,054	339	20,890		237	0	22,520
4.a. from upstream territories			17,650				17,650
4.b. from other resources in the territory	1,054	339	3,240		237	0	4,870
Decreases in stocks							
5. Abstraction	300	0	141		476	50	967
6. Evaporation/Actual evapotranspiration	346	520	333		-	20,125	21,324
7. Outflows	1,000	100	20,773		87	2,340	24,300
7.a to downstream territories			9,430				9,430
7.b to the sea	-	-	10,000		-	-	10,000
7.c to other resources in the territory	1,000	100	1,343		87	2,340	4,870
8. Other changes in volume							0
9. Closing Stocks	1,483	2,849	4,926		99,989	485	109,732

Precipitation consists of the volume of atmospheric wet precipitation (e.g. rain, snow, hail etc.) on the territory of reference during the accounting period before evapotranspiration takes place. The majority of precipitation would fall on the soil and would thus be recorded in the column of soil water in the asset accounts. Some precipitation would also fall into the other water resources e.g. surface water. It is assumed that water would reach aquifers after having passed through either the soil or surface water (e.g. rivers, lakes, etc.), thus no precipitation would be shown in the asset accounts for groundwater. The infiltration of precipitation to groundwater is recorded in the accounts as an inflow from other water resources into groundwater.

Inflows represent the amount of water that flows into water resources during the accounting period. The inflows are disaggregated according to their origin: (a) inflows from other territories/countries; and (b) from other water resources within the territory. Inflows from other territories occur with shared water resources. For example, in the case of a river that enters the territory of reference, the inflow is the total volume of water that flows into the territory at its entry point during the accounting period. If a river borders two countries without eventually entering either of them, each country could claim a percentage of the flow to be attributed to their territory. If no formal convention exists, a practical solution is to attribute 50 per cent of the flow to each country. Inflows from other resources include transfers, both natural and man-made, between the resources within the territory. They include, for example, flows of infiltration and seepage as well as channels built for water diversion.

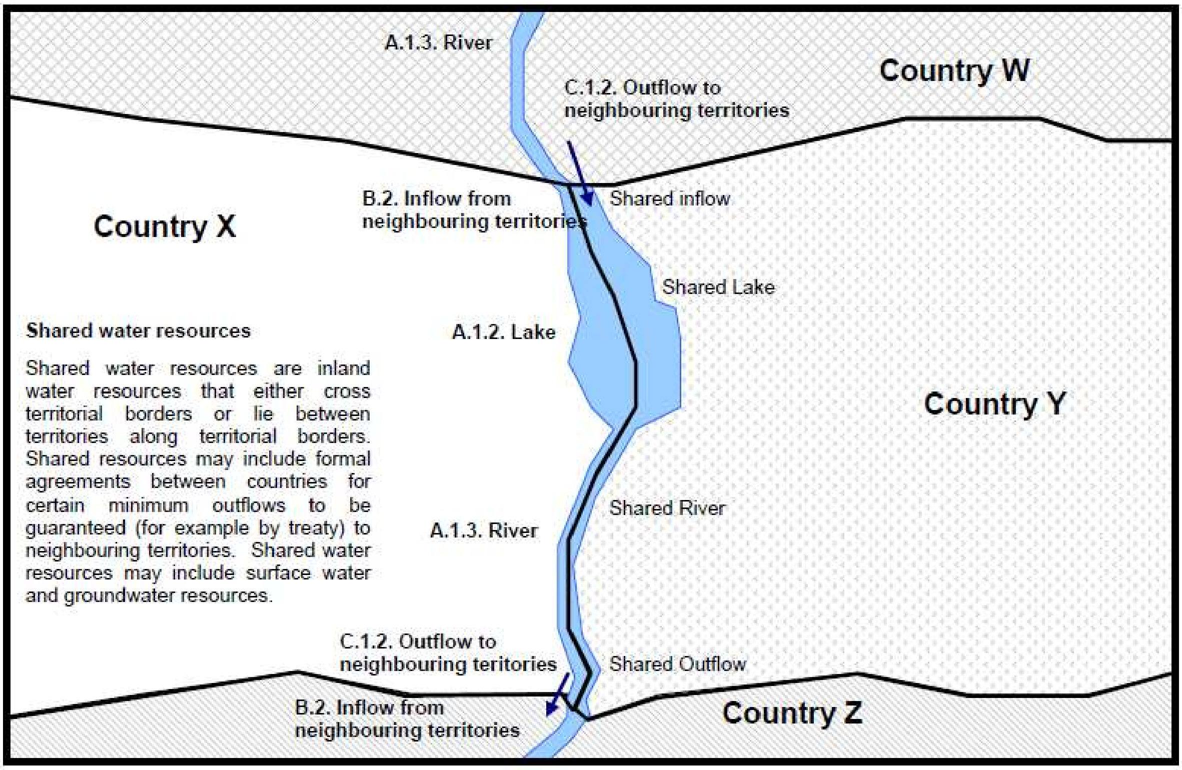


Figure 2.3: Asset Account for a river shared by two or more countries

Abstraction represents the amount of water removed from any resource, either permanently or temporarily, during the accounting period for final consumption and production activities. Water used for hydroelectric power generation is considered part of water abstraction. Given the large volumes of water abstracted for hydroelectric power generation, it is advisable to separately identify the abstraction and returns from hydroelectric power generation. Abstraction also includes the use of precipitation for rain-fed agriculture as this is considered a removal of water from the soil as a result of human activity (e.g. agriculture). Water used in rain-fed agriculture is thus recorded as an abstraction from soil water.

Evaporation/Actual evapotranspiration is the amount of evaporation and actual evapotranspiration that occurs in the territory of reference during the accounting period. Note that evaporation refers to the amount of water evaporated from water bodies such as rivers, lakes, artificial reservoirs, etc. Evapotranspiration refers to the amount of water that is transferred from the soil to the atmosphere by evaporation and plant transpiration. Evapotranspiration can be "potential" or "actual" depending on the soil and vegetation conditions: potential evapotranspiration refers to the maximum quantity of water capable of being evaporated in a given climate from a continuous stretch of vegetation covering the whole ground and well supplied with water. Actual evapotranspiration, which is reported in the accounts, refer to the amount of water that evaporates from the land surface and is transpired by the existing vegetation/plants when the ground is at its natural moisture content that is determined by precipitation. Note that actual evapo-transpiration can only be estimated through modeling and may be a rough approximation.

Outflows represent the amount of water that flows out of water resources during the accounting period. Outflows are disaggregated according to the destination of the flow, namely (a) to other water resources within the territory, (b) to other territories/countries and (c) to the sea/ocean. Outflows to other water resources within the territory represent water exchanges between water resources within the territory. In particular, they include the flows of water going out of a water body and reaching other water resources within the territory. Outflows to other territories represent the total volume of water that flows out of the territory of reference during the accounting period. Shared rivers are a typical example of water flowing from one upstream country to a downstream country. Outflows to the sea/oceans represent the volume of water that flows into the sea/oceans.

Other changes in volume include all the changes in the stocks of water that are not classified elsewhere in the table. This item may include, for example, the amount of water in aquifers discovered during the accounting period, disappearance or appearance of water due to natural disasters, etc. Other changes in volume can either be calculated as a residual or directly.

In Table 2.1 sustainable water abstraction which, broadly speaking, is the level of abstraction which meets the needs of the present without compromising the ability of future generations to meet their own needs, can be specified for each water resource. This variable is exogenous to the accounts and it is often estimated by the agencies in charge of water management and planning in a country. Its estimation takes into account economic, social and environmental considerations.

2.10.1 Spatial References

The choice of the spatial reference for the compilation of the accounts ultimately depends on the objectives of the analysis. The compilation of national water accounts is important for designing and evaluating macro-economic water policy. However, to reflect better spatial differences in the water use, supply, pressure on water resources and to make decision on water allocation between different users, it is often more appropriate to use a finer spatial reference.

The water accounting framework can in principle be compiled at any level of geographical disaggregation of a territory. The options are usually to compile the accounts either at the level of administrative regions, river basins or accounting catchments.

An **administrative region** is a geographic area designated by the provincial government for administrative purposes. Administrative regions are usually responsible for certain economic policies within their jurisdiction and regional economic accounts are usually compiled for administrative regions.

A **river basin** is a naturally defined region which is drained by a river or stream. It is internationally recognized that the river basin is the most appropriate unit of reference for Integrated Water Resource Management: Agenda 21 (UNCED) and the SADC Protocol on Shared watercourses call for the adoption of water management plans at river basin level. Water management can in fact be more effectively pursued at the river basin level since all water resources, including groundwater, within a river basin are inextricably linked to each other both in terms of quantity and quality.

In this way, managers are able to gain a more complete understanding of overall conditions in an area and the factors which affect those conditions. For example, emissions from a sewage treatment plant might be reduced significantly, and yet the local river and groundwater may still suffer if other factors in the river basin, such as polluted runoff from upstream emissions, go unaddressed.

As there are often large spatial differences in terms of availability and use of water resources between different river basins of a country, especially in "water stressed" countries, the use of national averages is not always sufficient for sound policy decisions at the local level. Policy analyses for each main national "basin area" (a homogeneous basin area formed by the association of contiguous river basins) are generally required. In addition, the compilation of the accounts by local basin data providers for their water management needs is generally essential to sustain their involvement in the water accounting process. River basin organisations have been established in SADC.

While the compilation of physical water accounts at river basin can be easily done (as river basin organisations generally collect physical data at river basin level), the compilation of monetary water accounts at river basin requires extra work to reconcile the spatial reference of economic information (such as output, value added etc.) which is only available at administrative region. Some countries have experimented in developing accounts at river basin level based on regional economic accounts.

Depending on the characteristics of the administrative regions and river basins in a country, it may be useful to define regions for the compilation of water accounts for which both economic and physical data are more easily available. Such regions, which are referred to as **accounting catchments**, would be composed by river basins or sub-basins and large enough so that economic information is available. An accounting catchment could consist, for example, of an administrative region and be composed by several river basins or it could be composed by several administrative regions to cover a whole river basin.

2.10.2 Temporal Dimension

The temporal reference of economic data generally differs from that of hydrological data: hydrological data generally refer to the hydrological year (which is a 12-month period such that the overall changes in storage are minimal and carryover is reduced to a minimum); economic data, and in particular accounting data, refer to the accounting year. It is imperative that the hydrological and economic data used in the accounts refer to the same temporal reference. Moreover, it is recommended that the reference period for the compilation of the accounts is the 12-month accounting period of the national accounts.

Yearly accounts often hide potential seasonal variability of water use and supply as well as of availability of water resources in the environment. Ideally, quarterly water accounts would be useful in the analysis of intra-annual variations. They are, however, very data demanding thus are often not considered a feasible option. The choice of the frequency of the compilation of the accounts depends on the availability of data and the type of analysis. Annual accounts provide detailed information on water resources and their use and allow for a detailed time series analysis. However, there may be cases where compiling annual accounts on water use may not provide significant information: the inter-annual variability may not be greater than the variability of the estimation procedure. Moreover an increase of those water uses which depend heavily on the climatic variations (such as agriculture) may be interpreted as a structural change of water use while in reality it may just be a short term increase in response to a climatic change. An alternative could be the compilation of accounts on water use every three or five years which would allow for a sufficiently complete analysis of the water use trend (Margat, 1996).

To reflect long hydrological cycle (longer than a year) "budgetary" accounts could be compiled. These accounts combine average data on water resources (budgetary asset accounts) with actual annual information on water use. Budgetary asset accounts refer to an average year in a series of years long enough to be stable (20 or 30 years) and provide information on the average annual water availability in the environment. These accounts could be also supplemented with accounts for a particular year, e.g. the dry year, which would describe the worst condition of the natural water system. Annual water use accounts describe the water use of the economy in a particular year.

Combining hydrological information on annual averages with economic information on water use for a specific year can be justified by the fact that while the variability of water resources is pseudo-cyclical and their average is relatively stable in the long term and in a given climatic situation (and it is often the reference for the assessment of water resources), water use tends to change over the years (due, for example, to increasing population and changes in the structure of the economy). Therefore the combination of these two types of information would allow for the analysis of the natural water supply in relation to the evolution of human water demand (Margat, 1996).

SECTION D: PREPARING ASSET ACCOUNTS AT NATIONAL AND RIVER BASIN LEVELS

2.11 Compiling Asset Accounts at National Level

At national level accounts are prepared in accordance with the information provided in Table 2.2 below:

Table 2.2 Asset account at national level

Cubic Metres

	Water Resources (classified according to the asset classification)	Legal Quotas established by treaties
1. Opening Stocks		
Increases in stocks		
2. Returns		
3. Precipitation		N/A
4. Inflows		
4.a. from upstream territories		
4.a.1 country (a)		
....		
4.b. from other resources in the territory		N/A
Decreases in stocks		
5. Abstraction		
6. Evaporation / Actual evapotranspiration		N/A
7. Outflows		
7.a to other Water Resources in the territory		N/A
7.b to the sea		N/A
7.c to downstream territories		
7.c.1 Country 2		
.....		
8. Other changes in volume		N/A
9. Closing Stocks		

2.12 Compiling Asset Accounts at Transboundary Level

When the accounts are compiled for water resources that are shared by several countries, the part of the shared resources which belongs to each riparian country as well as the origin and destination of specific flows can be explicitly identified. Two international conventions on transboundary water (The Helsinki Convention, 1996 and UN Convention on the Law of the Non-navigational Uses of International Watercourses, 1997) as well as the SADC Protocol on Shared watercourses cover issues related both to the quality and quantity of transboundary waters. Physical water asset accounts can provide information on inflows coming from and outflows going to neighboring countries.

Table 2.2 presents an example of how information on transboundary waters can be made explicit in the asset account: inflows and outflows are further disaggregated according to the country of origin (in the case of inflows) and destination (in the case of outflows). In addition, since some flows may be subject to agreements between riparian countries, information on the established quotas is reported alongside with information on the actual flows. If there is an agreement that establishes the part of the transboundary waters that belong to the country, the opening and closing stocks are measured by the quota established in the agreement.

If the territory of reference of the accounts is a river basin which extends beyond the boundary of a country, the opening and closing stocks of water resources could be disaggregated according to the country the water resources belong to. Similarly, information on abstraction and returns could be disaggregated according to the country responsible for those flows. Table 2.3 presents an example of an asset account for a river basin shared by two countries. Note that the same structure can be used in the case where there are more riparian countries sharing waters.

The opening and closing stocks of the water resources in the basin are disaggregated by country according to the quotas established in treaties if they exist. Abstraction and returns are further disaggregated according to the country abstracting and returning water. In principle, a country can abstract water only from its share of the asset. However, there may be cases that a country abstracts more than their share of the stock that is assigned by a treaty. In this case, there is a transfer of water from one country to the other.

Established quotas for abstractions and returns (merely in physical terms) as well as on other flows can be included in the tables in a separate column to monitor the compliance to the treaties as in Table 2.2. However, for sake of simplicity of presentation, this information is not included in the Table.

Table 2.3: Asset accounts for a river basin shared by two countries

Cubic Metres

	Water Resources (classified according to the asset classification)		
	Country 1	Country 2	Total
1. Opening Stocks			
Increases in stocks			
2. Returns			
2.a by Country 1			
2.b by Country 2			
3. Precipitation			
4. Inflows			
4.a Country 1			
4.b Country 2			
Decreases in stocks			
5. Abstraction			
5.a by Country 1			
5.b by Country 2			
6. Evaporation / Actual evapotranspiration			
7. Outflows to other resources in the country			
7.a Country 1			
7.b Country 2			
8. Outflows to the sea			
9. Other Volume Changes			
10. Closing Stocks			

2.13 Water Accounting at River basin (spatial and temporal references)

Economic accounting for water can provide data for water management at many geographic levels, from the local catchment, to national, to the river basin levels. The choice of the spatial reference for the compilation of water accounts ultimately depends on the data needed by users (e.g. decision-makers, analysts and researchers) and the resources available to data producers.

Water resources are not evenly distributed in time and space. Within SADC variability can be seen in the difference between arid regions of Namibia where almost no precipitation falls and humid regions of DRC Congo where several metres of rain can fall yearly. Even at a smaller spatial scale, there can be a great variability in the availability of water: within the same river basin there can be areas subject to water scarcity while others are subject to flooding. The temporal distribution of water resources depends on the characteristics of the water cycle. There is in fact a rain cycle for which periods of high rainfall alternate with dry periods, for example, on a yearly basis, dry summer months are followed by wet winter months. The frequency of the water cycle varies with climatic regions and the inter-annual variability can be significant.

Since water accounts consist of integrating hydrological information with economic information which is compiled according to the SNA and uses as spatial reference the country or administrative regions, and as a temporal reference the accounting year and in some cases smaller temporal references (such as quarterly accounts), some issues in the reconciliation of the temporal and spatial reference of the two sets of data arise.

In general, priority should be given to the spatial and temporal reference of the conventional economic accounts. The main reason being that it is easier to adapt the reference of hydrologic information to that of the conventional economic accounts, as hydrological data are often available at a more disaggregated spatial and temporal level than economic data. As a second principle, in order to allow for meaningful comparisons through time, the spatial and temporal references of the accounts should not be changed.

2.14 Empirical Examples

2.14.1 Empirical Example (Case of the Incomati River Basin)

An attempt has been made to apply the river basin account approach (Table 4.3) for water assets, which is the table proposed in the Methodologies for water accounts. The Incomati River Basin is shared by three riparian states namely Swaziland, South Africa and Mozambique according to upstream downstream listing of the countries. Figure 4.3 shows the map of the Incomati River Basin. Some level of information for constructing water accounts is available for part of the basin under the Komati River Basin Water Authority (KOBWA) which covers Swaziland and South African part of the basin.

Location:The Incomati System

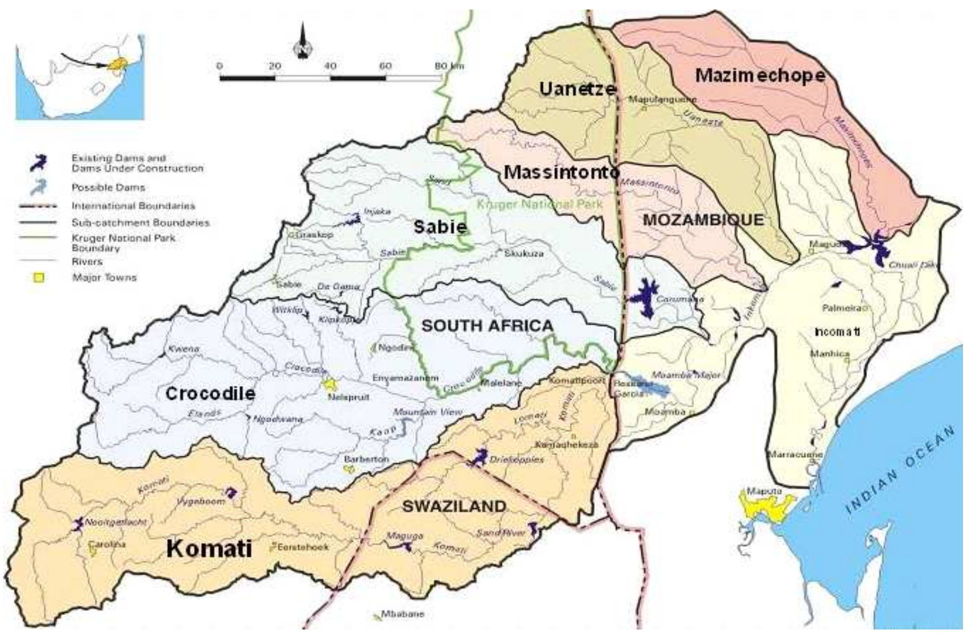


Figure 2.3: The Incomati River Basin

An asset account was constructed using Table 4.3 for this stretch of the basin. This is a one year account covering the period April 2009 – March 2010. Table 4.4 below presents the results.

Table 2.4 Asset account for part of the Komati River Basin (Mm3/a)

	Water Resources (classified according to the asset classification)		Total
	Swaziland	**South Africa**	
1. Opening Stocks	335.1	194.4	529.5
Increases in stocks	***963.4***	***1074***	
2. Returns	N/A	N/A	N/A
3. Precipitation	-	-	-
4. Inflows	826.5	898	-
5. Acruals	136.9	176.0	312.90
Decreases in stocks	***974.7***	***1005.0***	
5. Abstraction	225.8	276.2	502
6. Evaporation/(dam evaporation)	9.2	-2.0	7.2
7. Outflows to other resources - riverine losses (includes evaptranspiration & seepage losses)	13.7	33.6	47.3
8. Outflows to next country	726.0	697.2	697.2
9. Other Volume Changes	-	-	-
10. Closing Stocks	**323.8**	**263.4**	587.2

While reasonable information is available in the sub-basin, groundwater use information is not as readily available. Evapotranspiration information is considered as part of river channel losses and is estimated. Precipitation is considered as part of inflow, both on the reservoir water surface as well as already contributed in the inflow into the reservoirs and in the river channel. A systems approach that is aligned to the management approach of this part of the basin has been followed in presenting the inflow for this case study. This is, of course, a simplified approach to the detailed representation of inflow in the proposed standardized methodologies, which would have otherwise required a lot of effort to disaggregate the inflow into the reservoirs which is computed as total inflow by KOBWA. KOBWA estimates inflow into the reservoirs using a mass balance approach. Inflow in this context is essentially inflow into the two major reservoirs under KOBWA's responsibility and out of Swaziland. Surface water evaporation on reservoirs is accounted by KOBWA and is also used for monthly water use reconciliation. There are no significant returns due to improved irrigation systems. However, there are accruals which add to increase in stock which are largely a result of runoff from fields and ungauged streams. Since this is only part of the entire basin, outflow goes to Mozambique and not into the sea. The basin outlet for this purpose is at Lebombo before the confluence with the Crocodile River in South Africa, just before the Incomati River enters Mozambique.

In conclusion, it can be noted from this case that the information available at KOBWA is relatively highly aggregated as compared to information requirement in the water accounts tables. From a transboundary management point of view, this part of the Incomati is relatively at a more advanced level of information availability (particularly for asset water accounts) as compared to other basins. Actual monthly abstraction information is available and is kept up-to-date. This might be an indicator for consideration of aggregated information as a starting point for compiling river basin accounts, in the application of the proposed methodology for this project.

2.15 Group Exercise

Using the information presented in Table 2.1 and assuming a national population of 2.4 million, calculate the following:-

- Per capita water storage
- Index of non-sustainable use of water

2.16 Notes to the Facilitator

About this Module

This module is designed to address the training needs of technical staff to mid level staff of Departments of water, environment, statistics and agriculture; water utilities; municipalities and other institutions interested or engaged in compilation of water accounts. This module facilitates an interactive exchange of opinions, perspectives and experiences of participants on some of the key benefits and challenges of compiling Water Asset Accounts. You can allow for substantive discussion and encourage active participation by way of role playing.

Issues addressed include the usefulness of Water Asset Accounts in:-

- Deriving the index of non-sustainable water use and relative water stress Index
- Deriving indicators on total actual renewable water resource per capita

On completion of this module, participants will be able to:

- Prepare asset accounts and derive key indicators such as per capita water storage

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. The background papers should also be distributed to the participants well in advance. The main background papers for this module are:

Lange, G. and Hassan, R. (2006) The economics of water management in southern Africa: An environmental accounting approach. Edward Elgar Publishing Limited, Cheltenham, UK

United Nations et al, 2003. Integrated Environmental and Economic Accounting. United Nations, European Union, European Commission, International Monetary Fund, Organization for Economic co-operation and Development, and The World Bank

UNSD, 2006. System of environmental-economic Accounting for Water. United Nations Statistics Division, New York, USA

UNSD, 2010. International Recommendations for Statistics. United Nations Statistics Division, New York, USA

Facilitation

The module is designed for face-to-face facilitation. The duration is **approximately 2.5 hours.** This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator would need to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver this module.

The group exercise is described in detail in the attached Word Document titled "**Group Exercise on Water asset Accounts".** The exercise engages participants to calculate and apply indicators derived from water asset accounts. It is an opportunity to maximize interaction between participants and allow them to learn from each other through sharing knowledge and experience.

It is important to structure the presentation and Q&A period for the group exercise carefully in order to allow sufficient time for a productive discussion. The Q&A period per presentation should not exceed 15 minutes.

Be sure to clarify the objective of the training and describe the agenda at the start of the session. This gives structure and direction to what you intend to do. It is important to emphasize the link between this module and flow accounts such as the Physical Supply and Use Accounts in Module 3.

Participant Evaluation

An evaluation questionnaire should be provided to allow participants to assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your Feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to g.manase@gmail.com

2.17 Additional Reference Material

European Environment Agency, 2009. Guidance on the reporting required for assessing the state of, and trends in, the water environment at the European level.

http://eea.eionet.europa.eu/Public/irc/eionetcircle/water/library?l=/reporting_eionetwfd/guidance_2009pdf/_EN_1.0_&a=d]

Eurostat, 2005. Standard quality indicators. Eurostat. Quality in Statistics Eurostat, Seventh meeting,

Luxembourg, 23-24 May 2005.

http://epp.eurostat.ec.europa.eu/pls/portal/docs/PAGE/PGP_DS_QUALITY/TAB47143233/STANDARD%20QUALITY%20INDICATORS.PDF]

FAO Aquastat website: http://www.fao.org/nr/water/aquastat/main/index.stm

FAO, 2003. Review of World Water Resources by Country. Water Reports 23.

http://www.fao.org/DOCREP/005/Y4473E/Y4473E00.HTM].

GWP 2004. Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies. See Institutional Roles, p. 19.

http://www.gwpforum.org/servlet/PSP?iNodeID=215&itemId=496

SNA, 2008. System of National Accounts 2008.

http://unstats.un.org/unsd/sna1993/draftingPhase/WC-SNAvolume1.pdf]

Statistics Canada 2003. Standard Drainage Area Classification (SDAC) 2003.

http://www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdac-ctad-eng.htm]

Thaunoo-Chadee, P. and S. Sham-Jacmohum, 2007. Status of Environment Statistics in Mauritius: Country Report.

http://unstats.un.org/unsd/environment/envpdf/UNSD_UNEP_ECA%20Workshop/Mauritius.pdf]

UNSD webpage. Searchable Archive [Online

http://unstats.un.org/unsd/envaccounting/ceea/archive/Introduction.asp]

UNSD, 2007. System of Integrated Environmental and Economic Accounts for Water 2008. http://unstats.un.org/unsd/envaccounting/SEEAWDraftManual.pdf]

UNSD, 2008. International Recommendations for Industrial Statistics 2008.

http://unstats.un.org/unsd/industry/guidelines.asp]

WMO, 2001. Exchange of Hydrological Data and Products.

http://www.wmo.ch/pages/prog/hwrp/documents/TD74.pdf]

WMO, 2003. Hydrological Data Management: Present State and Trends.

http://www.whycos.org/IMG/pdf/964_E.pdf]

WMO, 2006. Guidelines on the Role, Operation and Management of National Hydrological Services

http://www.wmo.ch/pages/prog/hwrp/documents/WMO%201003.pdf]

Module 3
Quality accounts

Goal

The module aims to create an understanding of the value of water resources as measured by its quality.

Objectives of the Module

The objectives of this module are to:

- Give an understanding of water quality
- Explain the importance quality accounts in economic accounting of water
- Give an overview of current methods for producing water accounts
- Highlight challenges in preparing water accounts
- Give examples of quality accounts in practice

Module Structure

The module is divided into six sections:

1. Introduction
2. Overview of water quality including definitions
3. Narrative of importance of producing quality accounts and provides methods of producing water accounts
4. Key issues in quality accounts
5. Examples of quality accounts
6. Implications of quality accounts to decision makers.

3.1 Introduction

Global quality of water resources has become an issue due to the vast resources which remain unusable due to deteriorating quality. In Africa the highest medical expenses are due to diarrhoea diseases which result from use of poor quality water. The occurrence of diarrhoea among children under the age of 5 years is used as an indication of the quality of potable water indicating the direct relationship between water quality and health. The importance of water quality is now even more important due to the high HIV prevalence rate in Southern Africa. People suffering from HIV and AIDS have compromised immune systems which make them susceptible to infections if they use water of poor quality. Water quality related problems do not only affect health but also industry as its quality determines the use to which the water will be put. It is important that a nation understands the quality of the water resources at its disposal.

International efforts are being made to find out the best methodologies for producing quality accounts. Whilst water quality methodologies have not yet been agreed on, the importance of water quality in water resources management cannot be questioned. In the SADC region like other parts of the world water resources availability has been decreased by the fact that significant volumes are now unusable due to bad water quality. In Zimbabwe poor quality has resulted in the water hyancinth in Chivero and the Manyame River. This poor quality has resulted in increased water treatment costs for the city of Harare. It is therefore critical that water quality accounts are incorporated in efforts to understand and improve the management of water resources in the SADC region.

3.2 Concepts of Water Quality Assessments

3.2.1 Description of Water Quality

Water quality refers to the state of the water based on agreed dimensions. The quality of water results from natural processes in the environment to which the water is exposed to as well as from the anthropogenic activities. Some of the natural processes include erosion, wind and oxidation. The anthropogenic processes include industrial processes, agriculture and disposal of wastewater into the streams. All these processes have an impact on the chemical, physical, hydro morphology and biological characteristics. The water quality of a given water source is therefore described in terms of the chemical, physical and biological characteristics (Table 3.1).

The biological components refer to the living components in the water which include both flora (plants) and fauna (animals). Examples of the biological characteristics can be measured in terms of micro organisms and other sensitive plants such as algae. The physical components refer to the physical attributes such as the temperature, ph, conductivity and turbidity. The chemical components include nitrates and phosphates.

Table 3.1: Categories of Water Quality Parameters and Examples

Physical	Chemical	Biological
Ph	COD	Faecal coliforms
Temperature	BOD	Helminth
Turbidity	Nitrates	
Total suspended solids	Phosphates	
Colour	Pesticide	
	Heavy metals	
	Chlorine	

Think about it:

Which of the above water quality parameters have you worked with? In drinking water biological components are said to be the most important. Do you agree or disagree. Why?

The quality of the water is determined by the values of the physical, chemical and biological parameters and hence these parameters are commonly termed determinants since they determine the quality of the water. (Determinant and parameter can be used interchangeable) The different determinants give indication to certain broad categories of water quality indicators. Examples of determinants used to measure various indicators in Europe are shown in Table 3.2

Table 3.2: Indicators and their determinants included in SEQ-eau

Indicators	Determinants*
Organic and oxidizable matter	Dissolved O_2,COD, BOD_5,DOC,NKJ,NH_4^+
Nitrogen (except nitrates)	NH_4^+,NKJ,NO_2^-
Nitrates	NO_3^-
Phosphorus	PO_4^{3-}, total P
Suspended matter	Suspended solids, turbidity, transparency
Colour	Colour
Temperature	Temperature
Salinity	Conductivity, Cl^-,SO_4^{2-},Ca^{2+},Mg^{2+},K^+,TAC, hardness
Acidity	ph, dissolved A1
Phytoplankton	%O_2, and pH, chlorophyll a+ pheopigments, algae, ?O_2(24HRS)
Micro –organisms	Total coliforms, faecal coliforms, faecal streptococci
Mineral micro-pollutants in water	Arsenic, mecury, cadmium, lead, total chromium, zinc, copper, nickel, selenium, barium, cyanides
Metal or bryophytes (moss)	Arsenic, mecury, cadmium, lead, total chromium, zinc, copper, nickel
Pesticides in water	37 substances are concerned
Organic pollutants (except in water)	59 substances are concerned

Source: UNDS 2006

3.2.2 Approach to Water Quality Determination

Basically this can be done using:

3.2.2.1 The Functions Approach

This shows how the parameters relate to the intended functions or use. This recognizes the different intended uses for water and then assesses how the determinants fare versus the use into which water would be put. This is done by considering several indicators and the levels of their relevant determinants. Table 3.2 above shows common indicator categories and the types of determinants which can be used to determine the quality of water resources

The recognized functions vary from country to country. For South Africa the recognized functions are given as

- Domestic
- Industrial
- Agricultural
- Recreational purposes

In the case of Zimbabwe the recognized functions are

- Environmental
- Domestic
- Agriculture
- Industrial

The functions approach is the one commonly used in the SADC region.

3.2.2.2 The Energy Quality Approach

In this approach water quality is determined with respect to total hydraulic and osmotic power of river basins. This approach recognises that the water resources quality is affected by the salt concentration and the altitude. In general high salt concentrations decrease water available for animal and plant nutrition whilst lower altitude diminishes the potential for production of hydropower. There is no known application of this approach in the SADC region. Even globally there are not many studies that relate water resource quality to power qualities which can be evaluated by hydraulic power (HP) and osmotic power (OP). Total power (TP), obtained by adding OP to HP, can give an idea of the total power of a basin. Currently, this fact is very important in the SADC region as an increase in the price of energy (energy = power · time) can affect the short term implementation of water policy (water transfer or water desalination) in the countries where water is a scarce resource.

3.2.2.3 Ecosystem Health Approach

This is where water quality is determined by assessing the living components of the river system. The common terminology used is biomonitoring. Plant and animal species which are sensitive to the changes in the environment are used to measure water quality. Some plants and animals are known to thrive only in pristine environments whilst others will tolerate the harshest of water quality environments. This approach has been used in South Africa and Zimbabwe.

3.2.3 Where Should One Measure The Quality Of Water

The choice of the place to measure the water quality is dependent on the use of the result. One can measure the quality of the

- water body,
- water bed and
- even the riparian zone.

Situations where one would measure the quality of the water bed would be where one intends to understand further history of the location as some components can sink into the bed and may not be detected by measurements in the water body. However should some disturbances occur to the bed these can then be measured in the water body itself. One may also need to measure the quality of the riparian zone to determine the kind of vegetation to plant close to the river. The riparian zone quality may also be determined when one need to know how the quality of the body will be affected by its immediate environs and vise versa. The quality of the water body is determined when one needs to abstract and use the water. For this module we are interested in use of the water in the various economic activities and therefore the water body quality is what will be explained further.

Food-for-thought Question:

One needs to put a new wastewater treatment plant so that the waste can be disposed into the nearby river. Where would samples for water quality be collected to determine whether or not permission should be granted. Explain your answer.

3.2.4 Presentation of the Water Quality Status

Since water quality has many determinants the desired quality is often described by the level of selected desired variables above or below which the quality should not exceed. This level acts as the reference condition and acceptable level of variations are then indicated. The quality of water is often described as good or bad but strictly speaking these terms do not say anything as they are subjective to the intended use. For example water with nitrate content of 10 mg/l maybe bad for drinking but good for irrigation purposes. The term good may also be in reference to one particular parameter hence the call by some quality scientists for development of a water quality index. The terms good and bad also depends on targets set by the regions. Whilst in Europe water with of a certain can be regarded as poor for drinking in another region this level can still acceptable for drinking. Reference conditions vary from country to and from use to use. Legislative bodies in countries define the reference conditions to be maintained for their countries. These are sometimes termed water quality standards. Global bodies like the WHO will give general guidelines to be followed but countries will develop their own enforceable standards.

Reflection Questions:

Do you know the acceptable water quality standard for NO3, ph and coliforms for fresh water resources in your country?

The water quality standards differ from country to country. Do you think this is a good practice? Why?

Water quality is often reported in terms of the discrete classes of the determinants. This makes it easy to report and to give practical information which users need to make decisions. The water quality determines the use to which the water would be put. Many countries especially in the developed world have categorized uses of water into drinking, leisure, irrigation and industry. The quality to be attained by water used for these purposes is then indicated. South Africa has also categorized into four uses which are:

- Agriculture
- Domestic
- Recreational
- Industry

Quality guidelines for each of these parameters have also been given using selected indicators chosen for each category.

Botswana has also classified its water use into four uses which are

- Domestic
- Institutional
- Commercial
- Industrial

However no quality guidelines are provided for these uses.

3.2.4.2 Approaches to Presentation of Quality Results

The Water Quality Index

In this approach an index is derived by considering the levels of determinants and their respective categories and then giving them weighting which will be used to compute the index. This index is then used as a reference point. No examples of this in use have been attempted in the SADC region. However in France the index system has been used.

Using Ecological Status

This approach has been widely used by the European Water Framework Directive. The water quality is measured by how much it deviates from reference conditions. The WFD recognizes five ecological statuses which are high, good, moderate poor and bad based on the physical, chemical and biological determinants. The general description of these classes is shown in Table 3.3.

Table 3.3: Physico-chemical quality elements used for the ecological status classification of rivers in the WFD

Element	High Status	Good Status	Moderate Status
General Conditions	The values of the physicochemical elements correspond totally or nearly totally to undisturbed conditions. Nutrient concentrations remain within the range normally associated with undisturbed conditions. Levels of salinity, ph, oxygen balance, acid neutralising capacity and temperature do not show signs of anthropogenic disturbance and remain within the range normally associated with undisturbed conditions	Temperature, oxygen balance, pH, acid neutralising capacity and salinity do not reach levels outside the range established so as to ensure the functioning of the type specific ecosystem and the achievement of values specified above for the biological quality elements. Nutrient concentrations do not exceed the levels established so as to ensure the functioning of the ecosystem and the achievement of the values specified above for the biological elements.	Conditions consistent with the achievement of the values specified above for the biological quality elements.
Specific synthetic pollutants	Concentrations close to zero and at least below the limits of detection of the most advanced analytical techniques in general use.	Concentrations not in excess of the standards set in accordance with the procedure detailed in section 1.2.6 without prejudice to Directive 91/414/EC and Directive 98/8/EC	Conditions consistent with the achievement of the values specified above for the biological quality elements.
Specific non-synthetic pollutants	Concentration remain within the range normally associated with undisturbed conditions	Concentrations not in excess of the standards set in accordance with the procedure detailed in section 1.2.6 without prejudice to Directive 91/414/EC and Directive 98/8/EC	Conditions consistent with the achievement of the values specified above for the biological quality elements.

In this system the determinants are categorized into the predefined categories. Each determinant is given a value between 0 and 1. The value 1 reflects the reference condition whilst the value 0 reflects the furthest one can go away from the reference conditions. In other words values close to 1 show good while values close to 0 show worst conditions. The space 0-1 is subdivided into 5 sub intervals high, good, moderate, poor and bad. These ecological statuses can be comparable across European countries after standardizing/calibrating the results.

The quality class for the quality element is determined by two ways. In one scenario the medians, averages can be used but this is only done when the determinants in the quality class have similar responses to changes in the water body environment. In the second way the group of determinants do not show sensitivity to the same range of elements so the determinant with the worst class becomes the class of that quality elements. The worst class from among the relevant quality elements determines the class status of the water body.

Reflection Question:

Using the WFD method, state which determinant will determine the quality of the water body. Assume that determinants do not have similar responses.

Quality Element	**Determinants and levels**
Oxygenation quality element	BOD moderate, COD high, DO worst

3.3 Quality Accounts

3.3.1 Why should they be considered

The water quality accounts present the overall impact of the economic development on the water as measured by its various parameters. Because it presents impacts as measured by the various sub components affected by activities it is regarded as first step towards ecosystem accounting. The state in which the water is in is very important as it determines whether or not it will be used and the purposes to which it can be used. The reasons for considering quality accounts can be stated as:

1) Determining the impact of the specific activity on water resources- With determination of water quality impacts of certain activities can accurately be described
2) Determining the economic value of the resources- The quality determines what the water can and cannot be used for and hence its economic value
3) Decision making – The resultant impact of economic activities on water quality will assist decision makers in deciding whether or not to continue with the activities
4) Determining economic value of activities
5) Decide on charges for economic units
6) Assessing the efficiency of the applied protective and restorative measures by those mandated to ensure health water resources.

3.3.2 The Structure of Water Quality Accounts

Whilst the asset accounts describes the volume of water stocks at the beginning and end of an accounting period the water quality accounts describes the quality of the stocks of water resources at the beginning and end of the accounting period. It goes one step further than the asset accounts so that the quality of the stocks available can be known. Knowing the stocks with no indication of their quality does not really assist in allocations of the available resources. It should be stressed that the methodology of constructing water quality accounts has not yet been agreed but some nations have experimented using the one proposed by the SEEWA 2006 hand book. The basic structure of a Water Quality account is shown in Table 3.4.

Table 3.4: Basic Structure for Water Quality Accounts

Physical Units

	Quality Classes				
	Quality 1	Quality 2	Quality---	Quality N	Total
Opening Stocks					
Changes in stocks					
Closing stocks					

Each column under quality classes represents the volume of water of a certain quality class at the beginning and end of an accounting period. As many columns as the quality classes measured during the accounting period will be drawn in. If there are 25 quality classes then quality N in table above will be quality 25. The last column titled Total represents by volume the total stocks available.

The inputs for Opening stock and Closing stock are obtained by the direct measurements done. The inputs for the row changes in stock are derived by calculating the difference between opening and closing stocks.

Exercise:

Fill in the total for the quality accounts of Country X using information provided in table

Physical Units

	Quality Classes				
	Quality 1	Quality 2	Quality 4	Quality 5	Total
Opening Stocks	43430	330	1000	1200	
Changes in stocks					
Closing stocks	41000	205	990	1100	

3.3.3 Measurement of the Quality Classes

The quality classes are defined by the criteria set by the countries. For example in the WDF there are 5 quality classes namely very good, good, average, bad, poor. As already mentioned, each entry in Table 3.4 represents the amount of water of a certain quality measured in volume. However conducting this measurement is not easy. There are proposed methods for flowing water (rivers, streams) and for groundwater.

3.3.3.1 Determining Quality Class for Rivers

It has been agreed that a unit called the Standardized Kilometer Unit will be used for preparing water accounts. This has been revised to the term standard river unit (SRU). This unit represents a river stretch of one kilometer with a water flow of one cubic meter per second. Determination of quality classes is done as follows:

1. Divide the river into homogenous stretches. The river is divided into appropriate numbers of homogenous. The division can be made at points where consecutive monitoring stations have been located. The division is based on homogeneity of both water quality units and water flow.

2. Measure the length of the stretch and the flow in that particular stretch

3. Calculate the value of the SRU unit- The value of the SRU if given by the length of the stretch (L) and flow of the water (q)

Quality accounts of a single river can be compiled by summing up the corresponding SRU per quality class.

It can clearly be seen that for large basins with many rivers the process can be very tedious and time consuming. For example in France the total number of SRU using rivers mapped at the 1:1 400 000 is 10.8 million whilst if one uses the rivers mapped on a standard 1:50 000 map the SRUs increase by 2.5 times. Therefore it is recommended that quality accounts are calculated only for the areas being monitored and where quality assessments need to be done. In general the contribution of small rivers is left out during the calculation of quality accounts.

Exercise:

Calculate the water quality accounts of the Mupfure river which is divided into six homogenous stretches using the given information below

Physical Units

	Quality Classes				
					Total
Opening Stocks					
Changes in stocks					
Closing stocks					

Information supplied for the Opening Stocks

	Name of river stretch					
	A	B	C	D	E	F
Length in m	80	60	150	130	75	90
Flow m/s	5	12	20	8	15	17

You are also given that quality a & d are the same quality class so is b and f. You are also given that the difference in opening and closing stocks for all the stretches is 20%

It should be noted that the Total column in the water quality accounts does not correspond to the total columns in the asset accounts. The one for asset accounts is given by volume whilst the one for quality accounts is given in SRU units or (Lq).

3.3.4 Calculating the Quality Accounts For Groundwater

The quality of groundwater general does not vary much within the aquifer or groundwater unit. Further the extent of flow is generally negligible and calculations are made using the volumetric units such as cubic meters. For example if a given aquifer has 100 m3 of water and its quality class based on nitrates is good then we can safely put 100 under the quality class good.

3.3.5 Points to Remember in Constructing Water Quality Accounts

Influence from natural and economic spheres

Water quality accounting as already mentioned is useful in assessing the efficiency of the measures put in to regulate, protect and improve water bodies. The analysis of the change in stock data can be used to give an indication of the effectiveness of the protective and restorative measures. However the measured changes in quality not only result from pollutants emitted by the economic units but also from self purification processes, changes in dilution factor due to abstraction, increased runoff and new regulations on emissions. To illustrate the point lets assess the expression which gives us water quality at any given time *t1* as function of the variables which make contributions to quality. Water quality at *t1* is the result of a non linear function f of water quality at *t0* and those factors which can cause changes to the quality. From the statement above we can state this as

Water quality at *t1* = *f(water quality t0)*{?(uncontrolled events),? (abstractions),? (emissions),? (expenditures for restoring environments)}*

Where:

?uncontrolled represent events which cannot be related to any event in the economic sphere and ?abstractions, emissions and expenditure represent those changes related to the economic units.

Because of this complication of factors which influence quality, the observed changes in stock quality cannot be directly linked to the economic units under consideration. It is difficult to direct attribute changes in quality to events in the economic sphere alone since the measured quality is an aggregate of the changes due to the natural environment and those from the economic units and it is difficult to disaggregate the impacts into those from natural and from economic units. This makes the accounts much simpler as relational relationships are not included in the accounts.

Think about it:

A river passes through an industrial area and X amount of pollutants are discharged into the systems. In the same section the river bed is know to contain high levels of iron which result from the iron containing rocks. At the same area the river is know to contain plant species which absorb large quantities of oxygen. After passing this section a sample of water is taken to record the quality parameters. How would you determine the impact of the natural pollution from that of the industrial area?

However if the accounting period is for a period where it is known that there were no major events which affected the water quality then effectiveness of applied measures can be assessed using quality accounts.

Lack of linear relationships

It should be emphasized that quality accounts do no have a direct linear relationship to the activities which affect them making it very difficult to predict or extrapolate the impacts of the activities on the quality of the water. Furthermore it should not be concluded that linear relationships exist between expenditures for restoring environments and the observed changes as the changes are always determined on interactions within the water bodies as well.

No standardization of aggregation methods

Water quality parameters can be aggregated with certain agreed weightings to give one aggregate factor. However the aggregation can be done over a season or a year to give values fore the different parameters. Furthermore data measured at three different places can be added up and divided to give an average value for the three different locations.

3.4 Important Issues in Water Quality Accounts

3.4.1 Standardizing Water Quality Accounts

The water quality accounts have not yet been standardized because they vary across countries due to two major issues which are

- The choice of determinants to use
- The choice of assessment method

3.4.1.1 The Choice of Determinants

The number and type of determinants used in water quality assessments vary from country to country. Though the determinant category may be the same, the exact name and number of determinants used will vary. Table 3.5 shows the variations in the number of determinants used across determinant categories for four countries

Table 3.5: Determinants Used

Determinant group	Number of determinants				
	Total	*Of which:* specific to Canada	*Of which:* specific to France	*Of which:* specific to South Africa	*Of which:* specific to determinants
Biological information	**5**	1	1	2	
Environmental	10	1	1	1	6
Gases dissolved	5		2	1	1
Metals (and metalloids)	24	3	2	1	9
Nutrients	5		1	1	1
Organic matters	7		4	1	
Other	1			1	
Pathogenic germs	8	1		3	2
Pesticides	68	22	23	6	4
Radioactivity	26	26			
Salinity	14		1	3	4
Toxics (n-metal, n-pesticides	104	36	38	3	2

The number of determinants used is often dependent on:

Local quality issues- The local quality issues with emphasis being placed on the determinants which are likely to be problems. For example river passing through agricultural land are likely to monitor determinants to do with nitrates and phosphates.

What is practical and achievable- The choice of determinants is usually a compromise of the inputs from scientific, political and economic data. Though countries may want to monitor the whole range of a determinant category sometimes it is just not financial possible. Some times accurate methods of quantifying the desired determinants are not there. For measurement of all active substances in pesticides and biological toxins like cyanotoxins is difficult as some substances such as toxic hydrocarbon derivatives are not soluble in water and therefore collection of water samples may not give accurate readings of such substances.

Think about it:

Find out the determinant categories used in your country. Which determinants categories are important in your country for regular water quality monitoring. Why.

From the explanation above it can be clearly seen that standardization of determinants is difficult and due to the lack of this standardization comparison of results across basins and countries is difficult.

Think about it:

One water quality scientist from Namibia stated that the water quality in his country is good. Another one from the Netherlands also stated that the water quality in his home country is also good. The reporter reported that Namibia and Netherlands have the same water quality. Is the reporter correct or wrong. Why?

3.4.1.2 The Choice of Quality Assessment Methods

The choice of the method to use in deriving quality classes also varies. Basically two approaches have been widely used.

1. The rule of the worst/ One out, all out

In this rule the most detrimental value or most negative value is used to determine the quality class. The worst value can be considered at the determinant, indicator or classification level depending on the level on which the quality classes should be presented. If this rule is used for one determinant or one indicator it shows that peak pollution levels are the most important ones. It means that a water body can be classified as bad even if only 1 out of say 12 readings is in the bad category. Further it means no changes can be detected across years as long as there is the worst value in the two years under comparison are in the same category. This complication is illustrated by example below.

There are two locations in a river namely location A and B.

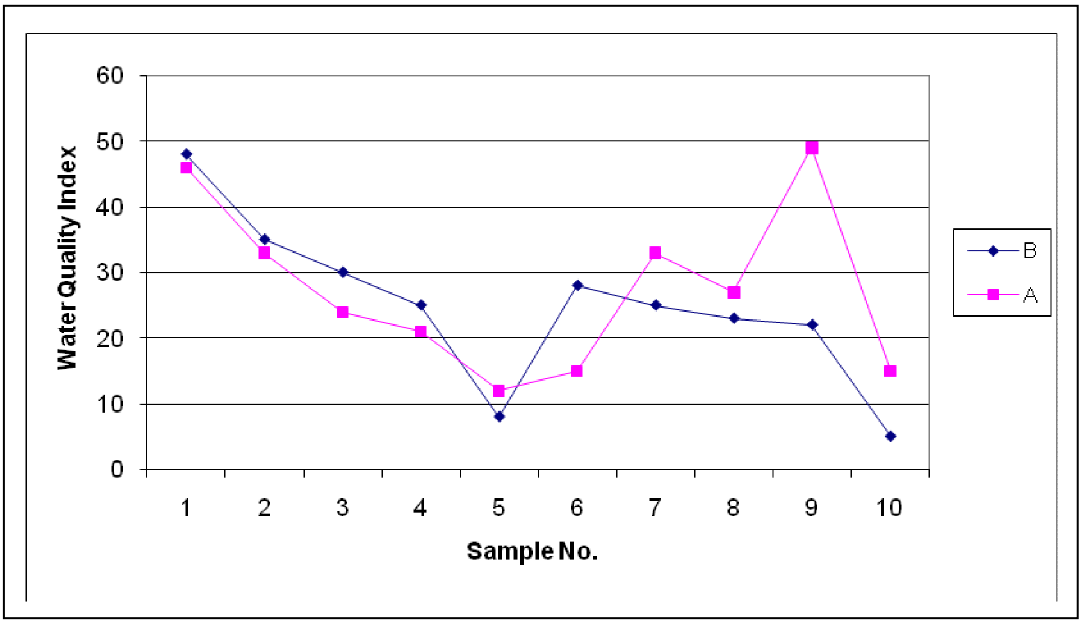


Fig 3.1: Variations in water quality at two locations A and B

10 samples were collected from each of the two locations in two consecutive years in order to determine change in the quality of stocks. Samples 1 -5 are for year 1 whilst samples 6 – 10 are for year 2. The results were aggregated to give water quality index which were then classified into 5 quality classes with given water quality index range as follows:

Excellent – Water index range	40 - 50,
Good –	31-40
Average –	21-30
Bad -	11-10
Worst-	0-10

The results were plotted into the respective classes to give graph in Figure 3.1 above.

Using the worst rule, there is no difference in the quality of year 1 and 2 for location B because the worst value in both years was in the worst category. However the graph shows that in comparison the second year had better quality resources.

Using the same rule shows that at location A the quality only moved only moved from the worst to the bad class because in year 1 the worst value was in the worst category but in year 2 the worst value was in the bad category. However the graph shows significant improvements than are picked up buy the worst rule.

In practice the worst rule has the following disadvantages

- Poor disaggregation of quality classes since water bodies are classified as bad whether it has one or 20 readings in the bad category
- Discourages expansion/increasing of monitoring variables because when these are increased then chances of getting one reading in the worst category are likely to increase.
- Does not reflect seasonal variations in quality since it records the worst quality attained in the accounting period which is usually a year.

There has been modification to use of the worst *rule. In* countries like France the quality has been decided by the worst value observed in at least 10% of the sample under consideration. Thus if one has 100 samples and only 5 show the worst category, 8 show bad, 11 show moderate and 70 show excellent and good the quality class would be moderate.

Weighting of Trespassers -This principle has been used widely in Canadian Council Ministers of the Environment. In this principle 3 factors of trespassing values are weighted. These are:

1) Number of determinants beyond their threshold values (S). This is given by number of failed determinants/total number of determinants
2) The frequency of trespassing during the determinant period (F). This is given by number of failed tests/total number of tests
3) The distance between the threshold and the observed (E). This is given by (observed value/target value)-1

All the factors are normalized so as to fall in the range of 0-100 where 100 represents best quality. The water quality index is then calculated as

WQI = 100- square root of (S2+F2+E2)/3

This method work with annual series data and it is recommended that at least 4 data series are required. The Canadians recognize 5 quality classes as follows

100-95 Excellent, good (94-80), fair (79-65), marginal (64-45) poor (44-0)

Calculate the quality index of the water for a given river X given that the number of failed determinants beyond threshold value = 5, frequency of trespassing = 12 and the distance between the threshold and observed = 15.

3.4.2 Use of Water Quality Indices in Water Quality Accounting

One attempt to try and aggregate water quality determinants is to produce water quality indices. The process of constructing water quality indices is still being experimented with. It should be noted that indices produced are targeted at addressing a need. Some of the major indices constructed are:

The Regional Quality Generalized Index (RQGI)- This index aggregates water quality data over basins and would be desired for measuring efficiency of water management programmes existent in the basins.

Do you know which basins in the SADC region have a water management programme?

The RQGI is given by the weighted average of quality classes according to the Standard River Units (SRU). It results in values between 0-10 where 10 is the best value.

The Pattern Index- This measures variations in the quality classes that underlies a particular RQGI score for a given basin. This index is used in differentiating between areas in the basin where water of uniform quality and those where hot spots indicate values are exceeded. This index is used to determine the nature of intervention strategies to be used in improving the quality of water resources, e.g., if there is low variance in stretches that could indicate permanent pollution in the stretch of water. However is there is high variance that could mean that there is a hot spot area responsible for a change at a particular place and therefore management interventions will be targeted at the hot spot.

3.5 Examples of Quality Accounts

3.5.1 Southern Africa

Production of quality accounts is challenging especially for the developing countries. In Southern Africa ministries of either water and or Environment have made efforts to obtain concentration of the various parameters used to measure quality. However flow data and the length of stretches with homogeneous quality is missing. Gauging stations are few and the costs of putting up are beyond the budget of most countries. The extent of groundwater resources has not been established and therefore comprehensive quality accounts of all groundwater resources will be difficult. There is some quality data available from SADC countries and examples of the data which is currently available are drawn from South Africa and Zimbabwe.

South Africa

In the SADC region only South Africa has tried to produce their quality accounts but inadequate data hampered the production of quality results which incorporate flow regimes. The data which is readily available for South Africa's quality accounts only measures the level of parameters in a given sample. In South Africa they have defined the quality classes from very good to poor. Examples of information displayed in quality accounts for the Lower Orange sub-catchment is shown below:

Table 3.6: Quality Accounts for the Lower Orange Catchment Drainage Region

Constituent	D3H008Q01		D5H021Q01	
	Level	Quality Class	Level	Quality Class
pH	8.2	Very Good	8.6	Very Good
Flouride	0.2	Very Good	0.8	Very Good
TDS	151.1	Very Good	2 660	Poor
Nitrate +Nitrite N	0.5	Very Good	0.3	Very Good
NH4- N	0.0	Very Good	0	Very Good
Na	7.7	Very Good	692	Poor
Mg	7.0	Very Good	88.4	Good
SO4	12.1	Very Good	624.1	Poor
Cl	5.1	Very Good	588	Very Good
K	1.3	Very Good	5.9	Very Good
Ca	19.6	Very Good	52.8	Very Good
EC	20	Very Good	3.71	Poor
SAR	151.1	Very Good	12.9	Fair

Zimbabwe

Zimbabwe has a nationwide monitoring system for its water resources. However the data collected is only based on concentration of parameters in the water samples. The monitoring sites have data captured on monthly, quarterly or annual basis depending on the importance of the site. Examples of quality results from a groundwater monitoring site is shown below

Table 3.7: Quality Results for a groundwater in Manyame Catchment

Parameter	Concentration mg/l
pH	6.5
TDS mg/l	200
Phosphate mg/l	4.4
Nitrates mg/l	N/D
Chloride mg/l	25
Carbonates mg/l	N/D
Calcium mg/l	31
Magnesium mg/l	17.1
Potassium mg/l	0.7
Sodium mg/l	8
Iron mg/l	N/D
Copper mg/l	0.05
Manganese mg/l	0.12
Nickel mg/l	N/D

Parameter	Concentration mg/l
Zinc mg/l	0.18
Lead	N/D
Cobalt	N/D
Chromium mg/l	N/D
Hardness as CaCo3 mg/l	120
Conductivity	113

3.5.2 Developed World

France and Australia are some of the countries from the developed world which have made advances in producing quality accounts. France has made progress in producing surface water accounts whilst Australia has provided data for groundwater accounts. Examples of these accounts are shown below.

France

Table 3.8 shows the quality accounts for rivers as compiled in France for the years 1992 and 1994. Five quality classes are A1 (best), 1B, 2, 3 and NC (not classified worst). The description of sticks according to quality was available for two years and the figures are comparable as they are obtained from comparable assessment methods. The quality accounts show that there has been an improvement between the two years: there are more SRUs in the good quality classes (1A and 1B) and less in the bad quality classes (3 and NC).

Table 3.8: Quality accounts of French watercourses by size class (organic matter indicator-in 1000 SRU)

	1992 state					Changes by quality					1994 state				
	1A	1B	2	3	NC	1A	1B	2	3	NC	1A	1B	2	3	NC
Main rivers	5	1253	891	510	177	3	336	9	183	165	8	1583	893	358	12
Main tributaries	309	1228	1194	336	50	16	464	275	182	22	325	1691	919	154	288
Small rivers	260	615	451	128	47	44	130	129	17	28	306	749	322	110	188
Brooks	860	1464	690	243	95	44	176	228	15	23	810	1295	917	258	72

Australia

Table 3.9 shows quality accounts for groundwater in Australia using salinity levels for defining quality classes. These categories correspond to potential limitations fro economic uses. Fresh quality is recommended for human drinking, marginal can be used for irrigation and some industrial processes are able to use very saline waters. Though accounts are incomplete the data shows a shift from the fresh to the marginal water quality category and Brackish waters also increased.

Table 3.9: 1985 and 1998 accounts of the groundwater quality in Victorian provinces, Australia

Gigalitres

	Fresh	Marginal	Brackish	Saline	Total
1985	477.5	339.2	123.3	32.3	972.3
1998(incomplete)	(39.1)	(566.6)	(141.1)	(NA)	(746.8)

3.6 Implications of Quality Accounts to Policy

Water Accounts are very important for decision makers because they assist in the following:

Determination of the presence of faecal coliforms – Once quantities of water which poor and bad with regard to this parameter are known then volumes of water which cannot be used as drinking water without further treatments will be known. In general this water will require chlorination prior to use. If quality accounts for rural areas imply high proportion of water with the presence of faecal coliforms then it implies the need for a groundwater source to ensure that people have access to safe drinking water.

Determining the proportion of water resources requiring remediation- The quality accounts will indicate what proportion of the water resources belong to the bad, poor categories and therefore inform policy makers on what percentage of their water resources requires interventions to remedy the situation. Adequate allocation of resources can then be done during planning so that environmentalists are given a budget to carry out the necessary management interventions.

Determine the quantity of usable water resources- The accounts will indicate the quantity of water resources which are in the good to very good category. This is especially applicable to groundwater and dammed water resources which give an approximate estimation of the resources of a country.

Determining the effectiveness of the Environmental Management Policies- The cumulative impacts of the activities in the environment are ultimately presented in the quality of the water resources. The runoff during rain events carries with it all pollution on the land and deposits it into water resources. Thus these accounts inform policy makers about how good their environmental management practices are.

3.7 References

Department of Water Affairs and Forestry (2006). Ministry of Agriculture Water and Forestry *Technical Summary of Water Accounts.* Namibia

Department of Environmental Affairs, Ministry of Environment, Wildlife and Tourism

- (2006) Policy Brief on Botswana's Water Management

- (2006) Water Accounts of Botswana (1992-2003)

Egis bceom International (2010). South African Development Community European Development Fund. Regional Indicative Programme. Economic Accounting of Water Use (9ACP RPR 39-90). Final Inception Report.

European Commission, eurostat (2002).Water Accounts-Results of pilot studies

GascÒ G., A. Saa, f Guerrero and A GascÒ (2005).Influence of salt concentration and topography position on water resource quality. The Spanish Case Study. Water

SA.Vol.2. Available online at http:/www.wrc.org.za

Korea Environment Institute (KEI) (1998). *Pilot Compilation of Environmental-Economic Accounts*. EI and UNDP: Seoul, Korea

Kristensen, P and Boestrand, J. (1996), *Surface water quality monitoring. Topic Report.* Inland Waters nº 2/1996, Copenhagen EEA.

Lange, G and Hassan, R. (2006). *The Economics of Water Management in Southern Africa: An Environmental Accounting Approach*. Edgar Elgar: Cheltenham, UK

Maarten van Rossum, Marije van de Grift (2009). Regional Analysis: Differences in Emission- Intensity Due to Differences in Economic Structure or Environmental Efficiency? Journal of Sustainable Development. Vol. 2, No 3. www.ccsenet.org/journal.html. Statistics The Netherlands.

(2002). A Discussion Paper on Environmental and Natural Resources Accounting and Potential Application in African Countries

The World Conservation Unit (1997). Environmental Accounting: What's It All About?

United Nations Statistics Division (2006). System of Environmental-Economic Analysis for Water

United Nations, Commission of the European communities, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank (2003). *Handbook of National Accounting on Integrated Environmental and Economic Accounting 2003*. Sales No. New York

Statistics South Africa

2005: Natural Resources Accounts- Quality Accounts for South Africa 2000.

2006. Natural Resources Accounts. Updated Water Accounts for South Africa: 2000. Discussion Document-D0405

United Nations Statistics Division

- (2006). Integrated Environmental and Economic Accounting of Water Resources; Draft for Discussion
- (2006). Regional Analysis: Differences in Emission-Intensity Due to Differences in Economic Structure or Environmental Differences?
- UNCEEA (2006). Water Accounting- A Tool for Integrated Water Resource Management? User-Dialogue (CBS-Voorburg-The Netherlands 2006)
- Division (2010). Progress on Water Accounts in ESCWA Countries Fifth Meeting of Experts and Environmental Economic Accounting

Useful Websites

-Unstats.un.org/unsd/envacountry/ceea/archive

-**Erreur ! Référence de lien hypertexte non valide.** of work

-www.fsd.n1/natureevaluation/70995

-pubs.acs.org/doi/abs/ceea/default.as

-unstats.un.org/unsd/methods/citygroup/landgroup.htm

-www.beyond-gdp.eu/indicators.html#Environmental%20%accounts

3.8 Notes to the Facilitator

About this Module

This module is designed for use by technical staff working hands on with issues of water quality. The staff members working in departments of Environment, Water, Industry and Water Treatment Works for local authority would find the course relevant. The general level of education should be at least a diploma related to issues of water quality. The participants should have the ability to use computers so that they can practice populating the data tables.

Participants will find this module useful in that it enables them to:

- Understand concepts in water quality
- Calculate quality accounts for surface and groundwater accounts
- Determine how they should improve their environmental management policies

Preparation for Facilitation

In preparation for the workshop the facilitator should:

- Send out invitation letters directly to industries, municipalities as well as through networks. The invitation should include the venue, costs of the course as well as a brief description of the course clearly outlining its objectives. The advert should state the background education required for the course. Furthermore the invitation should state target audience so that the right members send in applications.
- Provide the participants with background papers and websites indicated in this module so that they can prepare for the course by reading the materials

Facilitation

This module is designed for face to face facilitation. To enable group work exercise and exchange of learning the number of participants should be between 20 – 30 students. The approximate time for delivery of the module is 4 hours with the right audience but the time may be varied to cope with the level of understanding.

The Facilitator should have experience in dealing with water quality issues to enable them to give real life examples and work through examples. Good presentations skills will also be required.

In delivery of the module the facilitator should use

- Slides
- Flipcharts/board – to allow working of examples
- Computers – to allow students to practise
- Group work exercises – The group work should be given time so that participants can work on the exercises. The report back should be done in plenary where others can comment. Depending on time available the groups can be given the same exercise or different ones. On average 20 minutes should be enough for the groups to work through the exercises. The discussion and though questions should be dealt whilst explaining the

Evaluation

The participants should be allowed to evaluate the module based on the facilitator ‘s skills and ability to explain concepts, usefulness of the course to their daily work, added knowledge due to the course, length of the course. The evaluation sheet should have score levels for each evaluation component so that participants will select an appropriate score.

Module Adaptation

This module can be adapted to the training needs of the particular class. In producing adaptive versions acknowledgement of the source must be made. It will be important to give the authors a feedback on how the module can be improved. In particular examples of experiences in handling quality accounts will be welcome.

Module 4
Physical Supply and Use Tables

Goal

The goal of this module is to introduce participants to Physical Supply and Use Accounts with the view to empower them to compile this type of water use accounts.

Objectives

At the completion of the module, participants should be able to:-

- Describe the different water uses and how they impact on resources availability
- Describe the different types of water flows
- Explain the difference between physical supply and use tables
- Use information on water use and supply to compile physical supply and use accounts

Structure of the Module

The Module is structured as follows:-

A Types of Water Flows

B Physical Supply and Use Tables

C Constructing physical and use accounts at national and transboundary levels

D Physical supply and Use Accounts information

E Examples and exercises

F Note to facilitator

4.1 Introduction

Physical Supply and Use Accounts describe the flow of water from the environment to the economy, within the economy and back to the environment. This module discusses in detail how these flows are mapped and measured. The Module starts by defining the different flows in Section 4.2 followed by the framework for compiling the accounts in Section 4.3. Balancing issues of the accounts are discussed in Section 4.4. The module concludes by discussing data issues, examples of the Physical Supply and Use Accounts, glossary of common terms, exercises and notes.

4.2 Types of Water Flows

Many of the SADC countries are predicted to be confronted by a future of water scarcity and water stress or acute shortage of water supply. In general the demand is growingly rising to exceed the supply. The understanding of water use in relation to supply is very important to adequately inform water resources strategies and effective valuation of Member States' water resources.

The physical supply and use account (PSUA) provides comprehensive and structured information for this purpose. The PSUA builds from the information used in the Asset Account in terms of the resource availability, as the limiting factor in terms of use. The supply is dependent of the stock of water assets available in the country. The use and supply information is captured through use of Physical and use tables (SUT). The SUT describe three types of flows: (a) from the environment to the economy, (b) within the economy, and (c) from the economy to the environment. In particular, the use table is obtained by merging information on water use: the total water intake of an economic unit is the result of direct water abstraction (flow from the environment to the economy) and water received from other economic units (flow within the economy). Similarly, the supply table is obtained by merging information on the two types of water flows leaving an economic unit: one destined to other economic units (flow within the economy) and the other destined to the environment (flow from the economy to the environment).

Box 4.1: Important Questions to answer in tracing the flow of water

- **Retail** (Individual entitlement Holders and Users)
- *entitlements, allocations, consumptive use, trade*
- Where is the water allocated? How much entitlement is allocated?
- Who is it allocated to?
- Where is the water used?
- Who is using the water?
- How much is being used, how much is being returned, when and under
- what conditions?
- Who has an interest in the water?
- Where and what are the losses?
- Who traded water? Where, when, how much and at what price?
- **Wholesale** (Bulk storage/Management rules and Delivery)
- *storage, entitlements, environmental allocations, trade, recycling*
- Who is responsible for management of the resource?
- Who is entitled to use and trade the water? Under what conditions?
- Who has an interest in the water?
- Where and what are the bulk losses?
- Who used or reused the water? How much and use conditions?
- **Resource** (Overall availability, Knowledge)
- *basin/ catchment wide, systems inputs, physical resources*
- How much water is available and where?
- How is the availability changing?
- How is the quality changing?
- What is the availability, accuracy and relevance of contextual data (hydrology, geology, climate, land use)?

(Source: Australian Bureau of Statistics)

4.2.1 Flows from the environment to the economy

Flows from the environment to the economy involve the abstraction/removal of water from the environment by economic units in the territory of reference for production and consumption activities. In particular, water is abstracted from the inland water resource system (which includes surface-, ground- and soil-water as defined in the water asset classification). Abstraction from other resources includes abstraction from the sea (for example, for direct use for cooling, or for desalination purposes) and collection of precipitation (rain harvesting). The supplier of these flows is the environment and the user is the economy, more specifically, the economic agents responsible for the abstraction.

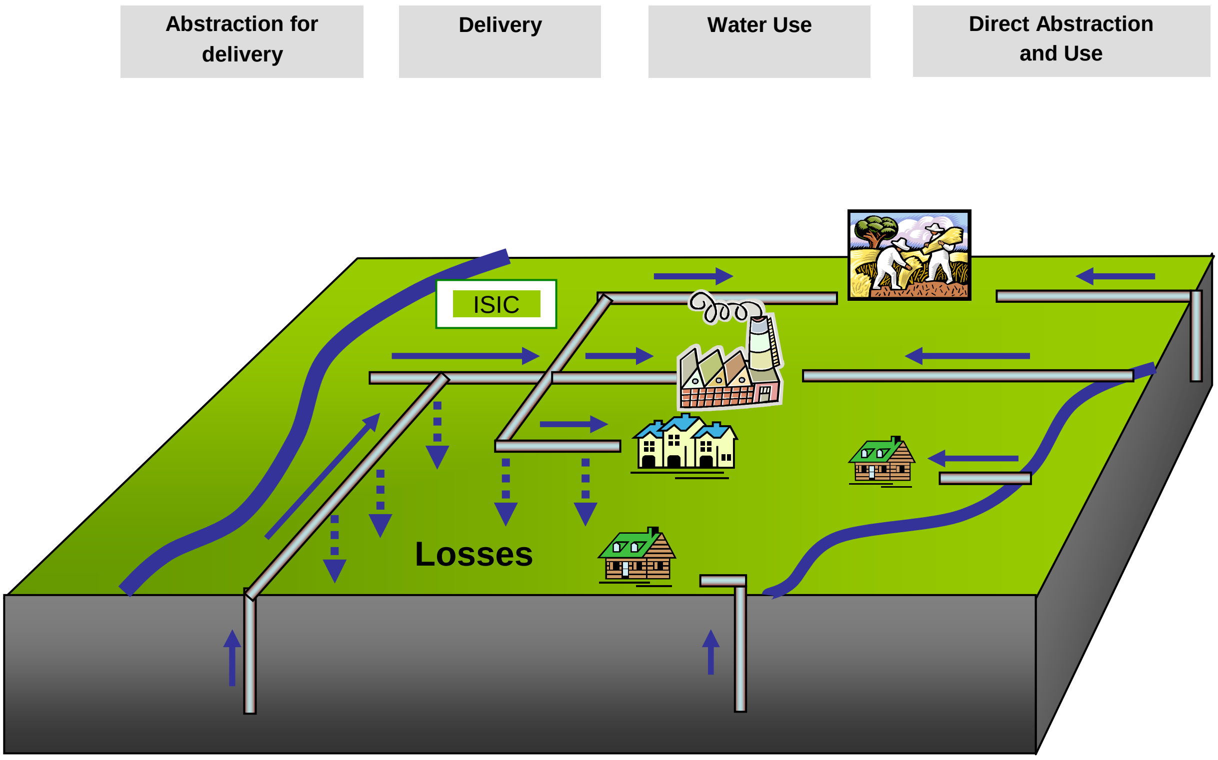


Figure 1: Water abstraction and use

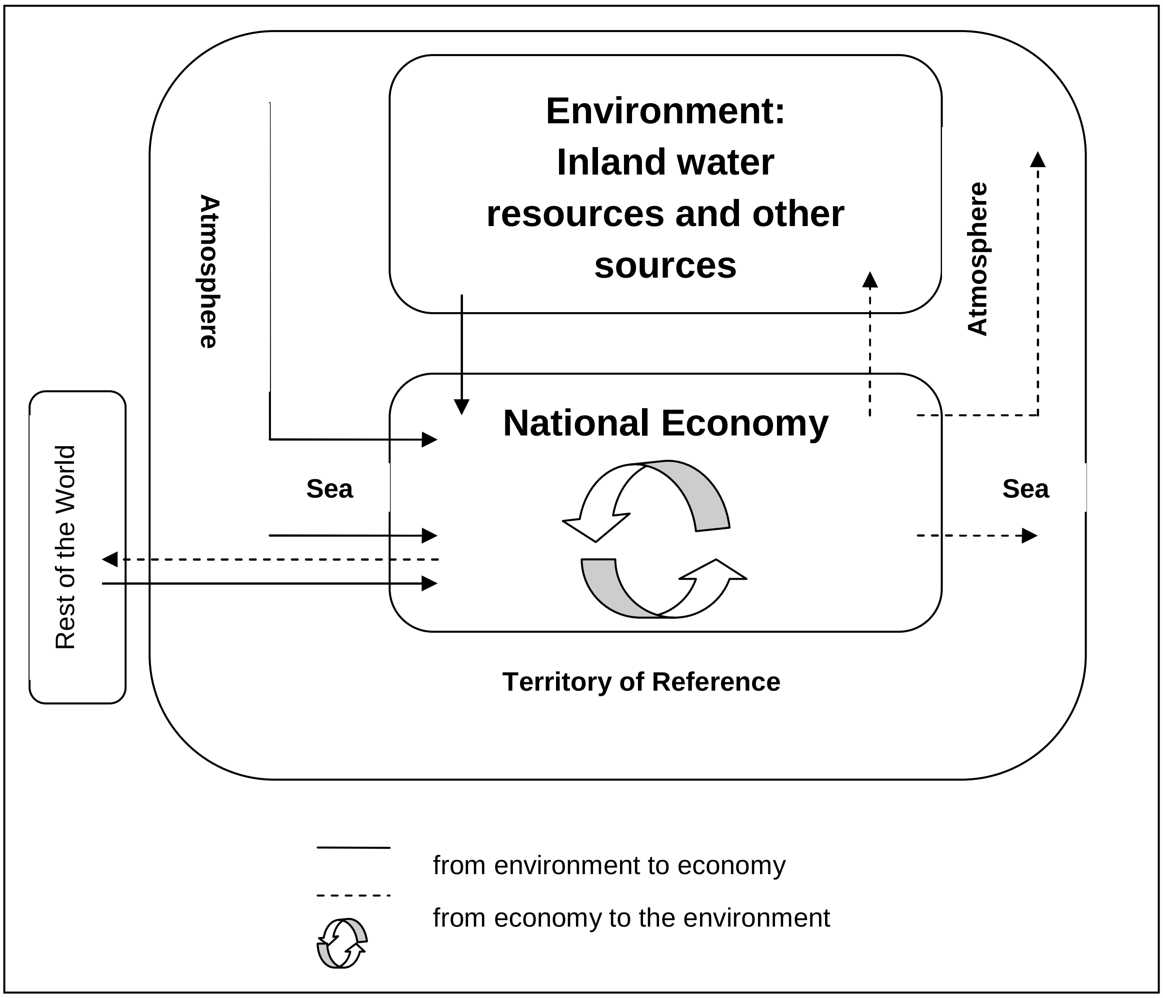


Figure 2: Flows in the physical supply and use account

Water is abstracted either to be used by the same economic unit which abstracts it (in which case, we refer to it as *abstraction for own use*) or to be supplied, possibly after some treatment, to other economic units (*abstraction for distribution*). The industry which abstracts, treats and supplies water as a principal activity is classified under class 36 of ISIC Rev. 4, *Water collection, treatment and supply*. There may be, however, other industries which abstract and supply water as a secondary activity.

The scheme in Figure 3 presents the sources, the abstractions (water withdraws) for own use and for supply, the users and the return flows.

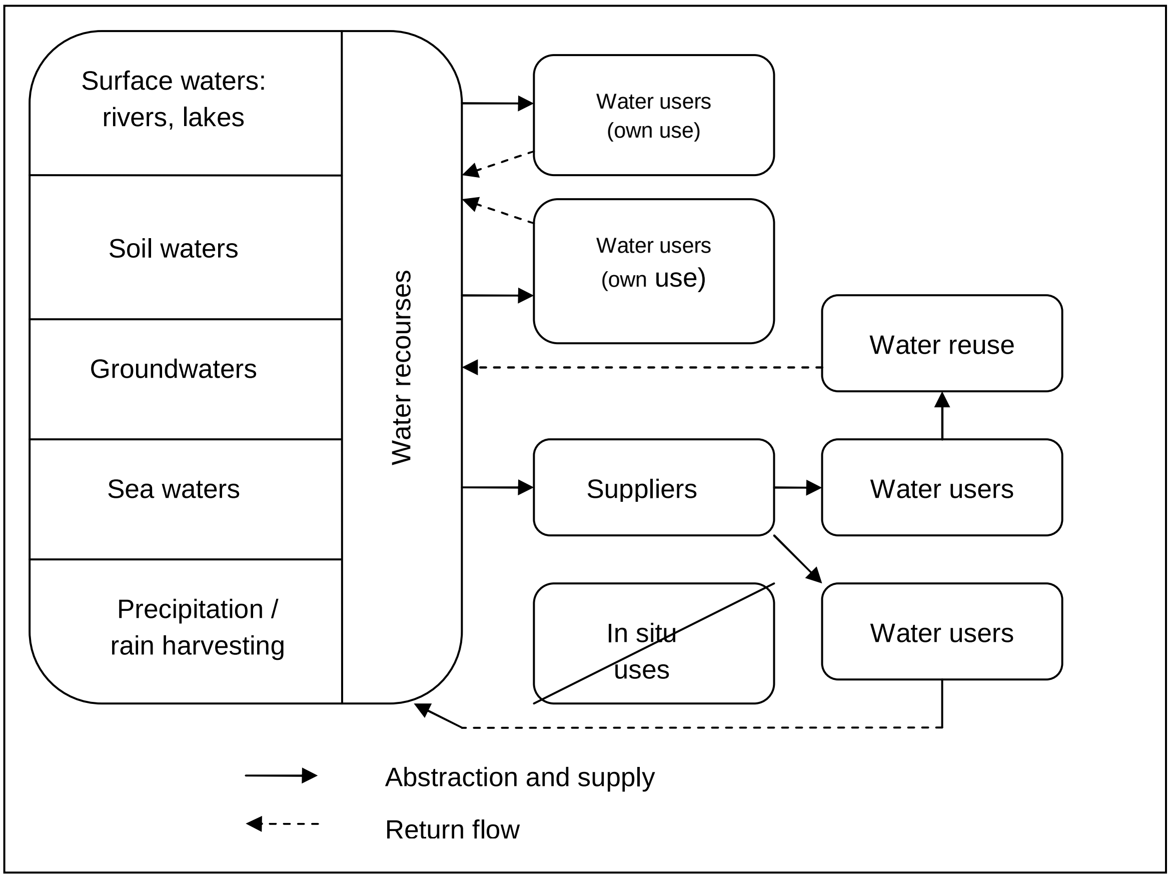


Figure 3: Physical flow

4.2.2 Flows within the economy

Flows within the economy involve water transfers between economic units. These transfers are usually carried out through pressure pipes or gravitation channels, but sometimes other means are also used such as for examples trucks with tanks for transporting drinking water.

Most of the water is generally supplied by the industry ISIC 36, *Water collection, treatment and suppl*y. However, it can also be supplied by other industries and households. For example, when water is supplied by industries and households (i) for further use or (ii) is supplied to treatment facilities before being discharged into the environment. The physical supply of water by households generally represents a flow of wastewater to ISIC 37, *Sewerage*.

UN Statistics Division (Figure 4)**:** Division: Water supply industry corresponds to ISIC division 37 (the International Standard Industrial Classification of All Economic Activities, ISIC Rev. 4) The water collection treatment and supply industry includes water collection, treatment and distribution activities for domestic and industrial needs. This includes abstraction of water for distribution from various sources (mainly surface water and groundwater), natural water (CPC 1800) treatment for distribution and the actual distribution of natural water (CPC 1800) by pipes, channels and others means. The operation of irrigation canals is also included; however the provision of irrigation services through sprinklers, and similar agricultural support services, is not included.

The collection of wastewater by ISIC 37, *Sewerage*, is recorded as use of wastewater by ISIC 37 and a supply of wastewater by the industry or households generating the wastewater.

During distribution of water (between a point of abstraction and a point of use or between points of use and reuse of water) there may be significant losses. These losses may be caused by a number of factors: evaporation when, for example, water is distributed through open channels; leakages when, for example, water leaks from pipes into the ground; and illegal tapping when users illegally divert water from the distribution network. In addition, when losses during distribution are computed as a difference between the amount of water supplied and received, they may also include errors in the meter's readings, malfunctioning meters, theft, etc. In the SUT, the supply of water within the economy is recorded net of losses during distribution. Furthermore, the losses during distribution are recorded as return flows when they are due to leakages and as water consumption in all other cases.

The use table describing the flows within the economy shows the destination of these flows: water can be used by industries to produce other goods and services (intermediate consumption), by households for their own use (final consumption) and by the rest of the world (exports). Other economic uses, i.e. change in inventories, will be neglected for water, since these are usually negligible given that water is a bulky commodity.

The basic National Accounting supply and use identity is satisfied also for flows of water within the economy, as the total water supplied by the national economy plus imports equals the sum of water uses for intermediate consumption, final consumption and exports.

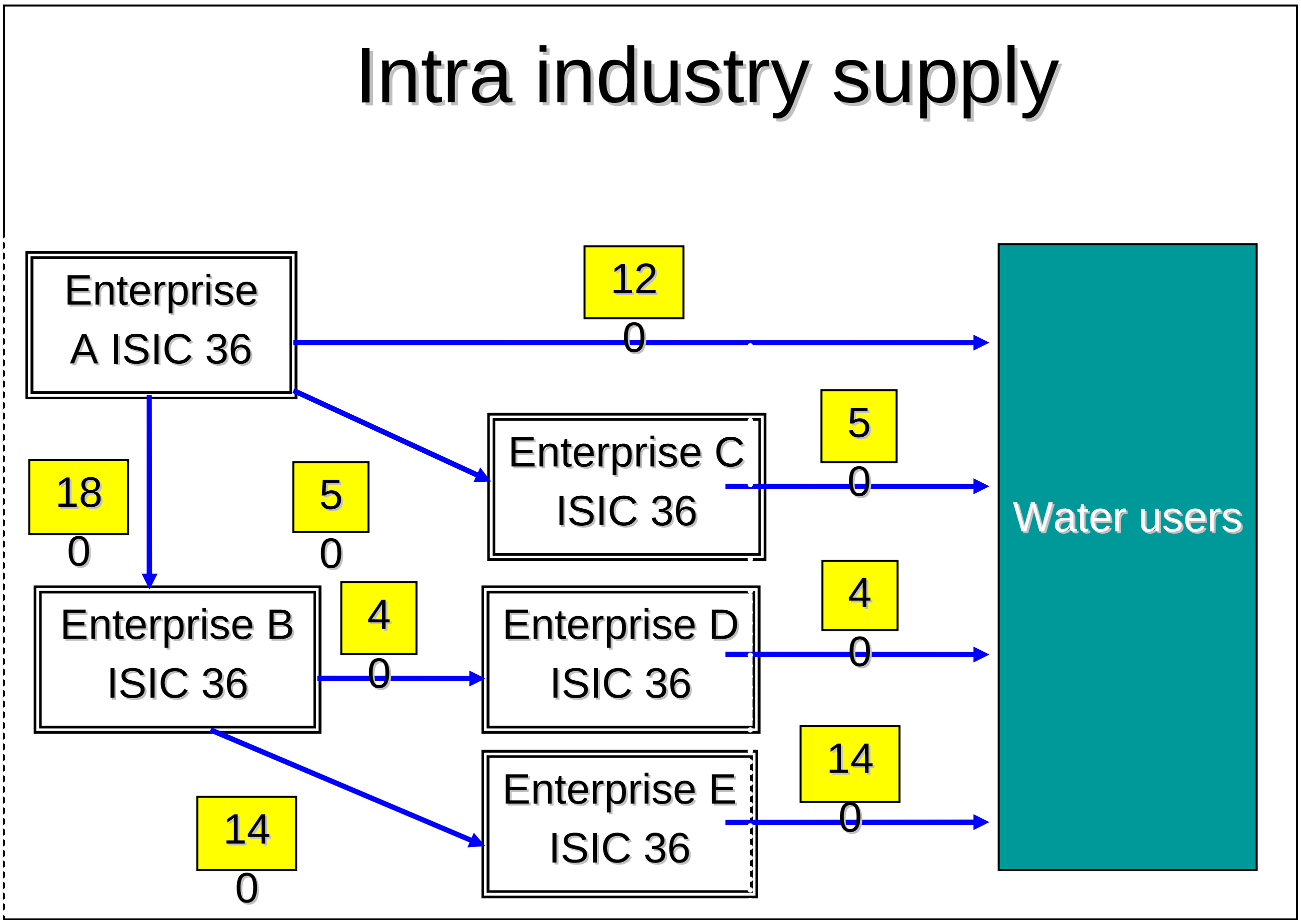


Figure 4: Water Supply Industry ISIC Rev. 4, 36(UN Technical Workshop on the Preparation of Water Accounts in Latin America)

4.2.3 Flows from the economy back into the environment

Flows from the economy back to the environment consist of discharges of water by the economy into the environment (residual flows). Thus the supplier is the economic agent responsible for the discharge (industries, households and rest of the world) and the destination (user) of these flows is the environment. The environment is assumed to use all the water that is returned (supplied) to it.

Hence, for these flows, use equals supply.

Flows from the economy to the environment are described in accounting terms in the supply table as a supply of an economic unit to the environment. Each entry represents the amount of water generated by an economic unit and discharged into the environment (in this manual discharges of water back to the environment are also referred to as *returns* or *return flows*).

Returns are classified according to the recipients: a distinction is made between 'water resources', which include surface-, ground- and soil water (as specified in the asset classification in chapter 6) and 'other sources' such as seas or oceans. Discharges of water by the rest of the world are those locally generated by non-resident units. These are often insignificant. Even in a country where there is a large presence of tourists, the discharges would generally take place through resident units (i.e. hotels, restaurants, etc.).

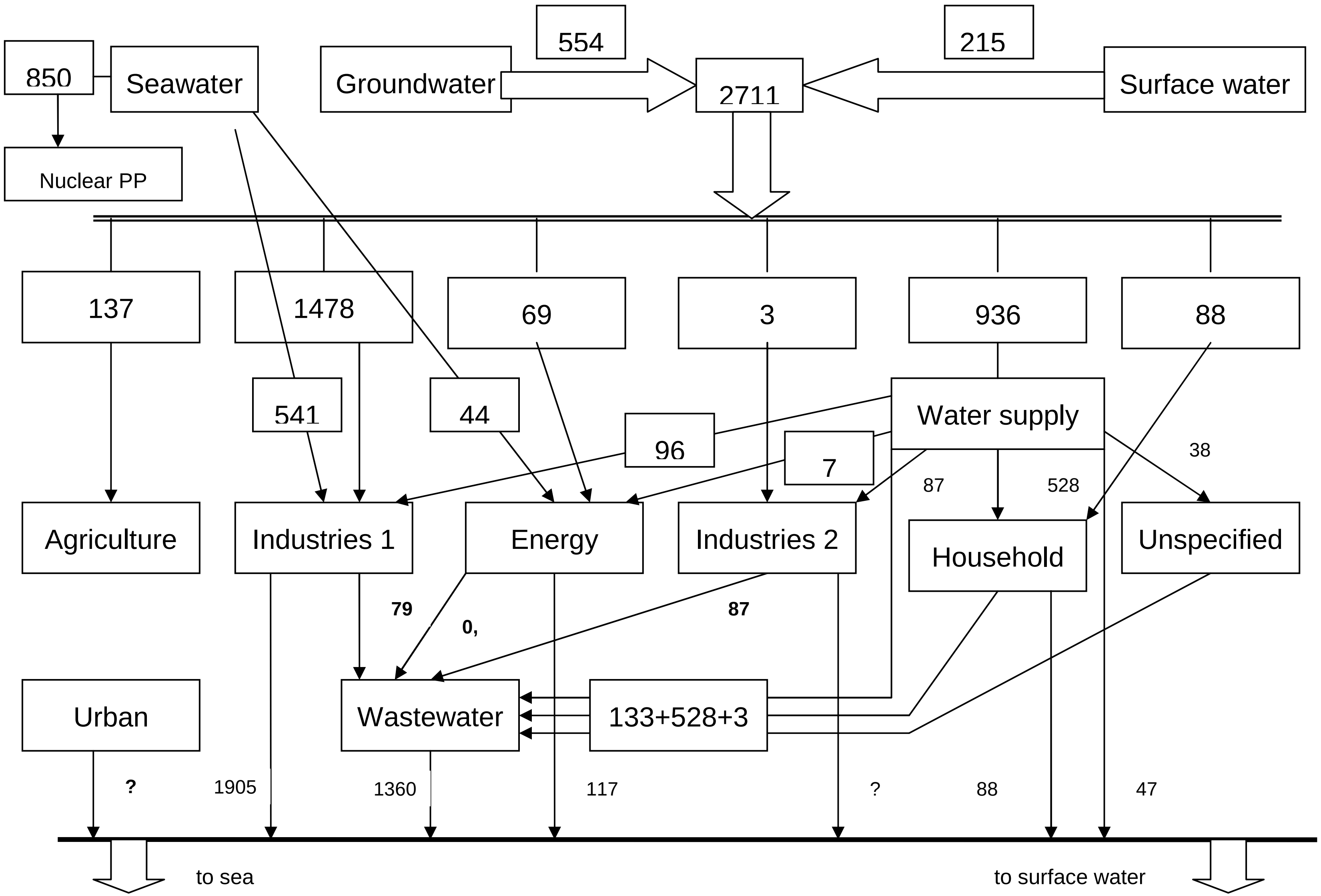


Figure 5 Swedish water flows account in 1995 (Mm^3)

4.3 Physical Supply and Use Tables

Supply and use table for water resources describes: (1) flows from the environment to the economy; (2) flows within the economy; and (3) flows from the economy to the environment (Figures 1 and 2). For each type of flow, the origin of the flow (supply) and its destination (use) are clearly identified. However, the SUT tables applied in the current project are simplified Methodologies for Water Accounting in SADC (Tables 4.1 and 4.2) therefore for example; abstractions from surface water resources (rivers, lakes, reservoirs) are combined.

Table 4.1: Physical use table

Million m3

		Industries (by ISIC categories)										Households	Rest of the world	Total
		1-3 Agriculture												
		Irrigation	Livestock	Forestry	Fisheries	5-33, 41-43	35	36	37	38,39, 45-99	Total			
From the environment	**1. Total abstraction** (=1.a+1.b=1.i+1.ii)													
	1.a. Abstraction for own use													
	1.b. Abstraction for distribution													
	1.i. From water resources:													
	1.i.1 Surface water													
	1.i.2 Groundwater													
	1.i.3 Soil water													
	1.ii. From other sources													
	1.ii.1 Collection of precipitation													
	1.ii.2 Abstraction from the sea													
Within the economy	**2. Use of water received from other economic units**													
3. Total use of water (=1 + 2)														

Table 4.2: Physical supply table

Million m3

		Industries (by ISIC categories)										Households	Rest of the world	Total
		1-3 Agriculture				5-33, 41-43	35	36	37	38,39, 45-99	Total			
		Irrigation	Livestock	Forestry	Fisheries									
Within the economy	**4. Supply of water to other economic units**													
	of which:													
	4.a. Reused water													
	4.b. Wastewater to sewerage													
To the environment	**5. Total returns** (=5.a+5.b) Losses in distribution due to leakages													
	5.a. To water resources													
	5.a.1. Surface water													
	5.a.2. Groundwater													
	5.a.3. Soil water													
	5.b. To other sources (e.g. sea water)													
6.Total supply of water (=4+5)														
Consumption (=3-6) of which 7a. Losses in distribution														

4.4 Balancing items

Just like in SNA, supply-and-use of water identity is satisfied as the total water supplied by the national economy plus imports is equal to the sum of uses of water for intermediate consumption, final consumption and exports. For this identity to hold:

> Total abstraction + Use of water received from other economic units = Supply of water to other economic units + Total returns + Water consumption

Since the total water supply equals the total water use within the economy, the identity can be rewritten as:

> Total abstraction = Total returns + Water consumption

Water consumption can also be computed for each industry and it gives an indication of the industry's water use efficiency. Since water supply does not equal water use by industry, water consumption is computed as a difference between the supply and use by industry:

> Water consumption by industry *i* = Total water use by industry *i* – Total water supply by industry *i.*

The difference between water use and water consumption is leakages that can be accounted for*. However, W*ater consumption includes the part of the losses in distribution which are not due to leakages. This includes unaccounted water (such as illegal tapping) and the cases when water is lost because of evaporation. This amount is used as a balancing item in accounting for water use and is given by the difference between water use and water consumption plus (accounted for) leakages.

The concept of water consumption gives an indication of the amount of water that is lost by the *economy* during use in the sense that it has entered the economy but it has not returned back natural water bodies. This is a useful measure as it gives indication about industry water use efficiency.

4.5 Constructing physical and use accounts at national and transboundary levels

The accounts can be compiled at river basin level and this is the recommended spatial unit for IWRM. The Challenge is disaggregation of data by river basin regions. Where industries are few in a region confidentiality becomes an issue.

4.6 Physical Supply and Use Accounts Information

4.6.1 Supply Table

Supply information is in relation to supply of water to other economic units within the economy such as reused water, wastewater to sewerage and desalination water. It also supply of water to the environment which includes total returns. Total returns include hydropower generation, irrigation water, mine water, urban runoff, cooling water, losses in the distribution and treated wastewater. Treated wastewater may be further classified according to its delivery to water resources whether to surface water, groundwater, soil water or to other sources (e.g. sea water).

Wastewater may be discharged to the environment (in which case it is recorded as return flow), supplied to treatment works (recorded as wastewater to sewerage) or supplied to another industry for further use (reused water). Total supply table is then the sum of the three.

Water used for hydropower generation consists of water used in electricity generation at plants. It is often diverted or used to turn the turbine in hydropower plants and returned immediately to the environment. It is vital to account for this as this use (hydropower generation) may be competing with other uses.

Mining water use generally involves removal and displacement of water in the environment (dewatering) when the mine extends below the water table. Its importance is that it often results in disposal of large volumes of water and its displacement can be particularly damaging to the environment.

Urban runoff often refers to flows via overland flow, underflow, or channels or piped into defined surface water channels. It is also sometimes referred to as urban storm water. When collected into the sewage system, it is recorded in the table as an abstraction from other sources (in particular from precipitation), and when discharged into the environment it is referred recorded as return flow in the supply table.

4.6.2 Use Table

Physical use information included in the use table is mainly the total abstraction and use of water received from other economic units. Total abstraction information includes information for own use such as Hydropower generation, irrigation water, mine water, urban runoff, cooling water and others; while use of water received from other economic units basically refers to reused water.

The understanding of the different types of information is the same as already discussed above for the supply table. The only major difference is that the use table accounts for “received waters” as opposed to “supplied waters”.

4.7 Examples and Exercises

4.7.1 Empirical example

In the region examples of Physical Supply and Use Tables exist for the countries of Botswana, Namibia and South Africa (see Lange and Hassan, 2006). However, for purposes of learning from countries with long experience of developing the accounts, an example from Sweden is presented and discussed in this Module.

Statistics Sweden has developed physical environmental accounts since 1993. Accounts for the use of energy and emissions to air are now regularly compiled. This section presents the development of water accounts, which were subsequently prepared. Available physical and monetary data referring to 1995 were recalculated and adjusted to the environmental accounts and the report was first published in 1999 [1]. Since, it was a first attempt in water account therefore it is instructive for the current SADC initiative for setting up water accounting.

The Swedish project focused on those water flows in the economy which referred to as water abstraction, use of water and emission to water. Both water which was market produced and sold as a commodity and self supply of water (non-market produced) was included in the account physical. Data on water resources was not included in the first water accounts.

The most important flows of water related to the economy are shown in Figure 5. The water resources in ground water, surface water and sea water are shown on the top of the Figure 5 and at the bottom are the sea and surface waters as recipients. The proportions of abstracted waters from different sources are presented in Figure 6. In between a few boxes are shown, representing the main economic activities relating to water. Flows between the boxes are measured in Mm3 and refer to the year 1995.

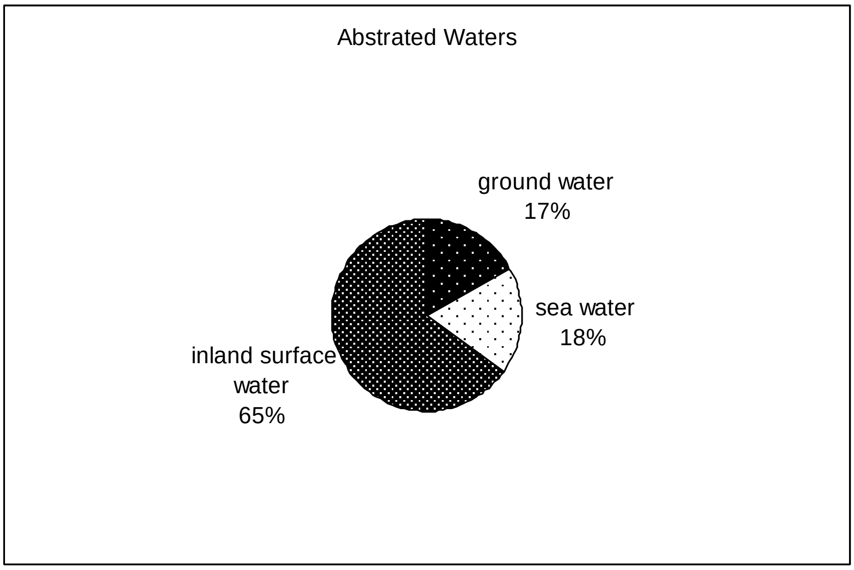


Figure 6: Proportion of abstracted waters from different resources.

The largest of all flows shown in the figure is 8 500 Mm3 of sea water used for cooling in Swedish nuclear plants. This water was excluded from the water use account since, the resource of seawater is almost unlimited and the environmental impact of cooling water use is very small in this case.

The large industrial abstraction of water, especially surface water – 1 500 Mm3 are concentrated to a few water intensive process industries, notably the pulp and paper industry. Some large mining, steel and chemical plants are also quite water intensive. We have to note that all industries with intensive water use are subject to rigorous environmental control, which imposes treatment programs for the process water.

The total abstraction divided by public waterworks and private abstraction. Abstraction by the public waterworks is referred to as market produced since it is produced to be a commodity to be sold on a market. For all other groups water is abstracted only for own-use i.e. non-market produced. For the manufacturing industry water from own abstraction cover 95 per cent of the total use of water and the public waterworks supply 5 per cent. For the households 86 per cent of the water are supplied by public waterworks and 16 per cent are from private withdrawal. The use of water in agriculture for irrigation and livestock are entirely from self supply. Data on self supply for other users is not available.

Based on the collected data different analysis were made and indicators derived, which one can see in the Report [1].

Data sources for abstraction and supply were

Industry

from public waterworks

(i) Swedish Water & Wastewater Association (SWWA) set up by the municipalities to assist their water utilities with technical, economic and administrative issues.

(ii) Estimations for the missing data by using information on population and average abstraction and use in the country.

from self supply

Most of the water used by the **manufacturing industry** comes from own private withdrawals only 5 per cent are delivered by the public waterworks. Statistics Sweden carried out a huge survey, which covered an extended number of manufacturing-, mining and electricity, gas, steam and hot water supply industry. For the rest of the establishments the abstraction and use of water was estimated by coefficients for industrial sector, among others the size of the establishment and use of water by employed. The coefficients are based on a survey on water use made in 1983.

Household

For households connected to public waterworks data was taken from SWWA while for not connected to public water systems, which were mostly population in rural areas, estimations on abstraction/use of water were made using the average use (189 litre /day) by person connected to public water supply. Water abstraction /use of water was also estimated by the coefficients based on a research study by the Royal Institute of Technology in Stockholm.

Agriculture

Agriculture water is used for irrigation and for the livestock. A survey on water used for future need of irrigation in agriculture was made based on questionnaire sent to about 800 farming enterprises. The data refer to amounts needed in a dry summer. The water needed for the livestock is estimated by the number of different animals and their yearly water needs. Data on the number of animals were taken from agricultural statistics.

Data sources for information on return flow

Large water outlets are required to report their main effluent parameters in annual environmental reports to their supervision agency, which is generally a local authority. Estimates are generally based on measurement programs. Public waste water utilities are required to produce an environmental report if they serve more than 2 000 persons. There are almost 500 plants of this type in Sweden and they are believed to treat more than 90 per cent of the total wastewater. The other data on return flow was estimated based on the (reduction of) abstraction values.

In summary on the Swedish Physical supply and use account study, we can see that the State Statistical Central Bureau completed the water accounts. The input data was collected from the SWWA, Municipal and Regional Administrations, Environmental Agency (EPA). The database was augmented by applying coefficient methods where the base date was taken from national statistics and performing surveys based on questionnaires and extending the findings to units not involved into the survey.

Finally, based on the Swedish experience we can affirm that presumptions for completing water accounts are regular reporting from large water users, systematic collection of information at professional associations, municipal and regional administrations as well at environmental agency. Application of coefficient and survey methods is necessary to augment the database, however, the extension of the records is only possible in case when the national statistics provides data on population, industry production, housing, agriculture activities (animals husbandry etc.).

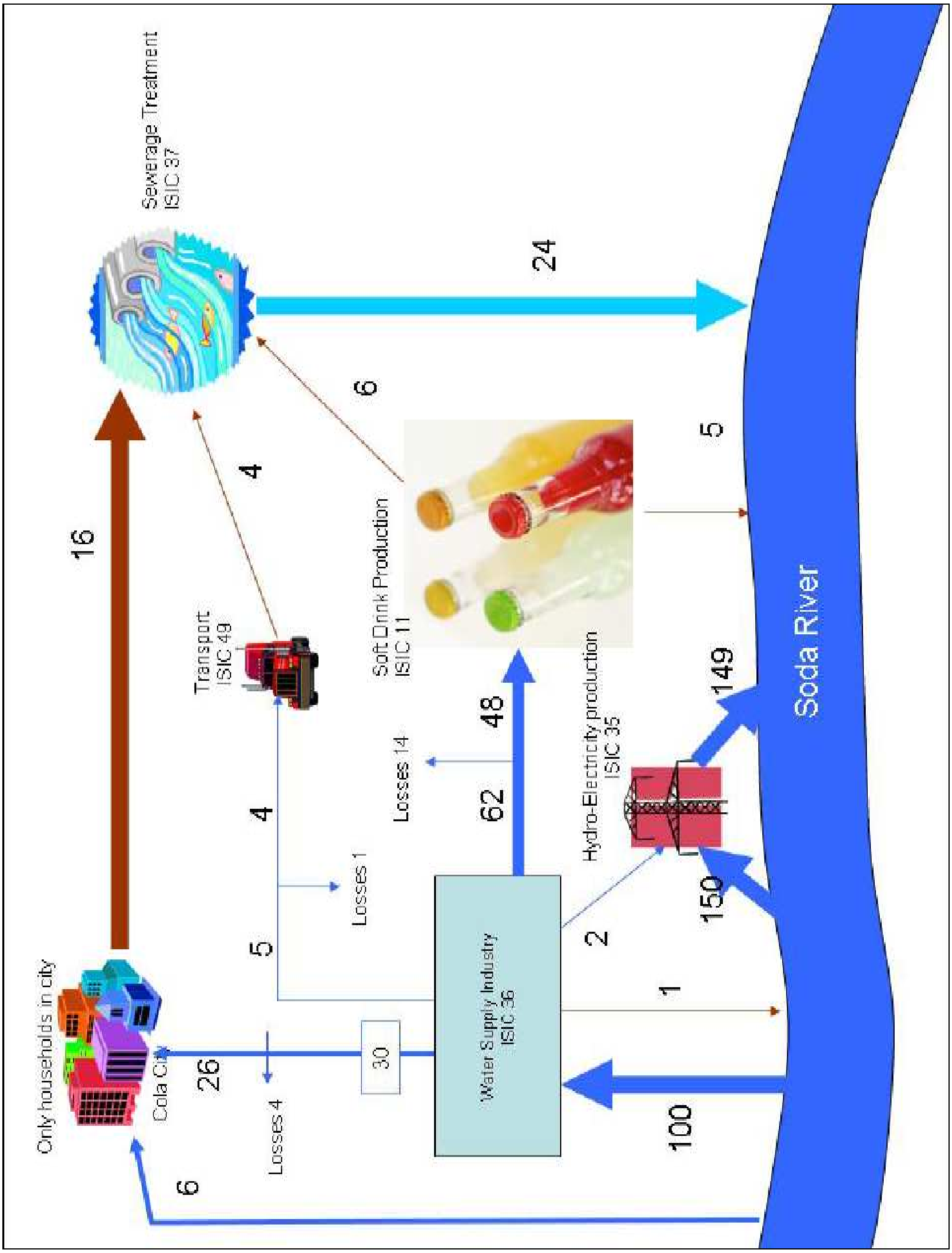
4.8.2 Exercises

The Module has two exercises: (i) “Cola City”, which comprises a simple synthetic exercise and (ii) Swedish physical flow account which consists of real data compiled by the Swedish Statistical Central Bureau.

(i) “Cola City”:

The group receives the data/information on the “Cola City” and empty Physical flow tables (MS Excel file). The participants individually complete the SUT tables and the results are compared with the ready tables included in the Module.

Figure 7: Physical water flow “Cola City”.



Physical Use Table ("Cola City") Physical units	ISIC classification					Total ISIC	Household	Total
	ISIC 11	ISIC 35	ISIC 36	ISIC 37	ISIC 49			
U1- Total abstraction (a1+a.2=b.1+b.2):	0	150	100	0	0	250	6	**256**
a.1 Abstraction for own use		150	1			151	6	**157**
a.2 Abstraction for distribution			99			99		**99**
b1. From water resources								
Surface water		150	100			250	6	**256**
Groundwater						0		**0**
b.2 From other resources								
Collection of rainwater						0		**0**
Abstraction from sea						0		**0**
U2 - Use of water received from other economic units	48	2	0	26	4	80	26	**106**
of which Wasterwater to sewerage				26		26		**26**
Total use of water (U=U1 + U2)	**48**	**152**	**100**	**26**	**4**	**330**	**32**	**362**

Physical Supply Table Physical units	ISIC classification					Total ISIC	Household	Total
	ISIC 11	ISIC 35	ISIC 36	ISIC 37	ISIC 49			
S1- Supply of water to other economic units:	**6**	**0**	**80**	**0**	**4**	**90**	**16**	**106**
of which: Reused water								
Waste water to sewerage	6	0	0	0	4	10	16	26
S2 - Total returns (= d.1+d.2)	**5**	**149**	**20**	**24**	**0**	**198**		**198**
d.1 To water resources	5	149	20	24	0	198		198
Surface water	5	149	20	24	0	198		198
Groundwater	0					0		0
Soil water	0					0		0
d.2 To other sources (e.g. sea water)	**0**							
Total supply (S = S1 + S2)	**11**	**149**	**100**	**24**	**4**	**288**	**16**	**304**
Consumption (U-S)	**37**	**3**	**0**	**2**	**0**	**42**	**16**	**58**

(ii) Swedish National Water Account exercise

The Swedish National Water exercise consists of three training moments such as

(a) The Physical supply and Physical use tables should be designed in an excel files using Tables 5.1 and 5.2 from the Methodology as models but its structure of the designed tables should fit to the scheme given in Figure 5.

(b) The columns in the table should be set up and coded according the ISIC classification:

Agriculture

Industry 1: Mining and manufacturing

Energy*:* Electricity, gas, steam and hot water production and supply

Industry 2: construction, trade, tourism, transport and service

Household

Others

(b) The Physical supply and Physical tables should be compiled using the values given in Figure 5.

4.9 Glossary of Terms

- **Abstraction** is defined as the amount of water that is removed from any source, either permanently or temporarily, in a given period of time for consumption and production activities
- **Abstraction from other sources** includes the abstraction of sea water and the direct collection of precipitation for production and consumption activities.
- **Abstraction from soil water** includes water use in rainfed agriculture. This is computed as the amount of precipitation that falls onto agricultural fields
- **Use of water received from other economic units** refers to the amount of water that is delivered to an industry, households or the rest of the world by another economic unit.
- **Total water use** of an industry is computed as the sum of the amount of water directly abstracted and the amount of water received from other economic units
- **Supply of water to other economic units** refers to the amount of water that is supplied by an economic unit to another.
- **Wastewater** is water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence.
- **Reused water** is defined as wastewater supplied to a user for further use with or without prior treatment, excludes recycling within industrial sites.
- **Total returns** include water that is returned to the environment.
- **Total water supply** is computed as the sum of the amount of water supplied to other economic units and the amount of water returned to the environment
- ***Water consumption*** - gives an indication of the amount of water that is lost by the economy during use in the sense that it has entered the economy but has not returned either to water resources or to the sea.

4.10 Note to Facilitator

About this Module

This module is designed to address the training needs of technical staff to mid level staff of Departments of water, environment, statistics and agriculture; water utilities; municipalities and other institutions interested or engaged in compilation of water accounts. This module facilitates an interactive exchange of opinions, perspectives and experiences of participants on the compilation of the Physical Supply and Use Tables. You can allow time for substantive discussion among participants as they learn how to construct the tables.

The module is intended to help participants appreciate and have hands-on experience in the construction of the Physical Supply and Use Tables (SUT). It is important that participants are able to: link the SUT to the Asset Accounts, derive useful indicators from the SUT and properly apply the derived indicators to policy. To allow for this, allow sufficient time for group exercises and discussions.

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. In addition, study the other modules to appreciate the role of water accounting in water decision making.

Facilitation

The module is designed for face-to-face facilitation. The duration is approximately 2.5 hours. This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator would need to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver this module.

Participant evaluation

An evaluation questionnaire should be provided to allow participants assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to mateteme@yahoo.co.uk

4.11 References

Lange, G. And Hassan, R.M. 2006. The Economics of Water Management in Southern Africa: An Environmental Accounting Approach. Edward Elgar: Cheltenham, UK.

UNSD (in cooperation with the Subgroup of the London Group on Water Accounting). 2005. Integrated Environmental and Economic Accounting for Water Resources (August Draft). UN.

4.12 Useful Websites

European Environment Agency, 2009. Guidance on the reporting required for assessing the state of, and trends in, the water environment at the European level. http://eea.eionet.europa.eu/Public/irc/eionetcircle/water/library?l=/reporting_eionetwfd/guidance_2009pdf/_EN_1.0_&a=d]

Eurostat, 2005. Standard quality indicators. Eurostat. Quality in Statistics Eurostat, Seventh meeting,

Luxembourg, 23-24 May 2005. http://epp.eurostat.ec.europa.eu/pls/portal/docs/PAGE/PGP_DS_QUALITY/TAB47143233/STANDARD%20QUALITY%20INDICATORS.PDF]

FAO Aquastat website: http://www.fao.org/nr/water/aquastat/main/index.stm

FAO, 2003. Review of World Water Resources by Country. Water Reports 23. http://www.fao.org/DOCREP/005/Y4473E/Y4473E00.HTM].

GWP 2004. Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies. See Institutional Roles, p. 19. http://www.gwpforum.org/servlet/PSP?iNodeID=215&itemId=496

SNA, 2008. System of National Accounts 2008. http://unstats.un.org/unsd/sna1993/draftingPhase/WC-SNAvolume1.pdf]

Statistics Canada 2003. Standard Drainage Area Classification (SDAC) 2003. http://www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdac-ctad-eng.htm]

Thaunoo-Chadee, P. and S. Sham-Jacmohum, 2007. Status of Environment Statistics in Mauritius: Country Report. http://unstats.un.org/unsd/environment/envpdf/UNSD_UNEP_ECA%20Workshop/Mauritius.pdf]

UNSD webpage. Searchable Archive [Online http://unstats.un.org/unsd/envaccounting/ceea/archive/Introduction.asp]

UNSD, 2007. System of Integrated Environmental and Economic Accounts for Water 2008. http://unstats.un.org/unsd/envaccounting/SEEAWDraftManual.pdf]

UNSD, 2008. International Recommendations for Industrial Statistics 2008. http://unstats.un.org/unsd/industry/guidelines.asp]

WMO, 2001. Exchange of Hydrological Data and Products. http://www.wmo.ch/pages/prog/hwrp/documents/TD74.pdf]

WMO, 2003. Hydrological Data Management: Present State and Trends. http://www.whycos.org/IMG/pdf/964_E.pdf]

WMO, 2006. Guidelines on the Role, Operation and Management of National Hydrological Services http://www.wmo.ch/pages/prog/hwrp/documents/WMO%201003.pdf]

Module 5
Waste Water and Pollutant Accounts

Goal

The Module contributes towards an understanding of the impacts of pollutants released into water resources on the national accounts.

Objectives

The module intends to take participants through the process of understanding and applying Pollutant and wastewater accounts. Specifically the module intends to:

- Define Pollutant and wastewater accounts
- Explain the importance Pollutant and wastewater accounts in water resources management
- Give an overview of current method for producing water Pollutant and wastewater accounts
- Highlight issues in preparing Pollutant and wastewater accounts
- Give examples of Pollutant and wastewater accounts in practice

Structure of the Module

The module contains 5 chapters whose contents are as follows:

Chapter 1- Introduction

Chapter 2: Concepts and Overview

Chapter 3: Constructing Pollutant and Wastewater Accounts

Chapter 4: Special Issues in Pollutant and wastewater accounts

Chapter 5: Examples from other countries

Chapter 6: Implications of Pollutant and Wastewater Accounts to Policy

5.1 Introduction

Water accounting refers to assessing the contribution of water to the economy and the impact of that economy to the water resources. This accounting is done by six sub accounts one of which is the Pollutant and Wastewater Accounts. Pollutant and Wastewater Accounts deal with a record of pollutants which are released from the economic activities to these water resources. In the SADC region efforts are being made to make water resources management policies which will make it possible for pollutant releases into water resources to be known.

Pollution of water resources in Southern Africa has been on the increase due to increase in the number of people residing in urban areas as well as industrial expansion. The waste from human settlements general goes through sewerage reticulation often to sewerage treatment plants where the treatment processes is intended to reduce impact to water resources. However the treatment inefficiencies in the wastewater treatment plants result in sewage of substandard quality finding their way to water resources. The income generating activities like agriculture and production processes also release pollutants which go to the water resources treated or untreated.

The pollutants decrease the quality of the water. Depending on the intensity of the pollutant the impact can be a reduction in quality of water resources to the level that the resources become unavailability for use. It is therefore important to understand the quantities of these pollutants being added to the water resources and ultimately the costs which may be required to the treat the water and make it suitable once again.

5.2 Concepts and Overview

5.2.1 What are Pollutant and Wastewater Accounts?

Pollutants refer to the constituents that are released to the environment by the economic units in a given environment. In the case of water accounting Pollutant and wastewater accounts assess the quantity of pollutants that are released into the water bodies by economic units. Some of these pollutants like human waste can result from consumptive activities whilst others like hydrogen sulphide can result from production processes. Therefore both humans and industries are important as sources of pollutants water resources. Some pollutants can have positive influence on the water resources whilst others can have negative consequences. Pollutants such as ammonia are toxic and can be lethal to the biotic components of the water resources. However other pollutants like phosphates though non lethal can lead to major ecosystem disturbances when they are released in excess.

Pollutants are important in water resources management because they help in determining the quality of the water. Pollutant and wastewater accounts describe the flow of pollutants from production and consumptive processes to the water resources either indirectly through sewage networks or directly through releases to the water resources. These accounts present the impact which the economic activities have on the water resources. The information is presented in disaggregated form whereby the type and quantities as well the origin and destination of the pollutants can be determined. Their greatest application is in designing economic instrument for the control of pollution discharges. Where possible they can be used to analyse the effectiveness of technologies used to treat waste water.

5.2.1.1 Aspects covered by Pollutant and Wastewater Accounts

In principle Pollutant and wastewater accounts should refer to all direct and indirect releases of pollutants to water resources. However in the SEEWA framework, only pollutants released into water resources directly from the economic units or indirectly via wastewater treatment plants are considered. Table 1 shows the scope covered by Pollutant and wastewater accounts. Those substances (such as heavy metals dumped into designated groundwater sites) which do not go through the wastewater system are not included.

Table 1: Scope Covered by Pollutant and wastewater accounts

Include	Exclude
Point sources: Pollutants added to wastewater	Point sources: Discharges of heavy metal and hazardous wastes not contained in wastewater (included in the SEEA waste accounts) Pollutants resulting from in-situ use (e.g. navigation, fishing, etc.)
Non-point sources: Urban runoff Irrigation water and rain-fed agriculture	Non-point sources: All non-point sources except for urban runoff, irrigation water and rain-fed agriculture (included in the quality accounts)

Source: UNDS 2006

5.2.1.2 Accounting Periods for Pollutant and Wastewater Accounts

Pollutant and wastewater accounts record the amount of pollutants added to the water resources by an economic unit during a specified accounting period. General speaking the accounting periods is one year. However depending on the frequency of data collection, some periods may be shorter or longer. In Zimbabwe the pollutants added by an economic unit to water resources is measured quarterly by the responsible ministry. The units of accounting are either kilogrammes for the lighter pollutants and tonnes for the heavier pollutants. In some SADC countries like Zimbabwe which uses the ‘Polluter Pays Principle’ the pollutant load of the economic unit determines the amount of environmental charges which units pay for discharging into water resources. Furthermore Pollutant and wastewater accounts describe the fraction of the water flows from the overall physical supply and use tables which are destined to the water resources either directly or indirectly.

How often do economic units have to submit pollutant release data to responsible authorities in your country?

5.2.2 Pollutants

5.2.2.1 Water Pollutants

A pollutant is that which makes a given substances less suitable for its functions. The first step in determining inputs to the Pollutant and wastewater accounts is to determine the pollutants to be measured. In countries this is often done by a board reporting to the Ministry mandated with Environmental protection. In Zimbabwe this is done by a special constituted board under the Environmental Management Agency whilst in Malawi this is done by the Ministry of Environmental Affairs. The list of substances regarded as pollutants therefore vary from country to country. General those variables which are regarded as pollutants are of concern to the water resources in the specific areas/countries. The quality of the water in the natural or undisturbed state determines which issues will be regarded as pollutants. For example water which originates from carbonate containing rocks will have carbonates defined as pollutant.

Is there data on the pollutants released via wastewater in your country?

Gross and net Pollutant Pollutants

Pollutants can be discharged in two ways which are

- Direct discharges
- Indirect discharges via treatments plants

The existence of these two pathways necessitates a distinction between two pollutants namely

- Gross and
- Net Pollutants

Gross pollutants are the levels of pollutants which actually leave the economic unit and go into the wastewater. They can go into the water resources via the direct discharges or indirectly via treatments plants. The net pollutants are the actual pollutants contributions which are discharged into the water resources by the economic unit. In situations where part of the gross pollutants are sent indirectly via wastewater treatment plants, the net pollutants is lower than the original gross values since treatment plants have an effect of reducing pollutant levels. (Since the purpose of wastewater treatment plants is to treat waste it is generally assumed that the levels of pollutants when wastewater leaves an economic unit is lower than the pollutant levels when the sewerage leaves the treatment unit. The treatment has the effect of reducing the pollutant contributions by the industries from which it receives sewerage.) However in instances where the whole discharge is sent directly to water resources then the values for the Gross and Net Pollutants are the same and therefore Gross = Net Pollutants.

In general Gross pollutants are higher than net pollutants and the difference between the two correspond to the pollution removed due to the treatment processes. Generally for Non point sources there is no distinction between gross and net pollutants. However in some instances urban storm water can be treated prior to discharge into the water resources for example in Australia where urban runoff is initially treated before discharge into water resources.

Often wastewater treatment plants treat a combination of waste from a variety of point sources and therefore the total pollutants from sewerage plants are an aggregate of pollutants all the contributing economic units.

It is difficult to reallocate the net value to the different units from which the wastewater collected originated. In practise the net pollutants of the individual units are calculated by applying the treatment efficiencies of the wastewater plants to the gross values measured from each economic unit. Thus if the gross pollutant of a cable manufacturing plant was 100 kilograms and the treatment efficiency of the wastewater treatment plant is known to be 30% then the net pollutant from the cable plant is 70 kilograms.

A wastewater treatment plant receives its wastewater from households as well as from a soap making plant. However the soap making plant need to know its pollutant contribution to water resources after the treatment process. How would you determine that value?

5.2.2 Pathways for Pollutants

There are many sources of pollutants which can be discharged into economic units. Pollutant and wastewater accounts cover pollutants from:

- Point Source Pollutants added to wastewater via the sewerage network
- Point source Pollutants added to water resources
- Selected non point pollutant like urban and agricultural runoff

Figure 1 shows the major pathways though which pollutants go into the water resources.

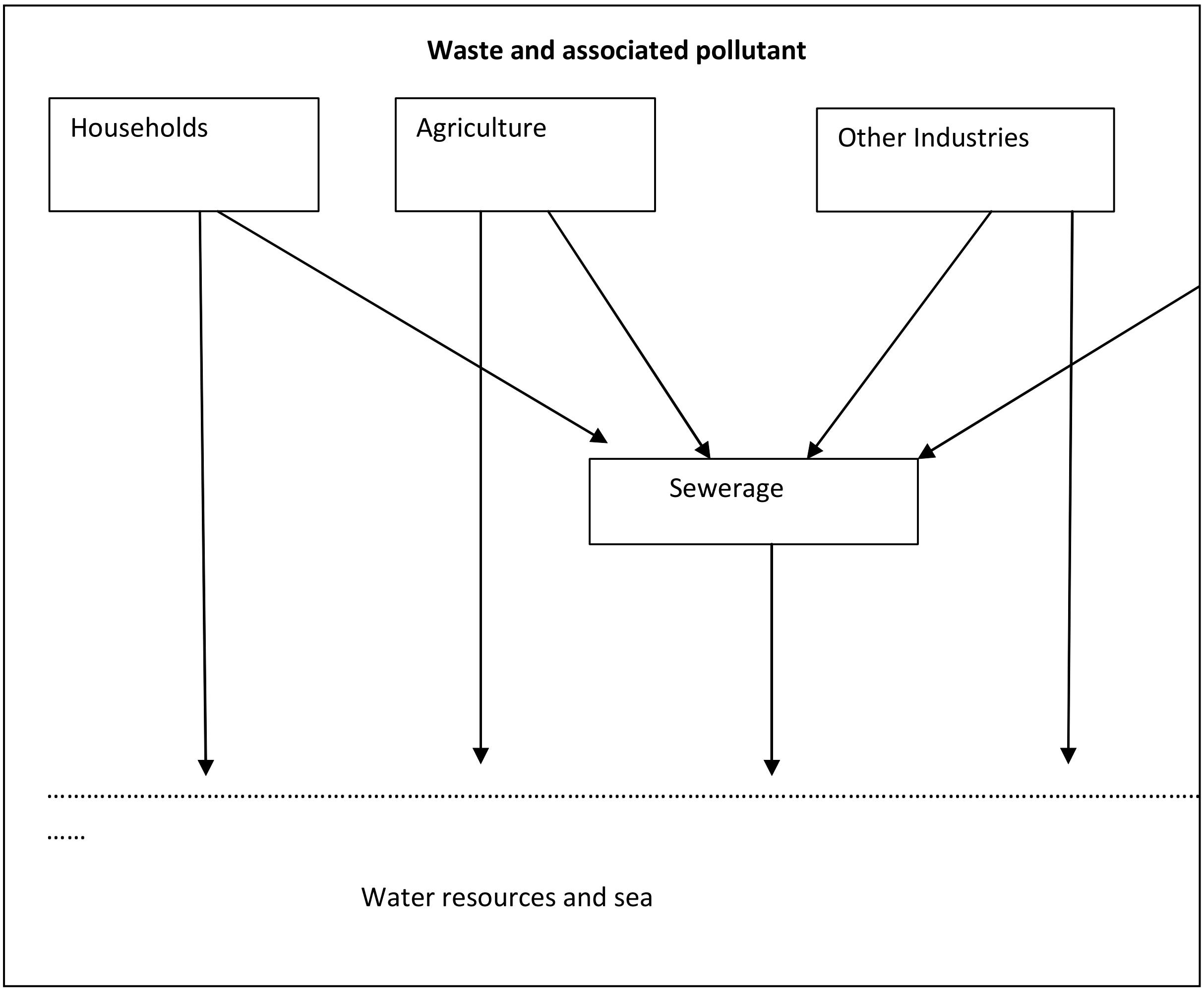


Figure 1: Pathways for Pollutants

Source: UNDS 2006

5.2.3 Point Sources

These are the sources of pollution which can be clearly defined as making contributions to pollutants being released into water resources. Their geographical location and extent can be clearly distinguished. Examples of point sources include sewage treatment plants, industrial units, power plants and hotels. The amount of pollutant load from these discrete units is easier to measure because the source can be identified and thus measuring devices can be installed. Samples for the analyses of pollutant can be taken just at the point the wastewater leaves the unit.

5.2.3.1 Non Point sources/Diffuse Sources

Non points sources are sometimes called diffuse sources. These are sources which have neither

a specific origin nor a specific outlet into the water resources but they bring pollutants. The pollutants can be carried by stormwater or runoff from their origin to the water resources. In some cases numerous small scale activities may also contribute to non point source pollution if the impacts of the single units can not be clearly measured. Examples of diffuse pollution sources are agricultural activities and urban runoff. The pollution in urban runoff is from pollutants deposited on both land belonging to the urban area and in the air as a result of economic activities within the confines of the urban area locations. In agriculture the activities include pollutants contained in the return flows from either rainfed or irrigated farming. The major components of the agricultural pollutants are pesticides and fertilisers.

The pollutant contributions of Non point sources cannot be directly measured because there is no specific location where samples for these measurements can be taken. Readings are only obtained through use of models which give estimations based on the soil characteristics, climatic conditions as well as the delay taken to record the pollutants in the water. As is the case in water quality accounts, it is difficult to allocate the extent of pollutants recorded with non point sources to a specific economic activity. Countries that use the Polluter Pays Principle often find it difficult to give proportionate pollution charges to the economic activities of a diffuse nature.

The effluent accounts should be consistent with the physical supply tables and therefore parameters included should be similar. For this reason some non point pollution sources are omitted from the construction of effluent accounts. In rigorous studies on construction of effluents accounts factors such as contributions of landfills, waste dumps and waste dissolved from the atmosphere are also covered.

5.3 Constructing Pollutant and wastewater accounts

5.3.1 Why Should Pollutant and wastewater accounts Be Considered

Pollutant and wastewater accounts should be considered because they:

- Enable detection of the activities which release pollutants
- Give an indication of the quantities and location of the pollutant
- When linked to the hybrid accounts they enable
  - The formulation of cost effective policies aimed at reducing pollutants
  - The evaluation of the economic impacts of the policies aimed at reducing pollutants

5.3.2 Experiences with Pollutant and wastewater accounts in the SADC region

Production of Pollutant and wastewater accounts in the SADC region has not been widely done. Though several countries have records of pollutions from various individual industries such as mines, production and treatments plant little effort has been put into aggregating this information to produce water accounts. In several countries the data on pollutant pollutants is recorded since it is the basis for companies to make payments for discharge licenses. Examples of countries with data on pollutant discharges are Zimbabwe, South Africa and Zambia. Internationally there are several examples where Pollutant and wastewater accounts have been developed. Some of the accounts from France and Sweden are shown in Chapter 5

5.3.3 The Structure of Pollutant and wastewater accounts

Pollutant and wastewater accounts only record the exact quantities of pollutants that are added to the water resources by an economic unit. The accounts do not take into the account the pollutants which were already in the water resources. For example if the water with 10 grammes of nitrates is abstracted and used by a fertiliser producing plant and the readings after use in the plant are 15 grammes of nitrogen then only 5 grammes are recorded in the pollutant table. The pollutants load is given by the difference between the incoming and the outgoing pollutant load.

Why do you think it is important to record only the contribution of the economic unit instead of the pollution unit of the whole load?

As explained in section 2.1.3 Pollutant and wastewater accounts are expressed for a given accounting period. The units of the pollutants can be in measured quantities of the selected parameters. At times the units can also be in arbitrary units such as BOD5 which represent more than one parameter. The structure of the account is shown in Table 2.

Table 2: Pollutant and wastewater accounts Tables

Table 2a: Gross and net pollutants

Physical units

Pollutant	Industries (by ISCI categories)							households	Rest of world	Total
	1-3	5-33 41-43	35	36	37	38,39 45-99	Total			
1. Gross pollutants(=1.a+1.b)										
1.a Direct pollutant to water(=1.a1+1.a2=1.a+1.aii)										
1.a.1 Without treatment										
1.a.2 After on-site treatment										
1.a.i To water resources										
Surface water										
Groundwater										
1.a.ii To the sea										
1.b. To sewerage ISIC 37)										
2. Rellocation of pollutant by ISIC 37										
3. Net pollutants (=1a+2)										

Table 2b: Pollutants by ISCI 37

Physical units

Pollutant	ISIC 37
4. Pollutants to water (=4.a+4.b)	
4.a After treatment	
To water resources	
Surface water	
Groundwater	
To the sea	
4.b Without treatment	
To water resources	
Surface water	
Groundwater	
To the sea	

Source: UNDS 2006

In the Pollutant and wastewater accounts the columns represent the types of industries contributing to the pollutant loads. In the System of Environmental Economic Accounting for Water (SEEWA) handbook all the economic activities have been categorised using a Standard systems. This system is called International Standard Industrial Classification (ISIC) and is based on the kind of economic activity an entity is engaged in. The various industries have been given codes obtained by assigning numerical values after the ISIC word. For example all sewerage associated activities are given the numeric figure 37 and the code is therefore ISIC 37. Each type of economic activity has its specific codes. However at national levels the coding systems for industries vary as some countries can use direct names for industries whilst SEEWA uses the standardized categories.

Why do you think it is important to record the pollutant using the SEEWA categories?

N.B. The heading of the first column represent the pollutant accounting unit used for the accounts presented as was explained on the section above. The heading can have pollutant COD (chemical oxygen demand) if COD is the unit chosen, Nitrates if nitrate is chosen. Remember the parameters used depend on the ones which is important for a specific country or situation.

Two tables are used in Pollutant and wastewater accounts. This allows for the separation of pollutants from all other industries from that of Sewerage industries ISIC 37.

First table i.e. Table 2a

The first table shown in Table 2 begins by

Row 1 – this describes/gives the pollutant value of the gross pollutants from the various industries contributing to the pollutant readings. The gross pollutants in Row 1 are a sum of the direct pollutants through direct discharge to water sources and indirect pollutants

Direct Pollutants

Row 1a- this is a subset of Row 1 which shows the values for the direct pollutants by a specific industry to the water resources. The direct pollutants are further disaggregated into two types which are represented by

Row 1.a.1 – This shows the pollutants which are sent straight to the water resources without any onsite treatment. In simple terms these pollutants are as they are from the activity/processes which has produced them.

Row 1.a.2- These are pollutants which undergoes some kind of onsite treatment before they are discharged to water resources. For example acid producing industries usually add lime to their wastewater before releasing it to the water resources.

The direct pollutants released can further be disaggregated into the type of water resources which receive these pollutants. The receiving sources are classified into

Row 1.a.i – These are pollutants to the fresh water resources

Row 1.a.ii- These are pollutants released directly to the sea.

N.B Remember that all the direct pollutants have to end up either in the fresh water resources or in the sea therefore the sum of Row 1a.1 and 1.a.2 is equal to the sum of Rows 1.a.i and 1.a.ii. Mathematical we write: Row 1a.1 + Row 1.a.2 = Row 1.a.i + Row 1.a.ii

In some instances the fresh water resources can further be disaggreagated into the type of receiving media. The levels of disaggregation will vary from country to county. What determines the extent of disaggregations is the levels at which input information has been collected. Some will design collection systems which will go right down to type of water body whilst others will only end with types of receiving water as was shown in the structure in Table 2. This is the minimum disaggregation expected.

Q2. You are told that a certain catchment X wants to compute direct pollutants from the economic units within it. Industries in it are X, Y, Z, which contribute 230, 150 and 300 kilogrammes of COD loads in a year. Present how the water accounts will look like with this information only.

Indirect Pollutants

Row 1b- These are the pollutants which are released by economic units to the Sewerage system. The quantities of the pollution loads released into the sewerage system from each economic unit is measured and recorded.

Therefore to find the gross contributions of each industry we then add the pollutants sent directly and the pollutants sent indirectly i.e Row 1 a + Row 1b.

Reallocation of Pollutants – Row 2

The sewerage system will treat all the sewerage flows received before it finally releases the pollutant to the water resources. It is clear that various industries or economic units make contributions to the total wastewater handled by the Sewerage Treatment Plant. The sewerage treated is an aggregate of all units contributing to the systems. However when the wastewater leaves the treatment plant the pollutant load is also measured and only one value is obtained. This figure is taken as the pollutant contribution of ISIC 37 to the water resources (figure in last column of Row 2). But there is need to know how much of the pollutant load brought by any one economic unit to the treatment system is still in the wastewater as it goes to the water resources. (This is the figure which is put in Row 2 which indicates reallocation of pollutants for each of the economic units.)

Second Table

To find an answer to that we need a second table (Table 2b) which shows us the pollutant load released by the ISIC 37 to the water resources disaggregated into pollutant released without treatment and those with treatment.

Table 2b: Pollutants by ISCI 37

Physical units

Pollutant	ISIC 37
4. Pollutants to water (=4.a+4.b)	
4.a After treatment	
To water resources	
Surface water	
Groundwater	
To the sea	
4.b Without treatment	
To water resources	
Surface water	
Groundwater	
To the sea	

The heading of the first column is still the accounting unit just as in table 2a. The second column heading only has one industry as only ISIC 37 is under consideration.

In the table 2b:

Row 4 shows the total pollutants sent to the water resources by ISIC 37 which is a sum of:

Row 4a- shows the total pollutants released after treatment

However the pollutants released after treatment can go either to fresh water or sea water thus

Row 4a.i shows release to the fresh water

Row 4a.ii shows release to the sea

And

Row 4b- shows pollutants released by ISIC 37 without any treatment. This figure normal includes urban and storm water runoff. It can also include sewerage which is just released without treatment.

The pollutants will also be released into fresh water and sea water and thus

Row 4b.i shows release to the fresh water

Row 4b.ii shows release to the sea

To answer the question of net indirect contributions by the various economic units we use a flat percentage of the treatment efficiency of the treatment plant on the original values Row 1b (To sewerage) contributed by the units. The abatement factor is obtained by dividing total input (I) into ISIC 37 by total output (O) from the system. Mathematical we write Abatement factor = I/O

After applying the abatement factor to the values of pollutants in Row 1b we will get the actual pollutant load of each economic unit and we write this value in Row 2. Row 2 gives the indirect pollutant loads of the economic units.

Net Pollutants from Economic Units- Row 3

The net pollutants to water resources of each economic activity is obtained by adding the direct pollutants (1a) and the reallocated pollutants in Row 2

Q3. You are given that economic unit ISIC 37 receives 15 000 tonnes of pollutant X. The total pollutants of X after treatment were 9 000 tonnes. Calculate the abatement factor which you would use to reallocate the contributions from each industry. Hence calculate the net contributions of industry X, Y and Z given that the loads discharged to sewerage by each of the units were 3500, 2400 and 7 000 tonnes respectively and that the direct pollutants to water resources from each of these industries were 5000, 23000 and 13000 tonnes for X, Y and Z respectively.

5.4 Some Issues in Pollutant and Wastewater Accounts

a) Urban runoff

Urban runoff is defined as the portion of precipitation on urban areas that does not naturally percolate into the ground or evaporate but flows via overland flow, underflow, or channels or is piped into a defined surface water channel or a constructed infiltration unit. This water is generally highly polluted with litter and organic materials from bacterial wastes, oil, detergents, pesticides and other pollutants which get washed from driveways, parking lots, streets.

The pollutants from urban runoff are allocated to ISIC 37 as by classification it is the economic unit which collects and discharges it. The contribution of urban runoff can clearly be measured if its sewer system is separate from that of domestic and commercial sewers. In most SADC countries these systems are separate and therefore urban runoff contribution can clearly be measured.

Storm/urban runoff can either be transported together with sewage (domestic and industrial) or in separate reticulation system. Which system is used in your country?

b) Water collections, treatment and supply

As explained in section 2.1.2 Pollutant and wastewater accounts only record releases to the environment via ISIC 37. Therefore whilst water treatment processes (ISIC 36) offers some degree of purification its contribution is not recorded in the accounts. However for most countries the water abstracted for water supply is thought to be fairly good and therefore there is minimal pollutant reduction anyway. The target for purification is general micro organisms.

Do you know the general quality of water abstracted for treatment in your country? Do you think the pollutant reduction by the water treatment process is significant?

c) Disaggregations

If information is available the waste water treated by wastewater treatments plants can further be disaggregated into types of treatment such as biological, mechanical and advanced systems. Information of receiving fresh waters can also be disaggregated into groundwater and surface water. In the SADC region releases are generally to surface water and no wastewater releases to groundwater are recorded.

d) Sludge

Sludge refers to the solids which are separated from wastewater during and after treatment. Some countries require the quantities and the pollutant loads of the sludge to be recorded. The quality of the sludge depends on the treatment processes applied to the system. In most SADC countries sludge is treated in digesters before being dried as cake. In the developed countries processes such as the filter belt press can also be used. The sludge usually has high concentration of heavy metals as well as nutrients like phosphate and nitrates.

5.5 Examples of Pollutant and Wastewater Accounts from Other Countries

5.5.1 Southern Africa

In Southern Africa no country has produced detailed Pollutant and Wastewater Accounts. However countries like Botswana and Zimbabwe has information which can be consolidated to populate pollutant and wastewater tables.

Botswana

Botswana has produced wastewater accounts which show only the volume of wastewater released into the water resources. The objective was primarily to assess the use of the wastewater as resources in other activities like agriculture. Table 3 shows the volume of waste water from the major Towns in Botswana

Table 3 Volume of wastewater from major Towns in Botswana

Source of waste Water	1992 supply in Mm3	2003 supply in Mm3
Gaborone	8	17.1
Francistown	1.9	4.1
Selebi Pikwe	2.2	3.1
Lobatse	0.9	1.6
Jwaneng	0.7	1.1

The volume of wastewater collected can be disaggregated to indicate types of contributors to the totals indicated for the various towns. However the pollutant concentrations data could not be obtained in the Botswana water accounts reference making it difficult to calculate the pollution loads of the units.

Zimbabwe

Zimbabwe has records of concentrations of pollutants from point sources of pollution. The Environmental Agency of Zimbabwe collects information from all the point sources of pollution. However the information collected is only measurement of the concentration of the pollutants. The volume of the wastewater is recorded but the intention is to use the volume to calculate the amount of charges which the industry should pay. An example of the information collected is shown in Table below.

Table 4: Pollutant Levels of a textile Processing Plant in Zimbabwe

Pollutant	Concentration (mg/l)
pH	9
BOD	800
COD	1400
TSS	500
TDS	1800
Chloride	700
Sulphate	900
Cr	8

Volume per day 10 ML

Furthermore the information has not been aggregated into types of industries so as such it can not be used to populate the Pollutant and Wastewater Accounts Tables. However with enough effort it should be possible to produce data which can be used to populate the tables.

5.5.2 Developed Countries

Source: UNDS 2006 Draft: This section presents how selected countries have compiled Pollutant and wastewater accounts: France and Sweden. The country's case studies cover the compilations of Pollutant and wastewater accounts at river basin level which provides information on the spatial distribution of the economic pressure on water sources.

France

Table A1 presents pollutants accounts for French river basin, the Loire-Bretagne basin. In this table gross and net pollutants are calculated according to the source. Very detailed geo-referenced data have been used, so that a specific treatment plant could be attributed to each point source of pollution with help of its geographical location. DE-pollution ratios of the identified treatment plants were applied. Consequently, the direct discharge of the sewage industry, SIC 37 (86 tonnes per day in Table A1 could be reallocated to the original emitter (row d).

Table A1: Pollutants of Nitrogen in the French Loire-Bretagne hydrological basin (in tones per day)

Pollutant N	ISIC		Households		Non-point sources	Total
	ISIC 1 Agriculture	Other	Scattered population	Urban population		
Gross pollutants(=a+b)	528.0	43.0	2.0	122.0	37.0	786.0
▪ Direct pollutants to water	528.0	15.0	2.0	7.0	37.0	643.0
▪ B. to sewage network	0.0	28.0	0.0	115.0	0.0	143.0
	322.0	28.0	35.0	0.0	0.0	385.0
Removed during onsite treatment		13.0		73.0		86.0
▪ Re-allocation of pollutants by ISIC 37 Net pollutants(=a+d)	582.0	28.0	2.0	80.0	37.0	729.0

Discharge from treatment/collection facilities to water

Pollutant N	ISIC 37
C. pollutants to water (=c.1.+c.2.)	86.0
c.1. after treatment	72.0
c.2. without treatment	14
removed during treatment	57.0

Source: adapted from Ifen, 2000.

Since in France information is available on the removal of pollutant during on-site treatment, Table A1 explicitly reports this information as it gives an indication of the effectiveness of on-site treatments. Note that the removal of pollutant during on-site treatment for agriculture includes spontaneous de-nitrification process of the soils (322 tonnes per day).

In this presentation, urban run-offs (column non-point sources) have been assumed by passing the sewage system. The pollution content of these flows (or at least part of it) has nevertheless been attributed to the economy as 'non-point source'. No breakdown of urban runoff between what is natural and what is of an economic origin was calculated as it was not considered to be a meaningful estimate. It is important to take into account flows of the rainwater runoffs to the sewers and, possibly, their treatment as they undergo an economic treatment which is accounted for in the expenditures (e.g. the investments in sewers for urban run-offs). In order to keep coherence within the different accounts, the pollutant content of these flows should be studied.

Sweden

Pollutants accounts have been compiled in Sweden for six major drainage basins for the year 2000. Table A2 summarizes information on the discharges to water from municipal waste water treatment plants: the pollutants reported in the tables are phosphorus, nitrogen, BOD_7 (biochemical oxygen demand) and COD_{Cr} (chemical oxygen demand).

Table A2: Discharges to water from municipal waste water treatment plants in 2000 by major drainages areas, tonnes

Major Drainage area		Tot –P	Tot –N	NH –N	BOD^7	CODcr
Bothnian Bay		21	1176	820	839	2752
Bothnian Sea		69	3212	2317	2003	8579
Baltic Proper		145	880	3413	3156	24359
The Sound		32	1058	273	792	4609
Kattegat		148	5069	2925	2813	15585
Skagerack		9	383	206	182	1586
Total	2000	424	18977	9954	9784	57472
Total	1998	430	21376	..	11270	58463
Total[1]	1995	470	25940	..	13060	66840
Total[2]	1995	415	25430	..	11670	63030
	1992	470	25310	..	12205	62190
	1990	655	26200	..	14050	69150
	1987	1050	25600	..	16700	66300

- Induces temporary large pollutants from a plant located on the Kattegatt, due to reconstruction.
- Excluding the above mentioned temporary pollutant.

The information of waste water and waste water treatment has been taken from the database connected to the publication MI 22 SM 0101 *discharges to water and sludge production in 2000 – Municipal Wastewater treatment plants and some coastal industry.* The report was made by statistics Sweden on behalf of the Swedish Environmental Protection Agency (Swedish EPA).

Under Swedish Environmental protection law, special permits are required to perform certain activities which are potentially harmful to the environment. In Addition, establishments performing these activities (which are more than 2000 in number) are required to report their pollutant data to the supervisory agency once a year. Estimates of the pollutant are usually based on results of measurement programs. The primary data of the statistics stem from these reports.

Municipal wastewater treatment plants designed for more than 2000 person equivalents, including industrial wastewater, are required to produce environmental report. Information on the discharge is based on environmental reports and cover 478 wastewater treatment plants in the year 2000. Data been mainly collected through a postal survey except 75 plants situated in Västra Götaland which have been taken from the Swedish EPA database EMIR.

Some pollution sources were not included. They included; (i) small waste water plants as there are no measurements of their pollutants but it is estimated that they account for less than 10 percent of municipal wastewater and therefore they were assumed to make a similar contribution to pollutants; (ii) people living outside urban areas (which amount to slightly more than one million people) which usually depend on self-supplied water and use septic tanks or similar devices to dispose of their waste; and (iii) establishments which are too small to be covered by the reporting requirement and which are also beyond the reach of the municipal wastewater networks.

Regarding industrial pollutants, the most water-intensive industry in Sweden is the pulp and paper industry, which consists of around 75 plants. A special survey of these plants was conducted by the Swedish EPA. Pollutants from 22 coastal plants in other industries are also included in the statistics. Inland factories outside of the pulp and paper industry were included.

The allocation of pollutants from wastewater treatment plants and other industries to the different drainage areas was straightforward as the basic data refer to individual plants whose spatial location is known.

A special project was carried out in Sweden in connection with the reporting to HELCOM, PLC-4, Recommendation 19/04. Yearly pollutants of nitrogen and phosphorous were estimated for all known point sources, even those that do not produce environmental reports. Also diffuse leaching from various types of land was estimated based on every detailed data. Incorporating weather data for 30 years, model calculations of leaching and transport were performed and calibrated to most known measurements in Swedish rivers during this period. The “gross” (average) load, pollutants and leaches, of phosphorous and nitrogen, was calculated for drainage areas larger than 1,000 km2. For nitrogen, “net” loads were also calculated using a special hydrological retention model. The project is presented on the Internet at http://www-nrciws.slu.se/TRK/index/html.

Table A3 shows pollutant to water for one of the drainage areas, the Bothnian Sea, for the year 2000. The table present additional information such as value added, number of employees and households, number of establishments and volume of wastewater collected by the sewage network in order to have a more complete picture of the economic profile of the industries emitting pollutants to water.

Table A3: Environmental economic profile for Water district Bothanian Sea, 2000

	Agriculture forestry, fishing	Water intensive industries	Manufacturing Industries	Water supply and wastewater	Services	House holds	Public Admin	Undistributed	Total
			Others						
	NACE	21+24	10 - 37[1]	41+90001	45-99				
	01-05	+27+40			Others				
Value added (Milj SEK)	9023	27498	23 335	639	77066	2643[2]	41703	20310	199574
Num of establishments	5449	56	3899	105	34835	-	-	2571	47215
Num of employed	11320	27840	53871	237[3]	149899	7835[2]	142460	5643	399105
Number of household		-	-	-	-	469581			469581
Wastewater collected and treated by sewage networks (1000m^3)[9]	0	217239	2793	152373	-	-	-	-	372405
Pollutant of P (Ton)[10]	-	168	0,3	58	-	-	-	-	226
Pollutant Of N (Ton) [10]	-	1561	0,3	2660	-	-	-	-	4221
Pollutant Of COD_7 (ton) [10]	-	29929	0,3	1586	-	-	-	-	31515
pollutant of COD cr (ton) [10]	-	119587	0,3	7225	-	-	-	-	126813
pollutant of Hg (kg)[11]	-	-	-	11	-	-	-	-	11
pollutant of Cd (kg) [11]	-	-	-	24	-	-	-	-	24
pollutant of Pb (kg) [11]	-	-	-	141	-	-	-	-	141
pollutant of Cu (kg) [11]	-	-	-	1799	-	-	-	-	1799
pollutant of Zn (kg) [11]	-	- -	-	7808	-	-	-	-	7808
pollutant of Cr (kg) [11]	-	-	-	213	-	-	-	-	213
pollutant of Ni (kg) [11]	-		-	515	-	-	-	-	515

Note: NACE—Consultation f economic Activities in the European community

[1]Excl21. 24, 27

[2]NPISH

[3]Employment in NACE 90001 – not included, here part of NACE 90

[9] Discharge of treated water, NACE 10-37 direct discharge

[10] For NACE 24, 27 and 40), only establishment by the coast

[11] Data for year 2002

Source: Statistics Sweden (2003)

5.6 Policy Implications of Pollutant and Wastewater Accounts

The Pollutant and Wastewater Accounts are important in assisting with calculations of indicators as well as directing the regulatory framework.

Pollutant Release per Person Indicator

Given the total pollutants released for a country and knowing the population of the country one can then calculate how each person has contributed. This informs policy makers on whether their pollutant releases per person is high or low compared to other countries.

Effectiveness of Regulatory Frameworks

The release of pollutants is general controlled through policies and charges which aim at reducing quantities which will be released into water resources. By comparing the quantities released over time a country can see whether or not the policies in place are resulting in a decrease in the total quantities of pollutants.

The Major Contributors to Pollutions

The Pollutant and wastewater accounts show the dis -aggregations of pollutions by type of industries so it can be clearly seen which types of industries are contributing the most and least pollution. It can allow formulation of sector specific policies so that industries who are impacting the most on water resources can be assisted with exposure. It can also allow cross learning between sectors.

5.7 References

Department of Water Affairs and Forestry (2006). Ministry of Agriculture Water and Forestry *Technical Summary of Water Accounts.* Namibia

Department of Environmental Affairs, Ministry of Environment, Wildlife and Tourism

(2006). Policy Brief on Botswana's Water Management

- (2006). Water Accounts of Botswana (1992-2003)

Egis bceom International (2010). South African Development Community European Development Fund. Regional Indicative Programme. Economic Accounting of Water Use (9ACP RPR 39-90). Final Inception Report.

European Commission, eurostat (2002).Water Accounts-Results of pilot studies

Korea Environment Institute (KEI) (1998). *Pilot Compilation of Environmental-Economic Accounts*. EI and UNDP: Seoul, Korea

Lange, G and Hassan, R. (2006). *The Economics of Water Management in Southern Africa: An Environmental Accounting Approach*. Edgar Elgar: Cheltenham, UK

Maarten van Rossum, Marije van de Grift (2009). Regional Analysis: Differences in Pollutant- Intensity Due to Differences in Economic Structure or Environmental Efficiency? Journal of Sustainable Development. Vol. 2, No 3. www.ccsenet.org/journal.html. Statistics The Netherlands.

Michael Vardon, Michael Nagy (2008).Training Session on the System of Environmental-Economic Accounting of Water (SEEAW) for Arab Gulf Countries. Pollutant and wastewater accounts. UN House-Beitrut-Lebaon

Office International de l'Eau (2005).

The World Conservation Unit (1997). Environmental Accounting: What's It All About?

United Nations Statistics Division (2006). System of Environmental-Economic Analysis for Water

United Nations, Commission of the European communities, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank (2003). *Handbook of National Accounting on Integrated Environmental and Economic Accounting 2003*. Sales No. New York

Statistics South Africa (2006). Natural Resources Accounts. Updated Water Accounts for South Africa: 2000. Discussion Document-D0405

United Nations Statistics Division

- (2006). Integrated Environmental and Economic Accounting of Water Resources; Draft for Discussion
- (2006). Regional Analysis: Differences in Pollutant-Intensity Due to Differences in Economic Structure or Environmental Differences?
- UNCEEA (2006). Water Accounting- A Tool for Integrated Water Resource Management? User-Dialogue (CBS-Voorburg-The Netherlands 2006)
- Division (2010). Progress on Water Accounts in ESCWA Countries Fifth Meeting of Experts and Environmental Economic Accounting

Useful Websites

-Unstats.un.org/unsd/envacountry/ceea/archive

-**Erreur ! Référence de lien hypertexte non valide.** of work

-www.fsd.n1/natureevaluation/70995

-pubs.acs.org/doi/abs/ceea/default.as

-unstats.un.org/unsd/methods/citygroup/landgroup.htm

-www.beyond-gdp.eu/indicators.html#Environmental%20%accounts

5.8 Notes to Facilitator

About this Module

This module is designed for use by technical staff working hands on with issues of pollutant discharges. The staff members working in departments of Environment, Water, Industry and Sewage Works for local authority would find the course relevant. The general level of education should be at least a diploma related to issues of water and wastewater. The participants should have the ability to use computers so that they can practise populating the data tables.

Participants will find this module useful in that it enables them to:

- Understand concepts in Wastewater
- Calculate pollutant and Wastewater accounts
- Determine how they should adapt their polluter pays policies

Preparation for Facilitation

In preparation for the workshop the facilitator should:

- Send out invitation letters directly to industries, municipalities as well as through networks. The invitation should include the venue, costs of the course as well as a brief description of the course clearly outlining its objectives. The advert should state the background education required for the course. Furthermore the invitation should state target audience so that the right members send in applications.
- Provide the participants with background papers and websites indicated in this module so that they can prepare for the course by reading the materials

Facilitation

This module is designed for face to face facilitation. To enable group work exercise and exchange of learning the number of participants should be between 20 – 30 students. The approximate time for delivery of the module is 4 hours with the right audience.

The Facilitator should have experience in dealing with pollutant accounts as well as having strong presentations skills.

In delivery of the module the facilitator should use

- Slides
- Flipcharts
- Group work exercises – The group work should be given time so that participants can work on the exercises. The report back should be done in plenary where others can comment. Depending on time available the groups can be given the same exercise or different ones. On average 20 minutes should be enough for the groups to work through the exercises. The discussion and though questions should be dealt whilst explaining the

Evaluation

The participants should be allowed to evaluate the module based on the facilitator ‘s skills and ability to explain concepts, usefulness of the course to their daily work, added knowledge due to the course, length of the course. The evaluation should have score levels for each evaluation component so that participants will select appropriate score for the evaluation.

Module Adaptation

This module can be adapted to the training needs of the particular class. In producing adaptated versions acknowledgement of the source must be made. It will be important to give the authors a feedback on how the module can be improved. In particular examples of experiences in handling pollutant and wastewater accounts will be welcome. Comments can be sent to ivhevha@yahoo.co.uk

Module 6
Hybrid Accounts

Goal

The goal of this module is to enable participants to present a comprehensive picture of the contribution of water to the economy and the impact of the economy on water resources.

Learning Outcomes

At the completion of the module, participants should be able to:-

- Define “hybrid and economic” accounts
- Compile hybrid and economic accounts
- Use hybrid and economic accounts to derive key indicators such as **water-use efficiency** and the **value added** of water use in the various economic sectors (**Water Productivity**)
- Use indicators derived from hybrid and economic accounts to inform policies on allocation of scarce water resources among competing uses, setting water tariffs and justifying the need to increase investment in water and wastewater management

Structure of the Module

In this Module we present the economics of water; that is to describe in monetary terms, the use and supply of water-related products and services.

In terms of scope, this module draws heavily on information presented in Modules 1 to 5 therefore the reader is advised to go through these modules first. This module focuses on presentation of hybrid accounts for water and does not try to reproduce all arguments underlying the rationale for the particular format of the economic accounts nor to explain in detail the strict accounting rules applied. Those who are interested in this detail are referred to the 1993 System of National Accounts (SNA) (UN, 2008), the System for Integrated Environmental and Economic Accounting SEEA 2003 (UN, 2003) and other materials dedicated to the economic accounts alone.

A word of caution - compiling hybrid accounts is a challenge, it is data intensive, and depends on the quality of the other accounts described earlier i.e. asset, supply and use, and wastewater and pollutant accounts.

The Module is outlined as follows:-

Section A	Brief description of Hybrid and Economic Accounts
Section B	Detailed description of Hybrid and Economic Accounts with examples
Section C	Data requirements
Section D	Indicators derived from Hybrid and economic Accounts
Section E	Group exercise
Section F	Resources
Section G	Note to the facilitator

6.1 Introduction

Water managers in the SADC region are faced with a number of difficult questions. These include the following:-

- How to allocate water among competing uses and users (households, agriculture, industry, hydropower etc.) during times of droughts?
- How to justify the need for more investment in water infrastructure, institutions and services to the Ministry of Finance?
- How to share benefits from utilisation of water resources in Transboundry watercourses?
- How to establish effective cost recovery mechanisms?
- What efficient mechanisms to use to ensure water security for strategic sectors at national and river basin levels?

What are some of the major challenges you face in allocating water among competing users at the national as well as River Basin levels?

Economic accounting for water provides most of the information which water managers require in order to make informed decisions on the various issues raised above. In this module we present economic information on water together with physical (hydrological) information on water abstraction, use and supply, and discharges of wastewater and pollutants into the environment. As such, hybrid accounts bring together information from the various accounts (Asset accounts (Module 2), Physical supply and use (Module 4) and Wastewater and Pollutant Accounts (Module 5)) and present this information in a way that allows a consistent analysis of the contribution of water to the economy as well as the impact of economic activities on water resources thus contributing towards achievement of **sustainable development**.

Definition:- These accounts are referred to as "hybrid accounts" since they present different types of units of measurement in the same accounts (e.g. M^3 and $). A hybrid account present in a single matrix, national accounts in monetary terms, physical flow of water and wastewater generated. The advantage of presenting physical and economic information in the same accounts is that it allows for the derivation of consistent indicators for evaluating the impact on water resources of changes in the economy, e.g. changes in the economic structure, changes in interest rates, etc. Furthermore, hybrid accounts can be used in economic models to analyze possible trade-offs between alternative water policies and economic strategies.

At finer levels of disaggregation, the hybrid accounts provide the scientific community with access to a structured database for monitoring the overall hydrological-economic performance of national economies thus contributing towards sustainable development

6.2 Hybrid supply and use tables

Hybrid accounts can be presented based on the supply and use tables (SUT). Hybrid supply and use tables present economic information side-by-side with the corresponding physical information on water supply and use, and effluent discharge. In so doing, the economic and physical data share the same structure, classifications and concepts. In summary hybrid accounts record the following **FIVE** sets of information:-

▪ The monetary contribution of an entity to the economy (supply)	**Monetary supply**
▪ Investment in water supply and wastewater management infrastructure	**Stock of Assets**
▪ The amount of water used by the entity	**Abstraction**
▪ Total amount of effluent discharged by the entity	**Total Returns Flow**
▪ Total discharge of pollutants by the entity (COD)	**Gross Emissions**

Hybrid accounts are made up of the water supply and use tables (SUT) discussed in module 4. In terms of presentation, the SUT show, by row, products classified according to the **Central Products Classification** (CPC). The industries are classified, by column, according to **International Standard Industrial Classification** (ISIC). These are the same classification used in National Accounts. The level of disaggregation of industries depends on the country's situation and data availability. The simplified standard tables identify a limited number of key water users in SADC for ease of compilation. These include the following groups:

Box 6.1: International Standard Industrial Classification (ISIC)

- ISIC 1-3 - Agriculture, forestry and fishing;
- ISIC 41-43 - Manufacturing and Construction;
- ISIC 35 - Electricity, gas, steam and air conditioning supply in particular, Hydroelectric power generation, transmission and distribution (part of ISIC 3510);
- ISIC 36 - Water collection, treatment and supply;
- ISIC 37 - Sewerage;
- ISIC 38, 39, 45-99 – Service industries.

In most SADC countries activities of water supply (ISIC 36) and sewerage (ISIC 37) are carried out by the same establishment- municipality for example and no separate accounts are kept. This makes it difficult to separate information on the costs related to the two separate ISIC classes. To the extent possible, information should be disaggregated so as to show explicitly the costs and output of water supply and sewage management. Additional information and estimation may be needed to separate these activities. In the case where water and wastewater are produced in an integrated production process, one may use the cost structure of a firm which is treating wastewater only to estimate the portion of the cost for treating wastewater.

6.2.1 Converting from physical flows to monetary flows

The hybrid water supply table corresponds to the physical supply table presented in Table4.1 in Module 4. In principle the physical outputs in row 4 of the Table 4.1 are converted to monetary flow by multiplying them with the basic prices and purchaser prices. The **Purchaser Price** represents the total cost to the purchaser including any taxes on products payable at the point of sale most importantly value added tax (VAT). **Basic Prices** on the other hand, exclude taxes such as VAT and profit and transport margins and more nearly represent the value initially retained by the producer (SEEA, 2003). In practice however, converting physical water supp tables to monetary accounts is a major challenge and this makes construction of hybrid water accounts a difficult task. In many SADC countries water for rural households and farmers is not metered and water services are recovered through taxes to the local authorities or water permits. Therefore when converting physical supply tables to monetary accounts these taxes and permits should be considered as payment in counterpart to a service, equivalent to a price (UNSD, 2006).

6.2.1.1 Balancing identity

In order to conform with the strict accounting rules some product balancing are included in hybrid accounts (see discussion in Section 4.4 of Module 4). All the water available for use within the economy must have been supplied either by domestic production or by imports from Lesotho for example in the case of South Africa. The same amount of water entering the economy in that accounting period must be used for intermediate consumption (as an input in agriculture and industry), final consumption (drinking by households), capital formation (reserves- although these do not apply for water) or exports. This product balance can be expressed mathematically as:-

Output + imports = intermediate consumption + final consumption + capital formation + exports

Because the use of water is usually valued purchaser's prices, yet supply of water is valued at basic prices, it is necessary to add trade and transport margins, taxes on products less subsidies

The product balance for water must satisfy the condition that the sum of output at basic prices plus imports plus trade and transport margins plus taxes on products less subsidies on products is equal to the sum of intermediate consumption, final consumption and capital formation, all expressed at purchasers' prices, plus exports. This explains the columns in Table 6.1

on products to the left-hand supply side of the identity above so both sides are expressed in purchasers' prices (see right hand side of Table 6.1).

6.2.2 Hybrid water supply table

Table 6.1 presents the hybrid water supply table. The table is similar to the physical supply table and consists of the following three parts:

- Monetary supply table
- Physical water supply table
- Pollution discharged

Box 6.2: Main components of the Hybrid Supply Table

- **Monetary supply table.** This describes income of each entity and its origins. The economic entities are shown in columns and their products in rows. For example, income for a water utility (ISIC 36 in columns) can come from sales of water (CPC1800) or provision sewage services (CPC 941) which are presented in row 1 in the Table.
- **Physical supply table of water**. It contains information on the volumes of water supplied to other economic units and wastewater discharged (returns) into the environment. This information corresponds to the physical supply table described in **Module 2**.
- **Total emission of pollutants in physical units.** It shows gross discharge of pollutants by each entity. For simplicity only gross discharge is presented not net discharge. This information corresponds to the emission accounts described in **Module 5**.

The monetary supply part presented in Table 6.1 shows by column the following information:

- Output at basic prices of each industry classified according to ISIC Rev. 4;
- Imports; this column is important for countries that import or export water such as South Africa and Lesotho respectively
- Taxes and subsidies on products;

From the example in Table 6.1 below you can see that the bulk of the supply of *Natural water* (CPC 1800) and *Sewerage services* (CPC 941) appears in the columns corresponding to water utilities (ISIC 36) and sewerage (ISIC 37) since these are the entities whose principal activities are the distribution of water and wastewater services respectively. However, other mines (ISIC 5-33, 41-43) can also supply water to other entities as a secondary activity. In the numerical example in Table 6.1 mines generate 40 million from supply of water to other entities. Sewerage companies (ISIC 37) can also supply wastewater for reuse in agriculture for example. In Table 6.1 Sewerage companies generated 8.8 million from sales of wastewater.

6.2.3 Hybrid use table

Hybrid use table is derived from a physical use table and what was discussed in section concerning the conversion of physical supply to hybrid supply table also apply here. The standard hybrid use table presented in Table 6.2 resembles the physical use table discussed in Module 2 and consists of two main parts:-

- Monetary use table
- Physical use table

For example, Table 6.2 shows that the mining sector spent 3 million and 2.4 billion on water and sewerage services. Similarly the services industry spent 2million on water and 1 billion on sewerage services. In terms of water use, the mining sector used a total of 200.2 million cubic meters compared with 53.4 million cubic meters for the service industry.

Box 6.3: Main components of the Hybrid Use Table

- **Monetary use table.** It shows the cost of water and sewerage services incurred by the various industries and households. Like the hybrid supply table, the hybrid use table also presents products in rows and industries classified according to ISIC in columns.
- **Physical use table**. It contains physical information on the volumes of water abstracted from the environment and received from other economic units. This information corresponds to the physical use table described in **Module 3**.

Box 6.4: Food for Thought

Use information presented in Tables 6.1 and 6.2 to answer the following questions

What is the average price of water supplied by the Water Utility? How does this compare with water supplied by mines?

Table 6.1: Hybrid Supply Table

	Output of industries (by ISIC categories)											
			35									
	1-3	5-33, 41-43	Total	*of which*: Hydro	36	37	38,39, 45-99	Total output, at basic prices	Imports		Taxes less Subsidies on products	Total supply at purchaser's price
1. Total output and supply (Billions currency units)	137.6	749.0	22.1	3.3	1.7	9.0	367.0	1286.4	363.0		70.0	1719.4
of which:												
1.a Natural water (CPC 1800)	0.0	0.040	0.0	0.0	1.7	0.2	0.0	1.9	0.0		-0.1	1.8
1.b Sewerage services (CPC 941)	0.0	0.0	0.0	0.0	0.0	8.8	0.0	8.8	0.0			8.8
2. Total supply of water (Millions m3)	82.9	157.0	405.6	300.0	426.9	526.5	49.8	1648.7	0.0			1648.7
2.a Supply of water to other economic units	17.9	127.6	5.6	0.0	379.6	42.7	49.1	622.5	0.0			622.5
2.b Total returns	65.0	29.4	400.0	300.0	47.3	483.8	0.7	1026.2				1026.2
3. Total (gross) emissions of COD (Thousands of tonnes)	3150.2	5047.4	7405.1		1851.0	498.5	1973.8	19925.9				19925.9
					4.422	20.6						

Note: Grey cells indicate zero entries by definition.

Billions currency units, Millions cubic metres

	Intermediate consumption of industries (by ISIC categories)								Actual final consumption					Capital formation	Exports	Total uses at purchaser's price
			35						Households			Government	Total			
	1-3	5-33, 41-43	Total	*of which*: Hydro	36	37	38,39, 45-99	Total industry	Final consumption expenditures	Social transfers in kind from Government and NGOs	Total					
1. Total intermediate consumption and use (Billions currency units)	72.9	419.4	9.9	1.1	1.1	1.7	157.8	664.0	321.4	131.4	452.8	53.6	506.4	146.0	403.0	1719.4
of which:																
1.a Natural water (CPC 1800)	0.2	0.3	0.02	0.0	0.0		0.2	0.8	0.6	0.4	1.0	-	1.0	0.0	0.0	1.7
1.b Sewerage services (CPC 941)	0.4	2.4	0.1	0.0	0.03		1.0	3.9	2.4	2.4	4.9	-	4.9		0.0	8.8
2. Total value added (Billions currency units)	64.7	329.5	12.2	1.8	0.6	7.3	209.2	622.4								622.4
3. Total use of water (Millions m3)	159.1	200.2	408.1	300.0	428.7	527.2	53.4	1776.7			250.3		250.3		0.0	2027.0
3.a (U1) Total Abstraction	108.4	114.5	404.2	300.0	428.7	100.1	2.3	1158.2			10.8		10.8			1169.0
of which: 3.a.1- Abstraction for own use	108.4	114.6	404.2	300.0	23.0	100.1	2.3	752.6			10.8		10.8			763.4
3.b - Use of water received from other economic units	50.7	85.7	3.9	-	0.0	427.1	51.1	618.5			239.5		239.5		0.0	858.0

Note: Grey cells indicate zero entries by definition.

6.2.3 Definition of terms used in the Hybrid Use Table (Table 6.2)

Intermediate consumption:- Refers to the value of the goods and services consumed as inputs in production, excluding the using up of fixed assets (depreciation) which is recorded as consumption of fixed capital in value added.

Final Consumption:- This is the actual final consumption of goods and services not expenditures which is the common practice in National Accounts. This way, physical quantities of water can be linked directly to the monetary value of water delivered to households. In most SADC countries water and sewerage services are not paid for fully by households but rather subsidised by the government or Non-Governmental Organisations. Actual final consumption measures the value of water delivered to households, regardless of whether it is paid for by households themselves or subsidised by NGOs and the government.

Actual final consumption of households:- This includes the costs of water that households actually incur (this corresponds to the concept of final consumption expenditure) plus subsidies from government and NGOs. These subsidies are recorded in Table 6.2 under the column social transfer from government and NGOs.

Actual final consumption of government:- This refers to the collective (not individual) expenditures of government on services that benefit all members of the community or society as a whole such as environmental protection, water quality monitoring etc.

Gross capital formation (GCF):- Is the total value of gross foxed capital formation, changes in inventories and acquisitions less disposals of valuables during the accounting period.

Exports: Consist of sales of water to other countries (non-resident units). In the numerical example presented in Table 6.2, there are no exports of water and wastewater services. However, this column is critical for countries that import or export water such as South Africa and Lesotho.

Box 6.5: Food for Thought

How is the use of the terms ***Supply*** and ***Use*** in water accounts different from the hydrological definition?

6.2.4 Hybrid account for supply and use of water

A hybrid water supply and use account brings together information from the various water accounts (physical supply and use, asset, and emission accounts) and presents it in such a way that makes it easy to analyze the contribution of an industry to the economy; its investment in water infrastructure; pressure on water resources through abstraction (water use) and contribution to pollution. In this way economic accounting for water goes beyond just efficient management of water resources to contribute towards sustainable development. The hybrid account forms the basis for the calculation of a consistent set of hydrological-economic indicators such as the following:-

- Water use efficiency,
- Water productivity,
- Water intensity of the economy,
- Pollution intensity of the whole economy and for each industry
- Subsidies per m3 per industry

Box 6.6: Food for Thought

Coinciding with the interest in resource and environmental accounting are worldwide concerns over "sustainability."

...the benefits of resource and environmental accounting for addressing sustainability issues are greater the more the accounting process is viewed as an information system to support broadly economic (or humanistic) objectives. These benefits diminish the more one focuses on narrow environmental objectives.

In terms of presentation the hybrid account is a combination of the hybrid supply and use tables – see Table 6.3. The Table 6.3 consists of the following five parts (refer to Box 6.2 and 6.3 above):-

▪ The monetary contribution of an entity to the economy (supply)	**Monetary supply**
▪ Investment in water supply and wastewater management infrastructure	Stock of Assets
▪ The amount of water used by the entity	Abstraction
▪ Total amount of effluent discharged by the entity	Total Returns Flow
▪ Total discharge of pollutants by the entity (COD)	Gross Emissions

Table 6.3: Hybrid accounts for supply and use of water

Billions currency units, Millions cubic metres

		Industries (by ISIC categories)													Rest of the world	Taxes less subsidies on products	Actual final consumption		Capital Formation	Total
		1-3 Agriculture						35 Energy												
		1 Irrigation	1 Livestock	2 Fisheries	3 Forestry	5-33 Mining and Quarrying	41-43 Manufacture	Total	*of which:* Hydro	36 Water Supply	37 Sewerage	38,39, 45-99 Services	Total Industry				Households	Government		
Contribution to GDP	**1. Total value added** (Billions currency units)																			
Investment in Infrastructure	**2. Gross fixed capital formation** (Billions currency units)																			
	of which:																			
	4.a. for water supply																			
	4.b. for water sanitation																			
	a. Stocks of fixed assets for water supply (Billions currency units)																			
	b. Stocks of fixed assets for water sanitation (Billions currency units)																			
Water Use	**3. Total use of water** (Millions m3)																			
	3.a. (U1) Total Abstraction																			
	of which: 7.a.1- Abstraction for own use																			
	3.b. Use of water received from other economic units																			
Effluent Discharge	**4. Total supply of water** (Millions m3)																			
	4.a. Supply of water to other economic units																			
	4.b. Total returns																			
Pollution	**5. Total (gross) emissions of COD** (Thousands of tonnes)																			

Table 6.4: Example of Hybrid accounts for supply and use of water

Billions currency units, Millions cubic metres

	Industries (by ISIC categories)								Rest of the world	Taxes less subsidies on products	Actual final consumption		Capital Formation	Total
	1-3	5-33, 41-43	35 Total	35 of which: Hydro	36	37	38,39, 45-99	Total industry			Households	Government		
1. Total output and supply (Billions currency units)	137.6	749.0	22.1	3.3	1.7	9.0	367.0	1286.4	363.0	70.0				1719.4
of which:														
1.a. Natural water (CPC 1800)	0.0	0.04	0.0	0.0	1.7	0.2	0.0	1.9	0.0	-0.1				1.8
1.b. Sewerage services (CPC 941)	0.0	0.0	0.0	0.0	0.0	8.8	0.0	8.8	0.0	0.0				8.8
2. Total intermediate consumption and use (Billions currency units)	72.9	419.4	9.9	1.1	1.1	1.7	157.8	664.0	403.0		452.8	53.6	146.0	1719.4
of which:														
2.a. Natural water (CPC 1800)	0.2	0.3	0.0	0.0	0.0	0.0	0.2	0.8	0.0		1.0	-		1.7
2.b. Sewerage services (CPC 941)	0.4	2.4	0.1	0.0	0.0	0.0	1.0	3.9	0.0		4.9	-		8.8
3. Total value added (gross) (= 1-2) (Billions currency units)	64.7	329.5	12.2	1.8	0.6	7.3	209.2	622.4	0.0					622.4
4. Gross fixed capital formation (Billions currency units)	6.6	65.7	13.1		11.8	10.5	23.7	131.4						131.4
of which:														
4.a. for water supply		0.311			11.8	1.3		13.4						13.4
4.b. for water sanitation		0.2				9.2	0.01	9.4						9.4
5. Stocks of fixed assets for water supply (Billions currency units)		5.2			197.1	22.2								
6. Stocks of fixed assets for water sanitation (Billions currency units)		2.4				115.7	0.1							
7. Total use of water (Millions m3)	159.1	200.2	408.1	300.0	428.7	527.2	53.4	1776.7	0.0		250.3	-		2027.0
7.a. (U1) Total Abstraction	108.4	114.5	404.2	300.0	428.7	100.1	2.3	1158.2			10.8	-		1169.0
of which: 7.a.1- Abstraction for own use	108.4	114.6	404.2	300.0	23.0	100.1	2.3	752.6			10.8	-		763.4
7.b. Use of water received from other economic units	50.7	85.7	3.9	-	0.0	427.1	51.1	618.5	0.0		239.5	-		858.0
8. Total supply of water (Millions m3)	82.9	157.0	405.6	300.0	426.9	526.5	49.8	1648.7	0.0		240.3	-		1889.0
8.a. Supply of water to other economic units	17.9	127.6	5.6	0.0	379.6	42.7	49.1	622.5	0.0		235.5	-		858.0
8.b. Total returns	65.0	29.4	400.0	300.0	47.3	483.8	0.7	1026.2			4.8	-		1031.0
9. Total (gross) emissions of COD (Thousands of tonnes)	3150.2	5047.4	7405.1		1851.0	498.5	1973.8	19925.9			11663.6			31589.5

6.2.5 Supplementary Information on Hybrid Accounts

In order to enhance their analytical capacity and to provide a complete picture of the economy of water, the hybrid accounts presented in Table 6.3 should be complemented with the Economic Accounts on individual investment in water supply and sewerage as well as on financing the water sector.

Water-related activities carried out for own use (i.e. individual investments) are not explicitly identified in the national accounts. Their costs are incorporated into those of the principal activity of the establishment. In this module, these costs are explicitly identified to obtain a more complete picture of the total water-related expenditures by the economy and to assess how much each economic activity spends for the direct provision of water and wastewater services.

Accounts for the expenditure of the government on collective consumption services related to water are a further disaggregation of the information in Table 6.4. Consumption expenditure of the government (intermediate consumption, compensation of employees and consumption of fixed capital) are separately identified by purpose, that is, in the case of the EAW, according to whether they are related to collective services related to water. These accounts are useful for the compilation of environmental protection expenditure and resource management accounts, as well as for the compilation of the financing table.

6.2.6 Hybrid accounts for activities carried out for own use

The accounts presented in this section explicitly identify the intermediate costs and output of water-related activities when they are carried out for own use by households and industries. To assess the contribution of water-related activities to the economy, the costs of these activities need to be separately identified.

Hybrid accounts for own use are compiled for water utilities (ISIC 36) and sewerage companies (ISIC 37) clearly identify the costs of water supply and sewage services for this industries. However, economic units may carry out abstraction or wastewater treatment for own use. This includes, for example, farmers who abstract water directly from the environment for irrigation purposes, electric power plants or other industrial establishments that directly abstract water for their own use (e.g. for cooling purposes). By the same token, enterprises and households may operate their own wastewater treatment facilities (industrial wastewater treatment plants, septic tanks, etc.). The costs associated with these activities do not explicitly appear in the accounts described in the previous section as they are incorporated with those of the principal activity (ISIC 36 and ISIC 37).

In the National Accounts, goods and services produced for own use should be valued at the basic prices at which they could be sold if offered for sale in the market (para. 6.84, 1993 SNA). However, since for water-related activities reliable market prices do not generally exist, in this Module the value of the output of these activities is deemed, by convention, equal to the sum of the costs of production: that is, as the sum of intermediate consumption, compensation of employees, consumption of fixed capital and other taxes (less subsidies) on production.

Table 6.5 presents the hybrid account for activities of economic entities carried out for own use. In the SEEAW, these activities are recorded under the ISIC class of the principal activity. For example, if a manufacturing industry (ISIC 17) treats wastewater on-site before discharging it to the environment, the activity of treating water is recorded under ISIC 17. This presentation is consistent with the way information is organized in physical terms where wastewater discharged to the environment (with or without treatment) by an industry is recorded under the ISIC class of the industry discharging water. The costs of water abstraction are therefore directly linked for each industry to the volumes of water abstracted, and the costs of treating wastewater with the volume of wastewater discharged after on-site treatment.

Table 6.5 also includes households as they may abstract water directly from the environment and often carry out activities of wastewater treatment through the use, for example, of septic tanks. The information required for Table 6.5 is not likely to be readily available in many SADC countries. Specific surveys need to be put in place in order to estimate the costs associated with the activities of water collection, treatment and supply and wastewater treatment when they are carried out for own use. Information on the physical quantities of water abstracted and average costs could be used to populate the table as a first step in the compilation of the table.

Box 6.6: Food for Thought

Using the example presented in Table 6.5, how much did household invest in water supply and sewerage for own use?

How much water did households use through own abstraction?

Table 6.5: Hybrid accounts for own-account production of water and wastewater services

Millions of currency units and Millions of m3

		Industries (by ISIC categories)								Households	Total industry
				35							
		1-3	5-33, 41-43	Total	*of which:* Hydro	36	37	38,39, 45-99	Total		
Water supply for own use	**1. Costs of production** (=1.a+1.b) (Millions of currency units)	336.0	355.3	1,253.0	930.0	71.3	310.3	7.1	2,333.1	33.5	2,366.5
	1. a. Total intermediate consumption	162.6	171.9	606.3	450.0	34.5	150.2	3.5	1,128.9	16.2	1,145.1
	1.b. Total value added (gross)	173.4	183.4	646.7	480.0	36.8	160.2	3.7	1,204.2	17.3	1,221.4
	1.b.1 Compensation of employees	104.1	73.3	258.7	192.0	14.7	64.1	1.5	516.4	0.0	516.4
	1.b.2 Other taxes less subsidies on production	-1.7	-1.8	-6.5	-4.8	0.4	1.6	0.0	-8.0	0.5	-7.5
	1.b.3 Consumption of fixed capital	71.1	111.8	394.5	292.8	21.7	94.5	2.2	695.8	16.8	712.6
	2. Gross fixed capital formation (Millions of currency units)	672.1	781.6	1,503.6	1,116.0			2.9	2,960.1	70.3	3,030.4
	3. Stocks of fixed assets (Billions of currency units)	11.2	13.1	25.1	18.6			0.0	49.4	1.2	50.6
	4. Abstraction for own use (Millions of m^3)	108.4	114.6	404.2	300.0	23.0	100.1	2.3	752.6	10.8	763.4
Sewerage for own use	**1. Costs of production** (=1.a+1.b) (Millions of currency units)		121.0					6.1	127.1	18.2	145.2
	1.a. Total intermediate consumption (Millions of currency units)		30.0					1.5	31.5	4.5	36.0
	1.b. Total value added (gross)		91.0					4.6	95.6	13.7	109.2
	1.b.1 Compensation of employees		27.3					1.4	28.7	4.1	32.8
	1.b.2 Other taxes less subsidies on production		-0.9					0.0	-1.0	-0.1	-1.1
	1.b.3 Consumption of fixed capital		64.6					3.2	67.8	9.7	77.5
	2. Gross fixed capital formation (Millions of currency units)		266.2					2.4	268.6	38.1	306.7
	3. Stocks of fixed assets (Millions of currency units)		3354.1					30.5	3384.6	480.2	3864.9
	4. Return of treated water (Millions m3)		10.0					0.5	10.5	1.5	12.0

6.3 Government accounts on water-related collective consumption services

For analytical purposes and, in particular for compiling the table of financing, it is useful to develop economic accounts for government expenditures on water-related services. These are classified according to the **Classification of the Functions of Government** (COFOG). COFOG is a classification of expenditures by the government according to purpose: it classifies transactions such as outlays on final consumption expenditure, intermediate consumption, gross capital formation and capital and current transfers by general government according to the function that the transaction serves.

The following functions classified in COFOG are relevant for water:

- Wastewater management - COFOG 05.2. This group covers sewage system operation and waste water treatment. Sewage system operation includes management and construction of the system of collectors, pipelines, conduits and pumps to evacuate any waste water (rainwater, domestic and other available waste water) from the points of generation to either a sewage treatment plant or to a point where waste water is discharged to surface water. Wastewater treatment includes any mechanical, biological or advanced process to render wastewater fit to meet applicable environment standards or other quality norms.
- Soil and groundwater protection – part of COFOG 05.3. It covers activities relating to soil and groundwater protection. These activities include construction, maintenance and operation of monitoring systems and stations (other than weather stations); measures to clean pollution in water bodies; construction, maintenance and operation of installations for the decontamination of polluted soils and for the storage of pollutant products.
- Environmental protection not elsewhere classified (n.e.c.) (related to water) – part of COFOG 05.6. This group, with focus on water, covers administration, management, regulation, supervision, operation and support of activities such as formulation, administration, coordination and monitoring of overall policies, plans, programmes and budgets for the promotion of environmental protection; preparation and enforcement of legislation and standards for the provision of environmental protection services; production and dissemination of general information, technical documentation and statistics on environmental protection. It includes environmental protection affairs and services that cannot be assigned to the previous classes (05.1), (05.2), (05.3), (05.4) or (05.5).
- Water supply – COFOG 06.3. This group covers (i) administration of water supply affairs; assessment of future needs and determination of availability in terms of such assessment; supervision and regulation of all facets of potable water supply including water purity, price and quantity controls; (ii) construction or operation of non-enterprise-type of water supply systems; (iii) production and dissemination of general information, technical documentation and statistics on water supply affairs and services; (iv) grants, loans or subsidies to support the operation, construction, maintenance or upgrading of water supply systems.

Box 6.7: Classification of Functions of Government

The classes COFOG 05.2 and 06.3 should not be confused with activities of Sewerage and Water collection, treatment and supply, classified in ISIC 37 and 36 respectively, which are considered as individual services in this module. Expenditures incurred by governments at a national level in connection with individual services such as water supply and sanitation are to be treated as collective when they are concerned with the formulation and administration of government policy, the setting and enforcement of public standards, the Table 6.3 presents economic accounts for government expenditures on water-related collective consumption services. The collective consumption services are assumed to be produced and used by the government. The value of these activities is equal to the costs of their production, namely the sum of intermediate consumption, compensation of employees, consumption of fixed capital and other taxes less subsidies on production. These accounts could be further disaggregated for central, state and local government.

Table 6.6: Government accounts for water-related collective consumption services

Millions of currency units

	Government (by COFOG categories)			
	05.2 Wastewater management	05.3 (part) Soil and Ground water protection	05.6 Environmental Protection	06.3 Water supply
1. Cost of Production (=1.a + 1.b)				
1.a Total intermediate Consumption				
1.b Total Value added (Gross)				
1.b.1 Compensation of employees				
1.b.2 Consumption of fixed capital				

6.4 Taxes, fees and water rights

This section deals with specific government instruments used to regulate the use of environmental services and how they are recorded in the SNA. Economic instruments used by government include decisions and actions that affect the behaviour of consumers and producers by causing a distortion in the prices to be paid for environmental services. One way that governments control the use of water and water resources is through taxes/subsidies. The other is through the issuing of licences – for a fee or for free – which entitle the owner to some sort of exclusive use of an environmental asset or part of it (for example, through water rights).

Box 6.8: Food for Thought

What instruments are used by the Government in your country to control abstraction of water?

6.5 Taxes, subsidies and rent

As mentioned in the previous sections, the uses are valued at purchaser's price. Therefore, they include taxes paid by the final consumer (taxes on products) as well as by the producer (other taxes on production). They also include subsidies to water related activities and products which lower the price paid by users or/and the production costs for the producers. Due to their importance as water policy instruments in SADC, a more in-depth examination of how taxes, subsidies and rent on water are treated in National Accounts is useful.

It must first be clarified that sometimes taxes and fees are used as a payment of a service (e.g. water delivery or collection of wastewater). In most SADC sewerage services are recovered through local 'taxes' paid to the municipality, the Rural District council, etc. In the accounts, these taxes are to be considered as payments in counterpart to a service, equivalent to a price although they may not cover the total cost of the service. These taxes are therefore recorded in the use table as a purchase of water related products.

6.6 Water rights

Water rights represent another economic instrument that government may use to regulate water use and give incentives to use water efficiently. Governments manage water resources by issuing rights (e.g. licenses, allocations, entitlements) to control water use and allocate water among different uses. Water rights vary enormously, within and between countries, in their duration, security, flexibility, divisibility and transferability.

Box 6.8: Food for Thought

Are water permits applied in your country? Are they effective in meeting the intended policy objective?

In the SNA, water permits fall under the category of assets called non-financial intangible non-produced assets among which is an item called leases and other transferable contracts. The characteristic of intangible non-produced assets is that they entitle their owners to engage in specific activities or to produce certain specific goods and services and to exclude other institutional units from doing so except with the permission of the owner. The leases themselves are not produced but are legal constructs designed to permit or inhibit certain actions. They may control, for example, who may extract a natural resource and under what conditions (para. 6.39-6.40, SEEA-2003). It is important to note the distinction between the right to control use of an asset and the asset itself: only the right of usage is designated an intangible non-produced asset.

In light of this new category of assets, water rights constitutes an intangible non-produced asset only if the right to use the asset is (or was) conveyed for a period exceeding a year. Sometimes the right of use will be indefinite. Almost certainly, some legal documentation will exist to evidence control over the property right. If the agreement is for a year only, even if it is renewable, then this agreement is commonly called a licence and the payment due under it is treated as rent (see previous section). It should be noted, though, that it is the period of the agreement which determines whether the payment constitutes rent or acquisition of an intangible asset and not the use of the word “licence” alone.

When water rights are acquired by purchase, the total cost will be negotiated at the outset. This cost is seldom subject to adjustment or renegotiation during the period of its validity. The transactions for the sale and acquisition of water rights are ***recorded as capital transactions*** and do not affect the saving of either the asset owner or user. If the cost is not met in full at the time the water right passes from the (original) owner to the new owner/user, the difference will be recorded in terms of financial assets and liabilities between the two parties. If a tax on the right to use the asset is levied, it is likely that the user will be responsible for paying this.

When water rights are tradable, the unit issuing the rights (almost always government) creates the asset and records this creation in its other changes in assets account. If the water right is sold, the sale and purchase are recorded in the capital accounts of the two units involved. If it is issued free, but has a positive value, determined e.g. on markets or through net present value calculations, it is still recorded in the same way as sale and purchase in the capital account, but in addition a capital transfer of the same size is made from the issuer to the new owner of the permit. This transfer exactly cancels the acquisition of the water right so the lending or borrowing position of each of the two units is unaffected.

6.7 Financing Accounts

In this section we present national expenditure and financing accounts for water-related activities classified by purpose. These activities are described in more detail below. The accounts presented in this section are based on environmental protection expenditure accounts. Information from the hybrid and economic accounts presented in the previous sections provide inputs to the tables on national expenditure and financing presented in this section.

6.7.1 Environmental protection and resource management related to water

6.7.1.1 Environmental Protection

Activities related to environmental protection are classified according to the ***Classification of Environmental Protection Activities and Expenditure*** (CEPA 2000) which is a generic, multipurpose, functional classification for environmental protection. CEPA can be used to classify **environmental protection activities**, **environmental protection products** and **expenditure for environmental protection**.

Environmental protection activities are those where the primary purpose is the protection of the environment; that is the prevention, reduction and elimination of pollution as well as any other degradation of the environment caused by economic activities. This definition implies that, in order to be considered environmental protection, activities, or parts thereof must satisfy the primary purpose criterion (causa finalis), i.e. that environmental protection is their prime objective. Actions and activities which have a favourable impact on the environment but which serve other goals are not classified as environmental protection.

Wastewater management (CEPA 2) comprises activities and measures aimed at the prevention of pollution of surface water through the reduction of the release of wastewater into inland surface water and seawater. It includes the collection and treatment of wastewater including monitoring and regulation activities. Septic tanks are also included. In particular, *Wastewater management* includes: (a) activities for the collection, treatment and disposal of wastewater, activities aimed at controlling the quality of surface and marine water, administration activities in the wastewater domain (these activities corresponds to Sewerage, ISIC 37 and part of the public administration activities ISIC 84); (b) the use of specific products relevant for wastewater management such as septic tanks; and (c) specific transfers.

Protection and remediation of soil, groundwater and surface water (CEPA 4) refers to measures and activities aimed at the prevention of pollutant infiltration, cleaning up of soils and water bodies and the protection of soil from erosion and other physical degradation as well as from salinisation. Monitoring, control of soil and groundwater pollution is included. *Protection and remediation of soils, groundwater and surface water* mainly include (a) activities for the protection of soil and groundwater (which correspond to part of ISIC 39 – Remediation activities and other waste management services - and part of the public administration activities ISIC 84) and (b) specific transfers.

Management and exploitation

Natural resources management includes activities and measures for research into management of natural resources, monitoring, control and surveillance, data collection and statistics, costs of the natural resource management authorities at various levels as well as temporary costs for facilitating structural adjustments of sectors concerned. Government financing of institutions such as The Water Research Commission in South Africa falls under this category. *Natural resource exploitation* includes abstraction, harvesting and extraction of natural assets including exploration and development. In general, these accounts typically correspond to the standard economic accounts for various natural resource-related industries such as fisheries, forestry, mining and water supply (based on paras. 5.39-5.41, SEEA-2003).

Water management and exploitation include (a) activities for the collection, storage, treatment and supply of water (ISIC 36), the administration of water ways and water bodies, supervision, research, elaboration of plans and legislation and water policy (part of ISIC 84) and (b) specific transfers.

6.7.1.2 Financing accounts

In most SADC countries, users of water-related products do not always bear the entire costs of production. In the case of water, it is not uncommon for users to receive transfers from other units (generally the government). These transfers include subsidies on the production of water-related products, investment grants and other transfers that are financed either from government expenditure or from specific taxes. This section describes the financing of national expenditure by identifying the financing sector (e.g. which sector is providing the financing) and the beneficiaries (e.g. which units benefit from the financing), as well as the amount being financed.

Table 6.5 presents the financing accounts for *Wastewater management* to show how the national expenditure for *Wastewater management* is financed. The columns of Table 6.5 show the same categories of users/beneficiaries identified in Table 6.4. The rows of Table 6.5 show the different financing units (that is, those actually bearing the cost) which are classified according to the institutional sectors of the national accounts: general government (which can be further disaggregated in central and local government), non-profit-institutions serving households (NGOs), corporations and households.

The expenditures recorded in the column of *Specialised producers* correspond to their gross capital formation (and net acquisition of land). The table entries describe how capital formation is financed: partly by the specialised producers themselves (row 3.a); and partly by the government through investment grants (row 1). If the investment grants, however, are funded from earmarked taxes, it is assumed that those who pay the taxes (in general households and other producers) are the financing units (row 4 and 3.b respectively).

The national expenditure recorded in the column of *Other producers* corresponds to the sum of the intermediate consumption of *Wastewater services* (including those produced for own use), the capital formation (investment in infrastructure and net acquisition of land) for secondary and own-use activities for wastewater services and specific transfers they may receive. The various column entries describe how this expenditure is financed. Other producers may finance their intermediate consumption and capital formation themselves (row 3.b) or may receive subsidies from specialised producers (row 3.a) or the government (row 1) through specific transfers and investment grants. If these subsidies and investment grants are funded through revenues from earmarked taxes, it is assumed that the unit that pays the taxes is the financing unit.

National expenditure of *Households* corresponds to their actual final consumption of *Wastewater services*, *Connected and adapted products* and any transfers they receive. Entries in the column describe how this expenditure is financed. Households may finance part of their final consumption themselves (row 4), however, they may receive: (a) social transfers in kind from the Government and NGOs (rows 1 and 2) and (b) subsidies that lower the price of environmental protection services or products, in which case it is assumed that the government is the financing unit. However, when subsidies originate in earmarked taxes, it is assumed that the units that pay the taxes (in general households and other producers) are the financing units.

The expenditure of the *Government* as a collective consumer corresponds to its expenditure on collective consumption services. In general, this expenditure is financed by the government from the general budget (row 1). It may happen that receipts from earmarked taxes fund some of government's provision of collective consumption services. In this case the collective services are financed by the sectors that pay the earmarked taxes. Revenues from sales of non-market services (partial payments) are not accounted in the column of government as the part of non-market output covered by partial payments does not come under collective services in the first place.

The expenditure recorded in the column of the *Rest of the world* corresponds to the transfers paid for international co-operation for environmental protection. These transfers can be financed either by the government or by households, through NGOs.

Table 6.7: Financing accounts for wastewater management

Billion currency unit

	USERS/BENEFICIARIES					
	Producers		Final Consumers		Reset of the World	Total
	Specialised Products (ISIC 37)	Other Products	Households	Government		
1. General Government						
2. NGOs						
3. Corporations						
2. Gross Capital Formation						
3.a Specialized products						
3.b Other products						
4. Households						
5. National expenditure						
6. Rest of the world						
7. Domestic use						

Grey cell indicates non relevant or zero entries by definition

Note: Grey cells indicate non relevant or zero entries by definition

6.8 Data Requirements for Compiling Hybrid Accounts

Data sets that are required to compile hybrid accounts relate to the abstraction of water by the economy from the environment, the supply and use of water, wastewater and sewerage services within the economy, and the discharge of water from the economy to the environment. These data sets are summarised in the following tables.

Table 6.8: Value and costs of water and sewerage services

1. Value of sales/turnover (IRIS 5.1)
1.1 Value of water sales (CPC 18000)
1.1.1. To resident economic units
1.1.2. To the rest of the world (export of water)
1.2. Value of sales of sewerage services (CPC 94100)
1.2.1. To resident economic units
1.2.2. To the rest of the world (export of sewerage services)
2. Compensation of employees (IRIS 3.1)
2.1. Compensation of employees related to water supply activities
2.2. Compensation of employees related to sewerage service activities
3. Purchases of goods and services (Combined IRIS 4.1, 4.2, 4.4, 4.6 and 4.7)
3.1. Purchases of goods and services related to water supply activities
3.2. Purchases of goods and services related to sewerage service activities
4. Purchases of water (IRIS 4.3.1)
4.1. Purchases of water from resident economic units
4.2. Purchases of water from the rest of the world (import of water)
5. Purchases of sewerage services (IRIS 4.3.2)
5.1. Purchases of sewerage services from resident economic units
5.2. Purchase of sewerage services from the rest of the world (import of sewerage services)

Table 6.9: Taxes, subsidies and investment grants

1. Taxes (IRIS 7.1)
1.1. Taxes on products
1.1.1. Taxes on water supplied
1.1.2. Taxes on sewerage services
1.2. Other production taxes (IRIS 7.1.1)
1.2.1. Other production taxes related to water supply
1.2.2. Other production taxes related to sewerage services
1. Subsidies received (IRIS 7.2)
1.1 Subsidies on products (IRIS 7.2.1)
1.1.1 Subsidies for water
1.1.2 Subsidies for sewerage services
1.2. Other subsidies on production (IRIS 7.2.2)
1.2.1 Other subsidies for water
1.2.2 Other subsidies for sewerage services
2. Investment grants (i.e. capital transfers)
2.1. Investment grants related to water supply
2.2. Investment grants related to sewerage services

Table 6.10: Assets and investment

1. Gross value of fixed assets (IRIS 11.1)
1.1. Gross value of fixed assets for water supply
1.2. Gross value of fixed assets for sewerage services
1. Capital expenditure (IRIS 11.2)
1.1. Capital expenditure for water supply
1.2. Capital expenditure for sewerage services
1. Depreciation of assets (IRIS 11.4)
1.1. Depreciation of assets for water supply
1.2. Depreciation of assets for sewerage services

Table 6.11 Tariffs and charges for water supply and sewerage services

1. Volumetric tariffs and charges for water supply
2. Fixed charges for water supply
3. Volumetric tariffs and charges for sewage collected
4. Fixed charges for sewerage services

6.9 Indicators

Information in the standard hybrid table presented in Table 6.4 can be used to derive a set of indicators that are critical in informing policy decisions. These set of indicators include those related to water intensity (amount of water require to produce a product); water productivity (dollars generated per m^3 of water used); water use efficiency (%age of water lost in distribution); and pricing indicators (UNSD, 2010).

The following are indicators that can be derived from comprehensive hybrid and Economic accounts and how they are computed.

Indicator	IRWS Data Items
Water intensity (physical units)	$WI = \frac{(E.+G.)-(F.+H.)}{\text{population}}$ E. = Abstraction of water G. = Water received from other economic units F. = Water supplied to other economic units H. = Returns of water to the environment by economic units
Water intensity of the economy	$WI_{economy} = \frac{(E.+G.)-(F.+H.)}{\text{GDP}}$ E. = Abstraction of water G. = Water received from other economic units F. = Water supplied to other economic units H. = Returns of water to the environment by economic units GDP = Gross Domestic Product
Water intensity by industry	$WI_{industry} = \left[\frac{(E.+G.)-(F.+H.)}{\text{value added}}\right]_{industry}$ E. = Abstraction of water G. = Water received from other economic units F. = Water supplied to other economic units H. = Returns of water to the environment by economic units
Water intensity by product	$WI_{product} = \left[\frac{(E.+G.)-(F.+H.)}{\text{monetary output}}\right]_{product}$ E. = Abstraction of water G. = Water received from other economic units F. = Water supplied to other economic units H. = Returns of water to the environment by economic units
Pollution intensity (physical units)	$PI_{PerCapita} = \frac{K.}{Population}$ K. = Waterborne emissions to the environment

Water productivity	$$WP_{industry} = \left[\frac{ValueAdded}{(E.+G.)-(F.+H.)}\right]_{industry}$$ E. = Abstraction of water G. = Water received from other economic units F. = Water supplied to other economic units H. = Returns of water to the environment by economic units
Water productivity ratios	$$WPrR = \frac{[(E.+G.)-(F.+H.)]_{industry}}{[(E.+G.)-(F.+H.)]_{total}} \times \frac{GDP}{ValueAdded_{industry}}$$ E. = Abstraction of water G. = Water received from other economic units F. = Water supplied to other economic units H. = Returns of water to the environment by economic units GDP = Gross Domestic Product
Water 'pollutivity' ratios	$$WPoR = \frac{NE_{industry}}{K._{total}} \times \frac{GDP}{ValueAdded_{industry}}$$ GDP = Gross Domestic Product K. = Waterborne emissions to the environment $NE_{industry}$ = Net emissions by a particular industry $$NE_{industry} = K._{industry} + K._{(ISIC\,37)}\left(\frac{J.1._{industry}}{J.1._{total}}\right)$$ $K_{.Industry}$ = Waterborne emissions to the environment from a particular industry $K_{(ISIC\,37)}$ = Waterborne emissions to the environment by the sewerage industry $J.1_{.Industry}$ = Waterborne emissions to the sewerage industry from a particular industry $J.1_{.total}$ = Waterborne emissions to the sewerage industry (total from all industries)

Indicator	IRWS Data Items
Discharges to the environment	Returns=H. (time series) H. = Returns of water to the environment by economic units
Treated returns to the environment as a percentage of all returns	$$TR\% = \frac{H.a.}{H.} \times 100$$ H.a. = Returns of water after treatment by economic units H. = Returns of water to the environment by economic units
Losses in distribution	$$LD\% = \frac{I.1.}{E.b.} \times 100$$ I.1. = Losses of water in distribution E.b. = Abstraction of water for distribution

Indicator	Definition and Source
Implicit water price	Supply cost divided by volume of water purchased (SEEAW)
Average water price per m^3 by industry	Actual payments divided by volume of water purchased by that industry (SEEAW)
Average water supply cost per m^3 by industry	Cost of supply divided by volume of water purchased for that industry (SEEAW)
Subsidy per m^3 by industry	Average water supply cost minus average water price (SEEAW)
Implicit wastewater treatment price	Supply cost divided by volume of water treated (SEEAW)
Average wastewater treatment cost per m^3 by industry	Treatment cost divided by volume of wastewater for that industry (SEEAW)
Average wastewater treatment price per m^3 by industry	Actual payments for treatment divided by volume of wastewater by that industry (SEEAW)
Subsidy per m^3 by industry	Average wastewater supply cost minus average wastewater price (SEEAW)

6.10 Group Exercise

Using the information presented in Table 6.5 and indicators provided above, calculate the following:-

- Water productivity in Agriculture
- Water Productivity in Mining
- Water Productivity in Hydro-power generation
- Using this information what will be the most efficient allocation of scarce water resources?

6.11 Examples

Table 6.12 below give examples of value added per m^3 of water used for the various economic sectors in South Africa, Botswana and Namibia. Table 6.13 gives value added for the various economic sectors in Botswana.

Table 6.12: Rands of Value added per M^3 of Water (1996)

	NAMIBIA	SOUTH AFRICA	BOTSWANA
Agriculture	8	2	10
Mining	72	59	437
Manufacturing	252	130	564
Services, Trade, Govt.	722	403	989
Households	na	na	na
GDP per m3 of water input	60	27	147

Table 6.13: Value Added of Water by Economic Sector in Botswana

(Constant 1993-94 prices Pula per M^3)

Use Category	1993	1994	1995	1996	1997	1998	1999	2000	2001
Agriculture	6.50	6.43	6.67	6.73	7.05	6.37	5.81	6.24	6.08
Mining	220.97	211.57	200.73	231.87	213.97	208.15	207.09	237.11	232.17
Manufacturing	194.27	235.98	255.98	298.92	250.60	223.74	190.17	179.89	162.81
Water and Electricity	190.07	222.61	228.33	366.90	409.44	357.19	500.91	796.56	895.79
Construction	2294.25	2999.12	3189.95	2269.05	2766.54	4889.56	2629.59	2565.12	2596.33
Trade	1116.19	1396.79	1653.76	1635.61	1631.08	1799.96	1522.98	1613.83	1570.70
Hotels and Restaurants	275.65	3199.90	367.99	364.84	380.04	372.69	281.75	277.32	303.24
Transport and communication	2447.82	2758.13	2649.87	2869.92	2971.32	3220.92	2739.93	2758.44	2853.47
Insurance, Banking, Business	2421.34	2821.44	3025.64	2770.76	2901.15	2883.80	2657.51	2692.61	2807.68
Social and Personal services	381.65	435.46	436.30	497.49	511.82	494.27	415.64	1631.55	1708.88
Government	236.34	199.61	218.47	238.06	261.76	237.48	244.53	247.06	261.69
Grand Average	**74.00**	**88.23**	**78.17**	**87.11**	**89.42**	**88.79**	**90.98**	**98.89**	**99.45**

6.12 Notes to the Facilitator

About this Module

This module is designed to address the training needs of technical staff to mid level staff of Departments of water, environment, statistics and agriculture; water utilities; municipalities and other institutions interested or engaged in compilation of water accounts. This module facilitates an interactive exchange of opinions, perspectives and experiences of participants on some of the key benefits and challenges of compiling Hybrid and Economic accounts. You can allow for substantive discussion and encourage active participation by way of role playing.

Issues addressed include the usefulness of hybrid and economic accounts to inform decisions on:-

- Efficient allocation of scarce water resources among competing uses
- Appropriate pricing
- Setting polluter pays charges
- Financing the water sector

On completion of this module, participants will be able to:

- Define “hybrid and economic” accounts
- Use hybrid and economic accounts to derive key indicators such as **water-use efficiency** and the **value added** of water use in the various economic sectors (**Water Productivity**)

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. The background papers should also be distributed to the participants well in advance. The main background papers for this module are:

Lange, G. and Hassan, R. (2006) The economics of water management in southern Africa: An environmental accounting approach. Edward Elgar Publishing Limited, Cheltenham, UK

United Nations et al, 2003. Integrated Environmental and Economic Accounting. United Nations, European Union, European Commission, International Monetary Fund, Organization for Economic co-operation and Development, and The World Bank

UNSD, 2006. System of environmental-economic Accounting for Water. United Nations Statistics Division, New York, USA

UNSD, 2010. International Recommendations for Statistics. United Nations Statistics Division, New York, USA

Facilitation

The module is designed for face-to-face facilitation. The duration is **approximately 2.5 hours.** This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator would need to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver this module.

The group exercise is described in detail in the attached Word Document titled "**Group Exercise on hybrid and economic Accounts".** The exercise engages participants to calculate and apply indicators derived from hybrid and economic accounts to make tough decisions on water allocation and pricing. It is an opportunity to maximize interaction between participants and allow them to learn from each other through sharing knowledge and experience.

It is important to structure the presentation and Q&A period for the group exercise carefully in order to allow sufficient time for a productive discussion. The Q&A period per presentation should not exceed 15 minutes.

Be sure to clarify the objective of the training and describe the agenda at the start of the session. This gives structure and direction to what you intend to do. This module brings together information generated from the other water accounts, therefore it is important to emphasize this linkage at the start.

Participant Evaluation

An evaluation questionnaire should be provided to allow participants assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your Feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to g.manase@gmail.com

6.13 References

(1993). Handbook of National Accounting on Integrated Environmental and Economic Accounting, Series F, No. 61, New York

(2000). Environmental accounts in France. NAMEA pilot study for France Phase III – Extract on Wastewater accounts. Final Report to Eurostat Subvention 98/778/3040/B4/MM.

(2002). Estimating the value of water in agriculture: case studies from Namibia. Paper presented at the Biennial Conference of the International Society for Ecological Economics. 6-9 March. Souse, Tunisia.

(2003). Water resource accounting in Namibia. In J. Arntzen, R. Hassan and G. Lange, *Groundwater and Water Accounting in Southern Africa Within the Perspective of Global Climate Change*. Report to START. Centre for Applied Research: Gaborone, Botswana.

(2004). Water valuation case studies in Namibia, in G. Lange and R. Hassan, *The Economics of Water Management in Southern Africa: An Environmental Accounting Approach*. Edward Elgar Publishing: Cheltenham, UK

(2005). Economic analysis of the Namibian water accounts. Draft Chapter 5 in Department of Water Affairs, *Namibian Water Accounts: Technical Report*. DWA: Windhoek, Namibia.

A.V. and Sweeney, J.L. (eds.) *Handbook for Natural Resource and Energy Economics*, Vol. 1, 325-341, Elsevier Publishing Co.: New York.

Foran, B. and F. Poldy (2002). The future of water. CSIRO Sustainable Ecosystems Working Paper Series 02/01, Canberra, Australia.

Frederick, K, T. VandenBerg and J. Hanson (1997). Economic values of freshwater in the United States. Resources for the Future Discussion Paper 97-03. RFF: Washington, D.C.

French Institute for the Environment (1999) “The accounts of the quality of the watercourses”.

Gibbons, D. (1986). *The Economic Value of Water*. Resources for the Future: Washington, D.C.

Hanley, N. and C. Spash (1993). *Cost-Benefit Analysis and the Environment*. Edward Elgar: Cheltenham, UK.

Hassan, R. (2003). Economy-wide benefits from water-intensive industries in South Africa; quasi input-output analysis of the contribution of irrigation agriculture and cultivated plantations in the Crocodile River catchment. *Development Southern Africa* 20(2): 171-195.

Institut Français de l’Environnement (1999). *The Accounts of the quality of the watercourses - Implementation of a simplified method, on-going development*.

International Monetary Fund (2001). *Government Finance Statistics Manual 2001* (*GFSM 2001*). International Monetary Fund: Washington, D.C.

Korea Environment Institute (KEI) (1998). *Pilot Compilation of Environmental-Economic Accounts*. KEI and UNDP: Seoul, Korea.

Koundouri, P., and Pashardes, P. (2002). Hedonic Price Analysis and Selectivity Bias, in “*Economics of Water Resources, Theory and Policy*” (eds. P. Pasharades, T. Swanson and A. Xepapadeas), Kluwer: The Netherlands, pp. 69-80. ISBN 1-4020-0542-3

Lange, G. and Hassan, R. (2006) *The Economics of Water Management in Southern Africa: An Environmental Accounting Approach.* Edward Elgar: Cheltenham, UK.

Lange, G. and R. Hassan (1999). *Natural Resource Accounting as a Tool for Sustainable Macroeconomic Policy: Applications in Southern Africa*. Policy Brief of IUCN Regional Office for Southern Africa. IUCN-ROSA: Harare, Zimbabwe.

Lange, G., J. MacGregor, S. Masirembu (2000). The Economic Value of Groundwater: Case Study of Stampriet, Namibia. Paper presented at the Workshop of the Resource Accounting Network of East and Southern Africa. Pretoria, South Africa, 4-8 June 2000.

Lange, G., R. Hassan, and M. Jiwanji (2003). Water accounts: an economic perspective on managing *Case Studies from Southern Africa*. Edward Elgar: Cheltenham, UK.

Lenzen, M. and B. Foran (2001). An input-output analysis of Australian water usage, *Water Policy* 3:321-340.

Manase, G. and Fawcett, B. (2009). Cost recovery for sanitation services. Oxford Press, UK.

Molle, F. and Berkoff, J. (2007). Irrigation water pricing: the gap between theory and practice. Oxfordshire, UK.

Report: Water of people, Water for Life. Paris, New York and Oxford, UNESCO and Berghahn Books.

Tietenberg, T. (2006). Environmental and Natural resource Economics. Seventh edition. Pearson Education, Inc. USA

United Nations and the World Water Assessment Programme (2003). *UN World Water Development*

United Nations Statistics Division (2006). System of Environmental – Economic Analysis for Water

United Nations, Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank (2003). *Handbook of National Accounting on Integrated Environmental and Economic Accounting 2003*. Sales No. New York.

World Health Organization and United Nations Children's Fund (2000). Water Supply and Sanitation Collaborative Council. Global Water Supply and Sanitation Assessment, 2000 Report, Geneva and New York. (pp. 77- 78).

Module 7
Concept of Value and Valuation Methods

Goal

The goal of this module is to introduce the main valuation concepts and methods that can be used for the water accounts.

Objectives

The module has the following objectives:

- Appreciation for the rationale for economic valuation;
- Introduction and familiarisation with key valuation and costing concepts, in particular that of the total economic value;
- Introduction of and familiarisation with the available valuation methods, particularly those relevant to water resources and accounts; and
- Provide participants with the basic skills to use valuation methods and review valuation case studies.

Participants are expected to understand, review and apply different valuation concepts and methods in general and to water resources and water accounts in particular (modules 2-6).

Module Structure

The module is structured as follows:

- Key valuation concepts such as the total economic value, economic rent, marginal opportunity costs, water prices and costs;
- Discussion of the main resource valuation methods
- Review of the suitability of the methods for water accounts
- Empirical examples of water valuation.
- Further development and information

7.1 Module Summary

Natural resources need to be valued in order to be appreciated, to safeguard against over-utilisation and to give sustainable resource management sufficient priority in development planning. In the case of water accounts, valuation is an essential step towards developing monetary accounts. At present few countries have fully developed monetary accounts; countries are putting efforts in developing parts of such accounts.

Two facts guide the topic of water valuation. Firstly, few countries have water market prices and water tariffs are usually regulated by governments and often include subsidies. Secondly, the value of water is more than the tariff or the water supply costs. The concepts of the Total Economic Value (TEV), the Marginal Opportunity Costs (MOC) and the economic rent (ER) are important for water valuation. In the context of Economic Accounts of Water Use (EAWU), resource valuation has to deal with different assets (e.g. well fields, dams & rivers), water stocks of different water quality (e.g. wastewater, fresh water & saline water) and water uses or flows to different uses (intermediate input for productive ventures, final use by households and environmental use/ ecoservices).

There is no single superior water valuation method for these diverse valuation needs, hence the choice of method is determined by: the area of the EAWU, the available data and the logistical means. The module reviews seven broad valuation methods (section 7.5), including production costs based methods, changes in net income, contingent valuation, hedonic pricing and mitigation or replacement costs. In addition, it discusses different data collection techniques, including surveys, rapid valuation methods and secondary data transfer methods (7.6 & 7.7). The module then guides users to the selection of the relevant methods for each use.

Resource valuation is a technical subject which requires economic expertise. The module does not offer full details as to how to implement each method in detail, but rather outlines their features, strengths and weaknesses and applicability in EAWU. For details regarding the implementation of each method, the reader is referred to the technical manual and the UN Handbook for Water Accounting.

The module concludes with three empirical examples of different aspects of water valuation in the SADC region (section 7.8), selected valuation issues such as data limitations, discounting and uncertainties and risks (7.9), and suggestions for group work (7.10).

7.2 Introduction

This introduction seeks to explain the vital, complex and diverse nature of water resources and the rationale for economic valuation. Water resources occur as stocks and flows and are critical elements in ecosystems such as rivers, lakes, oceans.

Natural resources are often not at all valued (considered as ‘free’ resources) or undervalued. This situation has led to over utilisation of natural resources and neglected resources maintenance and management. Resource valuation assists policy makers to appreciate the importance of resource management and conservation. For example, natural resource and ecosystems perform so-called ecosystem services that are free but valuable. The latter is often only realised when the resource is deteriorated or gone, halting the flow of ‘free’ eco services.

Water accounts have physical and monetary accounts, the latter being the physical accounts multiplied by the resource value. Therefore, resource valuation is a key component of water accounting system (even though many countries do not have full monetarised accounts[1]).

[1] Most water valuation studies are one off studies for specific sites (e.g. Zambezi River basin and wetlands such as the Okavango Delta). This poses spatial aggregation problems for water valuation in the context of EAWU.

In most countries, monetary accounts are underdeveloped due to data problems with resource valuation. Water valuation for EAWU requires consistent long term efforts of SADC MS and River Basins. In southern Africa, water accounts have recorded revenues and expenditures of water service providers and estimated the value added/m^3 in different sectors. The latter measure has raised major allocative efficiency concerns. Invariably, agriculture is the largest water consumer and yet it creates much less value added/m^3 than other sectors. Is this sustainable in future and wise? The available water accounts show that agricultural water use needs to become more efficient in future (see for the Limpopo river basin: Sulse *et. al*., 2009).

For water accounts, valuation of water flows and stocks is most important given the emphasis on supply/ infrastructure and use. However, the value of good water quality and the value of water rich ecosystems are also important for society to maintain the eco services that the environment provides (e.g. lakes, swamps, and river). This is captured under notions such as 'environmental flow requirements' and 'environmental water needs'.

The reasons for valuing the environment include the following:

- Absence of a monetary value in environmental goods may signal over-use of these resources;
- The value provides insight into people's perceptions about an environmental asset or system;
- Monetary valuation may support resource management and conservation (e.g. Zambezi River (Turpie et al, 2006); and
- Monetary valuation permits the comparison of alternative resource uses and management strategies. Suppose we want to preserve a wetland, which can also be used for irrigation. Valuation of the wetland would be useful to compare its conservation with the value of its use for irrigation.

'To assess the consequences of different courses of action, it is not enough to know that ecosystems are valuable, we also need to know how valuable they are, and how that value is affected by different forms of management.'

Source: IUCN *et al*, 2004, p.1.

For the above reasons, the SADC groundwater and drought management programme has, as an example, included valuation of groundwater in the set of tools that it seeks to provide for managers of groundwater resources (www.sadc-groundwater.org).

In the case of water accounting, the most compelling reason for water accounts is that monetary accounts are the best way of fully integrating national accounts (in monetary terms only) and resource satellite accounts (in physical and monetary terms). Potential policy uses include:

- Adjustment of the Gross National Product (GNP) for water losses and pollution;
- Assessment of water stock and wealth;
- Information about water use efficiency by sector;
- Greater cost recovery efforts;
- Review of the water resources impacts of policy changes

Other frequent uses of resource valuation are:

- Guidance for government cost recovery and rent capturing efforts;
- Project evaluations, particularly cost-benefit analysis (CBA) but can also be used in environmental impact analysis (EIA) or strategic environmental assessment (SEA);
- Programme and policy evaluations to assess the potential net benefits (ex-ante and ex-post)
- Ecosystem valuations to make the case for their sustainable use and conservation (e.g. Okavango and Zambezi);
- Cost assessments of environmental degradation to show the need for their conservation (e.g. water pollution and climate change).

7.3 The price of water

In a competitive market, the price of a good is found where demand equals supply. This situation rarely prevails in the water sector. Most water service providers have a monopoly and do not have a market incentive to minimise their production costs. They can set the price although in practice governments often set (or approve) the price and determine the level of government subsidies. Two supply costing principles are used by most water service providers:

- Average water supply costs (AWSC): what are the costs of production of 1 m3 of water from the available dams, aquifers and water transfer/ reticulation systems?
- Marginal water supply costs (MWSC): what are the unit costs of expanding the existing water supply infrastructure? These are the unit costs of the next investment.

The MWSC are normally higher than the AWSC as additional investments in water infrastructure are usually more complex and expensive than existing infrastructure. For example, an extra dam may have a lower yield or water may have to be transferred over a long distance.

7.4 Valuation and costing concepts

The value of water is more than its price. Water is often still considered to be a ‘public good’ with the emphasis on meeting the water demands and public funding of water infrastructure and delivery from general taxation. Water is used as a final good (to the public sector and households) and as intermediate consumption (to productive sectors and water transfer between water service providers). Water is also frequently used for own consumption, particularly in the mining and agricultural sectors.

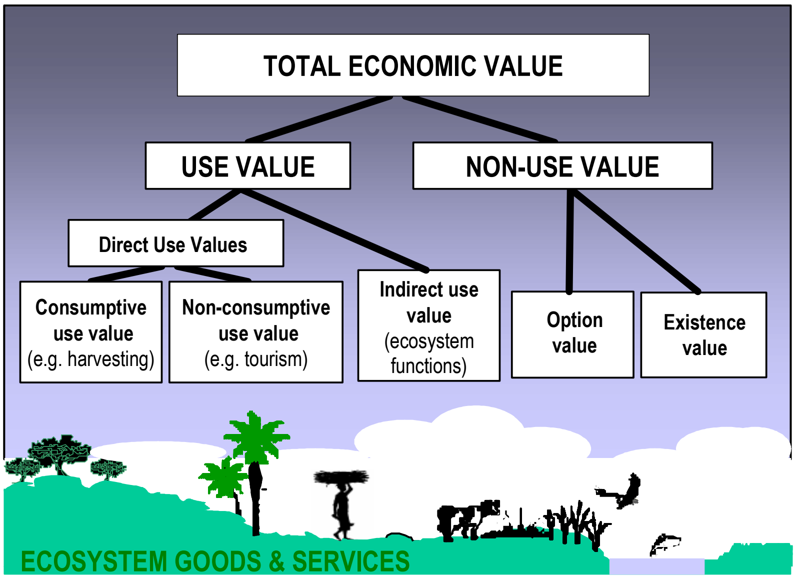
Figure 1: Food for thought questions

- Value is a multidisciplinary concept that economists have narrowed to utility and usefulness. Value has social, cultural and religious aspects too. Which social, cultural and religious values do water resources have?
- The resource value may differ among population groups, and between current and future generations. The practice of discounting of future benefits implies that future benefits carry less weight. Whose value are we talking about in water accounts for countries and shared river basins?
- The (market) price and value are not necessarily the same. Market prices are based on current demand and supply factors and do not include the costs of environmental externalities and changes in the value for future generations. Therefore, market prices are usually underestimates of the resource value.
- Water prices are highly regulated and often determined by monopolistic suppliers, governments or regulators. Who determines the water prices in your country and to what extent do they reflect supply and demand? To what extent is water subsidised and for whom?

7.4.1 Total economic value

The concept of Total Economic Value (TEV) emerged during the late 1980s, and has been widely recognised as the most inclusive valuation concept (Pearce *et al*, 1983). It has been widely used in southern Africa (e.g. Zambezi, Okavango, Makgadikgadi wetlands). A break down into components of the TEV is given in Figure 2.

Figure 2: A break-down of the total economic use value



Source: Turpie *et al*, 2006.

The TEV takes into accounts all environmental functions, and current as well as future perspectives. According to the Millennium Assessment Project, ecosystems provide the following services (IUCN *et al*, 2004 and EPA, 2009):

- Provision services: food, water etc.;
- Regulatory services such as flood and disease control;
- Cultural services such as recreation, cultural and spiritual roles and aesthetics;
- (Life) support services: nutrient cycle and maintenance of life support mechanisms.

Ecosystem	Eco service provided
Inland water (e.g. river, lake, swamp)	Provision: fresh water, food, new products? Regulatory; biodiversity, natural hazard regulation, detoxification Support; human life, climate Cultural services: culture & amenity
Coastal zone	Provision: fresh water, food, mangrove Regulatory; biodiversity, natural hazard regulation, detoxification Support: human life, climate Cultural services: culture & amenity
Marine	Provision: food & new products Regulatory; biodiversity, detoxification Support; human life, climate Cultural services: culture & amenity

Source: IUCN *et al*, 2004, p6.

The TEV is usually formulated as follows:

TEV = direct use value + indirect use value + option value + existence value.

There are minor differences in the description of the TEV but these are not essential. The (option) and existence values are in the literature sometimes also captured as non-use values, as opposed to the direct and indirect use values (e.g. Turner *et al*, 1994; IUCN *et al*, 2004). In that case: *TEV = the use value + non-use value.* Tietenberg (2003) describe TEV as the actual use value (direct and indirect) + option value + non-use value. The variations do not affect the overall usefulness of the TEV concept.

Direct use value is the value derived from actual use of a resource. This use can be consumptive or non-consumptive. For example: water abstraction is a consumptive direct use. Water use for hydro electric power generation or use of rivers for transport and recreation are non-consumptive direct uses. Baptising is another example of non-consumptive water use.

The *indirect use value* refers to the functional benefits of environmental functions (or eco-services) other than the production function. For example, ecoservices such as flood control, biodiversity maintenance and water purification are examples of indirect use values of water. Carbon sequestration by water bodies is another indirect use value. The indirect use value can be significant. For example, a recent valuation study for the Okavango delta estimated the indirect use value to be around P 188 million per annum, with a range of P 133-370 million (Turpie *et al*, 2006).

The option value is the value of a resource or ecosystem as potential *future* direct or indirect use by oneself (option value) or by others (bequest value). For example, if a renewable resource is mismanaged and disappears, future use options are restricted; hence there is a decrease in the option value of that resource. For example, construction of dams and large abstractions will reduced the option value as for example, there may be insufficient water for the environmental flows or for future irrigation projects. The option value is difficult to quantify and depends on current knowledge and technologies. New knowledge and technologies may change the future user options at the time!

The existence value is the value of a resource or ecosystem that is un-related to its use. It is difficult to quantify. The existence value can refer to current and future generations. For example, people may wish to preserve wetlands even if they (or their children) will never use them. An individual may derive satisfaction from knowing that certain species or ecosystems exist irrespective of the fact whether (s)he uses or will use it or not. It is sometimes argued that (some of) the existence value is reflected in the development assistance efforts to maintain rivers and wetlands in southern Africa.

In brief, TEV is a widely accepted and comprehensive value concept. There is no uniformly accepted classification of the TEV components and there are minor differences in definition of the components. It is important to note that:

- Resource value is more than the direct user costs. Value is derived from use and non-use of resources;
- Value has a time dimension: the value must cover current and future generations. Off course, future values can change (value endogeneity) and uncertain:
- The difficulties in estimation of value components increase from the direct use value, through to the indirect use values, option value and finally (and most difficult) existence value. The option and existence value are difficult to quantify;
- Valuation inevitably involves uncertainties, which can be addressed by presenting as range of likely values and/or sensitivity analysis.

7.4.2 Economic or resource rent

The economic or the resource rent is the resource price minus the costs of production, including a reasonable return on capital, and profit. For example, the resource price is Pula 10,000 per unit and the production costs, including a reasonable profit margin is P 7,500, then the resource rent is P 2,500 per unit. The resource rent may be high or low depending on the production costs and the market conditions.

Figure 3: Economic or resource rent: the Botswana mineral accounts

> The resource rent could only be calculated for the 1990s as later data did not permit the calculation of the resource rent.
>
> - The resource rent of diamonds in Botswana was high in the 1990s due to the high prices and low production costs;
> - In contrast, the resource rent of coal was very low at the time (DEA and CAR, 2005).
> - While the diamond stock decreased (physical accounts), the value of the diamond stock increased due to an increase in the resource rent.

In most SADC-Member States countries, the state owns the water resources and therefore it is important that the resource rent is captured to benefit the countries' economic development. This can be done through a proper system of tariffs and royalties.

7.4.3 Marginal opportunity costs (MOC)

The resource value can also be estimated through the costs of its use. Traditionally, the cost of resource use is equated with the actual user costs (marginal or average, see section 7.2.2), i.e. how much does it cost one to produce or consume a good or service. These are so-called 'private' or 'financial' costs. The costs to society ('economic' costs) may well be different. Questions arise such as:

- What costs (or benefits) result from a particular resource use to other members of society? These are so-called externalities.
- Would there have been a better use of the production factors, including natural resources. What are the *opportunity costs*? In that event, the extra benefits of alternative uses over the particular use should be considered as costs.
- Are there future costs of current production/ consumption? For example, groundwater pollution has rendered some aquifers un-usable for drinking water and therefore future groundwater abstraction is impossible. This is a cost or loss of resource value

These three factors need to be taken into account to assess the *true* costs of production and consumption. In the literature, the concept of *marginal opportunity costs* has been developed to do this. The MOC has three cost components:

- *User costs*: costs encountered by the resource user;
- *External costs*: costs of resource use, which are not incurred by the resource user;
- *Foregone future benefits*: missed future opportunities because of current resource use or pollution

It is relatively easy to quantify the user costs, either through market prices or surrogate market prices. External costs and foregone benefits are more difficult to quantify. Firstly, the type of externalities and foregone benefits need to be determined. Secondly, the associated costs need to be estimated. A range of methods is available to do this. Even if it proves impossible or too costly to estimate the externalities and foregone future benefits, it is necessary to assess their importance in qualitative terms. For example, diamond mining in Botswana has led to groundwater depletion. However, the foregone benefits of ground water depletion (i.e. adverse impact on livestock sector) are small compared to the benefits of diamond mining. Below, water examples of each cost component are presented.

Figure 4: Components of the marginal opportunity costs

MOC Component	Examples
User costs	Utility charges, extraction costs of ground water, costs of dams and distribution networks
External effects	Effects of inadequate environmental flows due to water abstraction Health impacts of water pollution; Reduced inflows in major dams due to small dams; Downstream impacts of large dams
Foregone benefits	Lost future development opportunities due to groundwater mining

TIP: Keep it simple and understandable. Do not get confused by slight differences in classifications and terminology. Use concepts that are clearest and most useful to you.

7.5 Valuation methods

As was the case with the description of the TEV, there is no uniform classification of valuation methods in the literature. Some use a demand – non-demand curve classification, others the indirect versus direct method classification and yet other revealed and explicit preferences. There are also different data collection methods, which are sometimes wrongly associated with different valuation methods. For example, the benefit transfer method basically uses (and adapt) data from elsewhere to fill data gaps when it is impossible to collect primary data.

Suggestions:

- Familiarise yourself with the main methods; most other methods are adaptations or variations of the main methods;
- Assess what needs to be valued for the water accounts;
- Assess your data situation and means;
- Choose the method(s) most suitable to your country or basin.

Valuation methods are differently suited for resources and ecosystems. It is important that the selected valuation method is relevant to the particular resource concern. The following resources concerns refer to water accounts:

- Value of different classes of water (use and supply accounts): fresh (untreated & treated), effluent (treated & untreated), groundwater and surface water;
- Value of water infrastructure (asset accounts); well fields, dams, transfer schemes, treatment plants
- Value of rivers, lakes, etc (stock accounts).
- Value of different water quality classes (water quality accounts)

Moreover, water flows can be used as inputs into productive sectors (intermediate consumption), for final consumption (e.g. domestic users) and for maintaining ecological services of ecosystems.

These may each require different valuation methods, and it is likely that water accounts will use a variety of valuation methods. It is therefore important that the main methods are discussed.

7.5.1 Market prices and tariffs

The market price in a competitive market balances demand and supply for a good or service. The National Accounts are based on market prices and market prices for resource use are therefore the first choice of valuation method. The problem is that competitive markets for natural resources rarely exist (Tietenberg, 2006; Ranzetti, 2002). Most suppliers have a monopoly and are strongly controlled by governments. Moreover, where markets do exist the market price should in principle be corrected for market failures and the consumer surplus (Figure 5). In the absence of markets for certain natural resources, prices of substitutes can be used for their valuation (e.g. electricity or paraffin for fuel wood). This method is hardly applicable to water as there are no substitutes. Water prices may be found in informal and in formal water markets (e.g. for irrigation).

Figure 5: Valuation issues related to market prices and tariffs

For market prices:

- Is the market competitive? If there are major externalities and foregone future benefits, these should be added. Try to assess and add the consumer surplus. Realise that the uncorrected market price undervalues the resources (in jargon market failures).

For government regulated prices and tariffs:

- Review the marginal production and supply costs, level of subsidies and taxation and try to estimate the 'market' price. In jargon: correct for institutional failures.

There are at several reasons why tariffs are an undervaluation of water resources (Tietenberg, 2003):

- Tariffs are often based on historical or average costs while they should be based on the marginal costs; as the costs of water supply are mounting, the marginal costs of water supply (i.e. units costs of the latest water supply system) are well above the historical and average costs of water supply (the average costs of old and new water supply systems);
- Government subsidies imply that only part of the direct user costs are charged to resource users;
- Economic rent and other TEV/ MOC components are rarely included.

Step 1: Document and review existing market prices (formal and informal) and water tariffs

These would be prices charged for water provision in the informal sector or the formal sector (if water rights are traded) as well as the water tariffs charged by the country or basin water service providers. Calculate an average water price or tariff (weighed or not).

Step 2: Assess the level of government subsidies

Government subsidies need to be identified and added to the water price/ tariff. This will result in the 'economic' water price (tariff plus subsidy).

NOTE OF CAUTION:

Tariffs are usually (co-)determined by government and may not reflect the true resource value. For example: the use may be heavily subsidised. If the percentage of subsidy is known, this can be added to the 'price'.

Example; the average water tariff is Euro 1.5/m^3 and the subsidy level is 40%, the 'price' would be 1.4*1.5 = Euro 2.10/m^3

Adjusted water prices could be suitably used for the valuation of water use for final consumption (e.g. domestic users). They are unsuitable for productive water uses where there is no water market or for ecoservices.

7.5.2 Production-cost based methods

The water value can be estimated through the MOC, which includes the supply and distribution costs. Costs often inform the water tariffs. Costs data can be generated but are usually not readily available. Tariffs data are widely available. If tariff data are used, it must be clear to what extent costs (capital investments and O & M) are recovered. Put differently, the level of subsidies needs to be known. Moreover, the external costs and opportunities costs should be added to derive at the MOC and the resource value.

Step 1: Assess the water supply and distribution costs

This requires collection of detailed investment and Operation & Maintenance cost data from water service providers, both public utilities and private suppliers. It include the water infrastructure/ assets (e.g. dams and well fields) and the distribution network (water transfer schemes and water delivery infrastructure).

Step 2: Assess external costs and opportunity costs of water provision

Step 1 generates the direct user costs; step 2 will lead to the MOC. It requires that the environmental externalities and foregone benefits are identified and valued (often using mitigation costs and lost production costs as proxies).

The method is suitable for water use accounts. Adding external and opportunity costs is, however, challenging and may not be feasible at the start. However, it is important that such costs are considered on the longer term. In practice, valuation based on the supply and distribution costs constitutes an undervaluation, and is theoretically inadequate. However, the simple version is may be used in practice because of existing data limitations.

7.5.3 Changes in net income and production

These methods can be used to estimate the resource value for productive uses (e.g. mining, agriculture and manufacturing).

The *production function approach* is similar in that it seeks to assess the change in production value by the use of an extra unit of water. This method can even be used when water is only a minor production factor/ costs (e.g. in manufacturing).

<u>Step 1: Collection of data regarding the production function: quantity of water used, quantity of other inputs used and output levels.</u>

The information is obtained from producer surveys or from experimental (e.g. agricultural research) data and it is used to estimate the production function.

<u>Step 2: Estimation of the production function</u>

The production function can be estimated from the collected input and output data as well as the prices of inputs and outputs.

<u>Step 3: Estimation of the marginal value of water</u>

The marginal value of water is estimated through the estimation of the increased output value associated with a unit increase in water inputs (e.g. 000 m^3). This value is then up-scaled for the entire water flow to the sector concerned.

The *change in net income approach* estimates the change in net income associated with a unit increase in water consumption. It is used for intermediate water flows to economic sectors, when it is impossible to estimate the production function. The method requires production cost and revenue data and assumes profit maximisation (Lange & Hassan, 2006b). Water is used to the extent where the costs of using an extra unit of water equal the extra (marginal) revenues. The method is mostly used in the crop production sector, and can be used for green (rain) and blue (irrigation water) water. The net income (or residual value) methods has been used by Lange (2006) to estimate the value of water for commercial farming in Namibia.

The income/ production valuation methods are sectoral valuation methods, which are typically used for water uses by productive economic sectors (e.g. agriculture and industry) and they cannot be applied to the public sector and to domestic use. They require detailed sectoral cost and revenue data and are therefore less suitable for country wide (or basin wide) water accounts.

7.5.4 The Contingent Valuation Method (CVM)

The CVM method is frequently used to estimate values for resource use, environmental amenities and other non-marketed goods and services. The CVM is normally through a survey among a representative sample and administering questionnaires.

<u>Step 1: Design a representative survey</u> (e.g. questionnaire, sample size and sampling of users, preparation of essential information for informed answers). Survey size and sampling must be based on statistical reasons as well as available resources (manpower, time and funds). There are three basic parts to most CV questionnaires:

1. Provision of essential information to respondents: respondents are given information about the nature and status of the resource concerned, about the meaning of WTP or WTA and the procedure to estimate the value;
2. Seeking WTA/WTP. The respondent is then ask to reveal how much (s)he is willing to pay for the resource use or how much (s)he is willing to accept for a loss of resource use (WTA);
3. Essential socio-economic and demographic characteristics of the respondents (e.g. age, gender, income, education and household size).

The design is done such that known potential CVM biases are minimised (Figure 7).

Figure 6: Handling potential biases

- Strategic bias. This arises from the respondent objectives to influence the outcome of the study to his/her favour. For instance, the respondent may indicate higher WTP just to influence the result to his/her favour. Remedies: provide detailed and proper information about the purpose of the method; highlight that respondents will not personally have to pay (WTP) or benefit (WTA) from the method;
- Information bias. This bias arises from the structure of information presented to the respondent. Remedies: make sure that all respondents have the same understanding and required level of information to give informed answers;
- Hypothetical bias. This bias arises when respondents are asked to state the WTP for changes which are hypothetical than real. Therefore responses are likely to be unreliable, as respondents know they will not affect the outcomes. Remedies: CVM studies must be close to reality as possible;
- Starting point and design bias. Bids are sensitive to the form of payment and the level of the starting bid tends to influence the final WTP. Remedies: identify a reasonable starting point for bidding based on literature and experience.

Step 2: Survey implementation. This is straight forward if the design has been proper. Usually, a small test run is conducted prior to the survey. The survey design is then adjusted where necessary.

Step 3: Data entry and analysis of survey results. This includes a validity check of the results.

Figure 7: Results & validity checks

- Assess the frequency distribution of the WTP results. If the results are normally distributed, there is no bias in the results. If there is binomial clustering at either the low or high extreme values, the results are biased and need to be corrected by attaching weights to results. Clustering at low values suggests that there is a problem of 'free rider'; clustering at high values suggests strategic behaviour, more commonly associated with the WTA. Clustering may also be the result of biased sampling (e.g. over or under representation of certain income groups).
- The estimates of the WTA are invariably higher than those of WTP and differ as much as a factor 2 to 6 (Pearce and Turner, 1990).
- Analysis of the determinants of WTP and by comparing the results with economic theory and similar WTP/WTA studies.
- Comparison with results of other methods for similar environmental issues (convergent validity).

Step 4: Up-scaling of the results to the country or river basin

Afterwards, the survey results are generalised to the entire population (e.g. country or river basin), and the aggregate WTP or WTA is considered to be the value of the resource or ecosystem.

Examples of CVM studies in the SADC region:

- Willingness to pay for water provision in rural villages in Tanzania
- Willingness to pay for a more reliable and better quality water in Maun, Botswana.

Applicability: CVM can be used for most resources and ecosystems, including water and wetlands, and CVM is able to cover all TEV components (unlike most other methods). However, it is time consuming and costly, and requires careful design and implementation to avoid biases. The method could, for example, be used to derive water values by productive sector and for end-users.

7.5.5 Travel Cost Method (TCM)

This method assumes that the resource value can be best measured through the travel costs. The method is mostly used for tourism and recreation (e.g. National Parks or important wetlands). The assumption is that the more a person is willing to spend on travel costs, the higher the value is of the resource or ecosystem. TCM normally requires a survey among visitors.

The key parameters are the average travel cost by category of visitor, the number of visitors per annum per category and the number of visits. The travel costs include transport costs, entrance fees and foregone benefits (e.g. time costs).

The TCM is then calculated as:

$TCM\ Value_i = no\ of\ visitors_i\ \ x\ number\ of\ visits_i\, x\ average\ travel\ costs_i.$

Where: i = category of visitors

The total TCM is the aggregate value of all TCM_i.

The following steps are involved:

- Identify the zones of origin of visitors/ travellers (e.g country, SADC region and international);
- Conducts a survey among visitors to obtain the average costs of travel from each zone;
- Obtain the visiting rate from each zone and plot-visiting rate from each zone against the cost involved from each zone. The visiting rate = visits from each zone/population in that zone
- Derive an aggregate demand curve for the site and estimate the resource value as the area under the demand curve.

Weaknesses of the TCM are summarised in Figure 8.

Figure 8: TCM Weaknesses

- People may visit several parks on one trip, and it is difficult, yet important, to separate the values of each destination.
- The travel costs need to be estimated comprehensively and include the costs of time.
- There may be alternative sites emerging which could reduce visitor numbers and TCM without any change in the quality of the site that is valued.
- The income factor needs to be carefully dealt with. Obviously higher income groups can afford to travel more even though this does not necessarily reflect a higher resource value.
- The pleasure of travelling is not recognised in this method, and therefore travel costs are fully associated with resource values
- TCM measures a particular direct use value only;
- TCM is not applicable to many resources and ecosystems other than Parks and tourism attractions.

Applicability: the TCM is mostly used for recreational purposes and not for valuing water flows. For water resources, it could be relevant value assets such as wetlands, waterfalls, beaches etc.

7.5.6 Hedonic pricing method

Hedonic methods infer the value of an environmental good when it is an attribute that affects the value of a market good (such as housing prices), based on what market transactions indicate people are actually willing to pay for the good in various situations. For example, the benefits of clean air can be inferred from variable prices of identical houses in areas with different air quality. Hedonic pricing is mostly used for pollution issues, mostly in urban areas.

The hedonic pricing method assumes that a difference in environmental quality (e.g. poor an d good water quality or proximity to a wetlands or river) can be valued through property prices. It is mostly applied to urban areas and for pollution problems. For example, the value of good air quality could be assessed by comparing house prices of similar characteristics, but one located in an area with poor air quality and the other one in an area with good air quality. The difference in property price would then be used as an estimate of the value of good air quality. The identification of a property price effect due to a difference in environmental quality is usually done by means of a multiple linear regression. Data are taken from either on a small number of similar residential properties over a period of time or on a large number of different properties at a point in time (cross sectional).

The steps involved include: 1. the identification of identical properties with a different environmental amenity (e.g. air or water quality); 2. Specification of value formula; 3. Review of property market prices and collection of other relevant data; 4. Value derivation and up scaling of the value result.

Though air quality is not marketed, its value can be inferred from the value of house. For instance value of the house is made up of the following parameters.

$$H_p = F(S, B, P_{CBD}, N, A, Q_A)$$

H_p = house price

S =	Size
B =	Number of bedroom
P_{CBD} =	Proximity to centre of town
N =	Neighborhood
A=	Age
Q_A=	Air quality

The coefficient of air quality is expected to be negative and it is the marginal implicit price of the attribute. It is defined as the additional amount of money an individual is willing to pay if the air quality improves by a certain standard.

The hedonic pricing method can only be used for environmental resources that can be linked with free property markets[2]. It requires careful design and significant statistical analysis and expertise to isolate the environmental variable from the other determinants of property prices (see Figure 9). Moreover, it is often difficult to find a control group, where everything else is equal except for the environmental variable.

[2] Government control over property markets often distorts the property market value.

Figure 9: Hedonic pricing issues

- Multi-collinearity between property prices determinants
- Requires a property market, where environment is one of the price determinants
- Property buyers need a choice
- Requires advanced statistical analysis and skills
- Require a competitive property market.

No examples are known of water applications of the hedonic pricing method in SADC countries.

Its usefulness for water resources is limited to specific application such as water pollution and assets such as beach, wetland or lake front properties.

7.5.7 Replacement and mitigation costs

Replacement and mitigation cost techniques infer the value of environmental resources by looking at the cost of replacing or restoring damaged resources to their original state. These will be taken as a measure of the value of the resource (otherwise, no mitigation measures would be taken or no replacement would be considered). The costs incurred will therefore be the willingness to pay for improved environmental quality or benefit of restoration. Mostly applicable in valuing air pollution, for instance, the case of air pollution in Selebi-Phikwe and the amount of costs incurred in repairing houses and other properties.

The following steps are taken:

- Step 1: Identify mitigation and/or replacement measures
- Step 2: Cost the mitigation and/or replacement measures

Substitutes for water use are limited and therefore the method cannot easily be used for valuing water uses/ flows. The method is suitable for the valuation of ecological services, water assets (e.g. reconstruction of a wetland) and environmental externalities or opportunity costs.

7.6 Data collection techniques

Most valuation methods require primary data collection from water service providers, governments, private companies and households.

7.6.1 Secondary data methods & benefits transfer

This is not a new pricing method but fills existing data gaps with data from another study that seem relevant to the particular application (e.g. country or RBO).

The benefits transfer method is likely to be a feasible approach for many applications. It adapts values reported in other studies that employed primary research. While benefits transfer is among the most practical approach to valuing environmental impacts, several general cautions apply.

- Only good quality literature should be used. Moreover, valuation studies may differ in scope and transparency and therefore it needs to be clear which value components are covered and which ones are not;
- Sound judgment is essential to ensuring a fit between values from study sites and those for the new study. Thus, the methods should only be used by experienced and well informed persons;
- Many valuation studies refer to developed countries and therefore they need to be adjusted to developing countries' context.

Step 1: identify relevant literature. A large body of literature exists from which to obtain values of water and estimates of damages and benefits of water resources. All benefits transfer studies are subject to uncertainties in addition to those that exist in the results of the original valuation studies. Whether the uncertainties in a benefits transfer are so great that the transfer should not be attempted is the decision to be taken by the project analyst. Generally, with uncertainties a sensitivity analysis may help to test the robustness of the value results. Importantly, if no suitable literature can be identified, the method cannot be used.

Step 2: Adjust values. The most basic adjustment that is usually required is to identify and quantify the difference in resource conditions that may influence the resource value. At the valuation stage one can adjust monetary values to account for those differences. The average monetary values reported in the research study generally will have to be adjusted to make them applicable to the new study. This is done in any of the following ways: 1. when several values are reported, use the most appropriate values; 2. use a range (or an average) of reported values from several studies through sensitivity analysis.

The method can be used for water as an intermediate product, final products and for valuing of ecological services.

7.6.2 Rapid valuation methods

Concern about the reliability and objectivity of economic resource valuation motivates the application of state-of -the-art primary and secondary valuation techniques. However, these may be time consuming and costly. To address this problem, rapid valuation techniques have been developed for the event where conducting primary data collection is not feasible. Rapid valuation methods include a range of techniques and practices, which involve determining what impact quantification and valuation data are readily available, and then using these data in a logical and well-documented manner to provide insights into the overall economic valuation.

In the case of water accounting, this requires discussions with the main water service providers and water users/ sectors in the country or river basin

The data used in rapid valuation methods may come from various sources. For instance, data can be obtained during a short field visit (e.g., through focus group discussions), and then interpreted in a rapid valuation analysis. The monetary value assigned in a rapid analysis may be based on observable market prices.

Although they are not generally as precise or technically robust and defensible as primary research, when carefully applied, rapid analytic methods are often very useful. While rapid valuation methods may in certain instances the only practical means available to assess the resource value, caution in its use is required. There are risks of inadvertent inaccuracies and distortions in rapid analyses and benefits transfers. In addition, there will be times when these methods will not be of sufficient technical quality or comprehensiveness to provide an adequately accurate perspective of the project's overall benefits and costs. In such cases, rapid analytic methods can demonstrate the need for primary research, and to provide a well-focused agenda for future primary research.

The FGD has recently been used for the estimation of the direct use value of the Makgadikgadi wetland in Botswana. It can be used for valuing of water as final and intermediate product.

7.7 Valuation methods and water accounting

The valuation methods have been discussed in section 7.3 and the data collection methods in section 7.4. This section deals with the choice of valuation method and data collection techniques.

The general advantages and disadvantages of each valuation method and their applicability to EAWU are summarised in Table 1. Clearly, TCM and hedonic pricing methods have limited application to the EAWU and they are data and resource intensive. Their use is generally not recommended, with the possible exception of important special features such as beaches and unique wetlands. The group of mitigation-replacement and defensive expenditures methods also has limited application because of the limited substitution possibilities for water. They are best used for valuing environmental externalities and water quality issues. This leaves the group of price, production costs and net income methods as most suitable, the costs being the easiest to apply. However, it is important to go beyond the financial costs and include subsidies and (later on) environmental costs and opportunity costs. The alternative approach is to apply the CVM but this requires considerable data collection efforts, secondary data use or rapid assessments. A CVM could be applied to different categories of uses/ sectors.

Data collection tip

- Countries and river basins should include EAWU data requirements in their collection of regular statistics (e.g. water statistics) or reporting requirements to the water regulator.

The choice of valuation method and data collection technique is determined by a number of factors, including:

- Concerned aspect of EAWU to be monetarised;
- Data requirements and availability;
- Human and financial resources at disposal; and
- Time requirements and availability.

The suitability of valuation methods for EAWU parts and the resource requirements are indicated in Table 2. Generally, the price- cost methods have the lowest resource requirements and the highest and are applicable to water uses/ flows and assets of the EAWU. The production value and net income methods are applicable to productive uses but require micro (i.e. firm/ sector) data. CVM can be applied to all aspects of the EAWU but has high resource requirements unless rapid assessment techniques are used.

Development of EAWU is a process whose implementation can start simple but needs to keep the long term requirements in mind right from the start. The *long term* priorities are largely determined by the SEEA methodology and approach and their adjustment to the country or river basin concerned. SEEA is a comprehensive, generalised framework, parts of which may be irrelevant for particular applications. For example, countries without a coast, wetland or perennial rivers do not need separate asset accounts for these features.

The short term priorities are determined by which parts of the EAWU are prioritised by the country or river basin, what the implementation capacity is, which data are available which ions need to be collected. In general terms:

- Where market prices are available, this is the preferred valuation method (according to SNA and SEEA). Market prices include water tariffs and subsidy assessment;
- If time and resources are limited, do not initially use the CVM, TCM or hedonic pricing methods;
- If similar studies have been done in other SADC MS countries or countries with comparable socio-economic and water resources conditions, adopt (and adapt) the methods;
- If data are scarce, choose data extensive valuation methods and use results of similar exercises in other countries;
- When skills and the data base expand and improve, adopt more advanced valuation methods. For example, the supply cost approach could be expanded to the MOC approach and to indirect use values.

Ways of making resource valuation cheaper and faster:

- Use of secondary data from other valuation studies
- Use of rapid valuation methods
- Include EAWU in regular collection of national and river basin statistics

Be aware that there may be a trade-off between cheaper and faster methods and reliability of the results.

Facilitating an efficient long term EAWU progress:

- Designation of a dedicated EAWU institutional home
- Building of EAWU capacity at the host institution and among major stakeholders
- Expand data base through incorporation of EAWU data needs in collection of regular government statistics and reports to water regulators.

Table 1: Advantages and disadvantages of valuation methods

Method	Advantages	Disadvantages	Application to water accounts
Market price & surrogate prices	Easy to understand and collect Could be used for water markets	Under valuation (e.g. external costs and opportunity costs often left out) Many resources have no market	Applicable to water but water tariffs are often determined by government not the market. Useful for water markets
Production function/ net income estimation	Accurate	Requires detailed data about products, output and input prices and their resource linkages	*Most useful* for irrigation sector and other productive sectors. Difficult to apply to public sector and domestic c use
Supply costs/ Marginal opportunity costs	Data available from water service providers	Under estimation where it leaves out external costs and opportunity costs Supply costs differ per sector and a national average is required.	Can be used with good water service expenditure data.
CVM	Wide applicability (e.g. wetlands, rivers, water) Potential to cover TEV	Careful design and many biases Interpret difference between WTP & WTA Requires skilled staff, a survey and is resource intensive	For Water accounts, it requires a survey among all major water users/ sectors. This is demanding & costly
TCM		Only works where there is a link between travel effort/ costs and resource value	*Only applicable* to water recreation and visits to wetland - protected areas; unsuitable for water valuation in general
Hedonic pricing		Only works when there is a property market (e.g. around wetland or river)	*Only applicable* to properties close to wetlands/ rivers.
Mitigation & defensive expenditures	Cost estimates are easier than benefit estimates Can be widely applied, especially linked to EIA and SEA	Does not work for irreversible resource losses	*Mostly applicable to projects* rather than water accounts
Replacement costs	Cost estimates are easier than benefit estimates Can be widely applied, especially linked to EIA and SEA	Does not work for irreversible resource losses	*Mostly applicable to projects* rather than water accounts

Table 2: Considerations for the choice of method

Method	Water topic suitability				Requirements		
	Resource use issues	Inland water systems, coasts and marine	Water quality issues	Water infrastructure	Data	Resources	Time
Market prices & tariffs	Depend on water markets and real costs of water rights (e.g. irrigation) and RBOs-catchment areas	Partial application for market products	Not suitable as there is no market	Unsuitable in absence of a market	Few markets Cost of water rights often mostly administrative	Limited	Low
Production costs based methods	Applicable	No	Applicable	Applicable	Depends on no of producers	Limited to medium	Low to medium
Net income/ production value or costs	Yes (productive use and water services)	Yes (productive use and water services)	Yes (productiv e use and water services)	Suitable	Production and costs data by sector Supply costs easier to obtain	Medium to high	Low (supply costs) to moderate
CVM	Yes	Yes	Yes	Possible	Primary data collection or transfer Data intensive	High skill requirement s & costly	High
TCM	No	Recreation/ use only	Not suitable	Unsuitable (exc. for dams for recreation)	Primary data collection or transfer Data intensive	High skill requirement s & costly	Moderate to high
Hedonic pricing	For properties only	For properties only	For properties only	Unsuitable	Few data; difficult to find required contrasts Data intensive	Medium to high	Moderate to high
Mitigation – defensive expenditures	Not suitable	Partial	Suitable	Unsuitable	Published & grey	Limited to medium	Limited to moderate
Replacement - substitution valuation	Partial	Can be used but not when system is irreplaceable	Less suitable	Suitable	Published & grey	Limited to medium	Limited to moderate

7.8 Empirical examples

7.8.1 Cost benefit analysis of proposed wastewater treatment project for Dar es Salaam, Tanzania- 2001

Source: Cost-benefit analysis case studies in eastern Africa for the GPA Strategic Action Plan on sewage. Institute of Marine Sciences, Dar es Salaam and UNEP GPA Coordination Office, 2001

The case study is one of three case studies selected in eastern Africa which explored the cost and benefits of improved wastewater management systems in coastal cities. Valuation was part of the cost-benefit analysis carried out for the project. The region has four major rivers and there is access to groundwater sources, which are often polluted. The poor segments of the society living in unplanned settlements access water from the streams as they cannot afford to buy water commercially. Economic activities include agriculture, tourism, fishing, industry and activities in the informal sector. By 2001, the sewerage system supporting the regions was regarded as old and degenerated as it was developed in the 1950s and unsuccessful rehabilitation efforts were undertaken in the 1980s.

The benefits of the project are regarded as the avoided costs of the environmental impacts resulting from environmental changes due to pollution. The assumption is that the proposed project would address these problems and thus benefit the community and the nation at large (Table 3).

Table 3: Classification of the benefits

Benefit type	Indicators
Tourism & recreation	Change in tourism revenues and avoided losses due to better quality of sweater
Fisheries	Change in fisheries production and revenues as well as avoided losses
Human health	Access to sewerage infrastructure, reduction in environmental related diseases thereby reducing fatalities
Property	Change in property price
Preservation of coastal marine, natural and cultural heritage	WTP for conserving and maintaining biodiversity

The benefits are valued as follows.

Tourism; avoidance of production- income losses

Dar es Salaam receives about 201 000 tourists per annum who spend on average $ 945 per person ($ 190 million) for a stay of about 10 days. $ 945 is assumed to be constant for all the years. Three scenarios are applied:

- Scenario 1 (with the project): - this assumes that tourism will grow at an annual growth rate of 5% with arrivals reaching 700 000 by 2025.
- Scenario 2 (without the project) – it assumes that tourism arrivals (and income) will remain constant at the level of 200 000. This represents the unlikely situation of no immediate and severe environmental problems.
- Scenario 3 (without the project) - This is a more realistic scenario which assumes that tourism will decline annually at an average rate of 5% due to the lack of pollution management facilities.

The value estimates are presented in Table 4. To get the net revenue, the value added co-efficient of 50% of gross revenues has been assumed by taking into consideration the cost of material input purchases (to avoid double counting). Therefore the value added is half of the estimated gross foregone benefits.

Table 4: Tourism scenarios and the present values in million US$

Year (1)	**With the project** (5% growth in arrivals per year) **(2)**	**Without the project** (5% decline in arrivals per year) **(3)**	**Net decrease in arrivals (2) minus (3)**	**Undiscounted gross forgone benefits x income per tourist ($ millions) (5)**	**Value added of benefits (5) x 0.5 (6)**	**Present value of net revenues at 10% discount rate ($ millions) (7)**
2000	200 000	200 000	0	0	0	0
2001	210 000	190 000	20 000	20,000 x 945 = 18.9	9.5	8.6
2002	220 500	180 500	40 000	40,000 x 945 = 37.8	18.9	15.6
2010	325 000	113 500	212 000	212,000 x 945 = 200.3	100	38.6
2025	677 250	52 600	624 600	624,600 x 945 = 590.2	295.1	27.2

Fisheries: avoidance of production- income losses

There was insufficient data on the production of fisheries and the associated income losses. Annual production was estimated at 50 000 metric tons valued between $ 5 and $10 million and the annual losses were assumed to be 10% of the production value, i.e. between $ 0.5 and $ 1 million per annum.

Health: avoided costs method and income losses

Health problems are mostly linked to inadequate access to sewerage infrastructure. Therefore it has been assumed that 15% of the population is connected to waterborne sewers, and about 590 100 disease cases have been reported from the available medical statistics for the period 1993 to 1997. This translates to 118 000 reported cases per year. The average cost of treatment is assumed to be $13 per person thus the total cost would be $1.5 million per annum.

Loss of income from work days lost is about $1.6 million. This is based on the assumption that 50% of the population are of working age (50 900) and that the loss of earnings for 15 days is $27. This amounts to $3.1 million ($1.6 million + 1.5 million). The loss of earnings due to death is based on the cost due to loss of productive years caused by death (child mortality). The estimated loss of earnings is *$11.6* million per annum.

Property values: assume hedonic pricing method

There is insufficient information on the loss of value of the affected areas. However, on a general note, it is known that properties near polluted areas tend to depreciate in value. It has been assumed that since 30% of population live in planned areas, and the average household size is 6.4, the number of residential properties is 115 000 (2451 000/6.4). A third of these are located on the coast or near the coast and 25% of the units are of high value (about $50 000) and the rest have been regarded as located where there is no environmental degradation. Applying 5% loss of value, the estimated annual cost would then be 9,825 x 50,000 x 0.05 which equals $24.6 million.

The indirect costs (to recreation, mangrove swamps and biodiversity) have not been quantified due to a lack of information. The total annual estimated costs are thus US$64.8 million.

The valuation of benefits was used in a CBA framework. The project has a positive estimated economic NPV of $643 million. Discount rates of 10% and 5% were applied in the analysis. Given the long term benefits of the project, the 5% discount rate yielded higher returns. The sensitivity analysis showed positive NPVs and benefit cost ratios were attained.

7.8.2 Valuation of the Okavango wetland and Ramsar site

Source: Turpie et al, 2006

The study builds on considerable work that has been carried out in the study area, as well as primary data collection using surveys. The TEV framework was slightly modified to define four different types of values:

- tourism value (both consumptive and non-consumptive direct use value);
- natural resource use by households (a consumptive use value);
- indirect use value (values generated beyond the study area due to services provided by the study area); and
- non-use value (option and existence value).

Tourism value was estimated on the basis of existing information only. An inventory of tourism enterprises was compiled. Three types of enterprise models were developed or used in the study: a typical ecotourism lodge, a safari hunting enterprise, and a CBNRM model in which a tourism operation enters into agreement with a local community for use of their resources. Using the models in conjunction with the inventory and expert opinion, three methods were used to estimate turnover in the accommodation sector which provided a range of plausible estimates. A portion of this was then attributed to the delta, using defined ratios for different types of enterprises. Turnover values were divided into non-consumptive tourism, safari hunting tourism and CBNRM. Turnover in related sectors (e.g. expenditure on airfares) was estimated using ratios from a previous study. Direct value added was calculated based on the ratios of turnover to direct value added in the enterprise models.

Household use of resources was quantified using primary data collected in a survey of 430 households in all five zones of the study area. The household questionnaire elicited information on household demographics, the relative importance of different sources of income, the quantities of natural resources harvested and value added, and on agricultural production. General information on agriculture and use of natural resources, such as seasonality, input prices etc. was gleaned during focus group discussions and key informant interviews in each of the zones. Information collected in the survey was supplemented with existing information and used to construct a household production model to calculate the gross and net private value of different activities to households in each zone.

Five main ecosystem functions were identified as being important in the generation of indirect use value: groundwater recharge, wildlife refuge, carbon sequestration, water purification and scientific and educational value. Recharge value was estimated as the value of groundwater abstraction immediately around the wetland. Carbon sequestration was estimated using published rates of sequestration applied to different habitat types, and using published values of carbon. Wildlife refuge value was estimated by estimating the hunting value of animals that were hunted beyond the delta but whose presence in those areas was attributed to the delta. Water purification value was estimated by calculating the input of pollutants and estimating what the treatment cost of this quantity of effluent would be. Scientific and recreational value was estimated on the basis of the expenditure on these activities in the study area.

Direct use value: tourism value estimated from net income

The value was estimated based on the number of tourism operation types in the area and the estimate net income (from models). Overall, the study area is estimated to generate a gross income of some P1 115 million, making a direct contribution of P401 million in terms of direct value added to GDP. About 99% of this is attributed to the delta. An estimated 81.0% of tourism value accrues to photographic tourism companies, 15.5% to hunting safari companies, and 3.5% accrues to communities through CBNRM arrangements.

Direct use value: household use of natural resources estimated through survey and focus group discussions

The value of natural resource use was estimated by the participation rate multiplied with the amount used and the unit value. The unit value was derived from the informal price, market price, price of substitutes etc, A large number of natural resources are utilised, many of these being used by a high proportion of households in each area.

Firewood is the most commonly-used resource, harvested by most households. An estimated 1.76 million bundles are harvested annually. Wild plant and animal foods are next most commonly used resources, with an estimated total annual harvest of some 280 tonnes of plant foods and 160 tonnes of wild meat. Raw materials are generally next most important in terms of the proportion of households involved, particularly poles, reeds, and grasses, which are used in the construction of household dwellings. Some 276 000 poles, 150 000 bundles of reeds and 174 000 bundles of grass are harvested annually in the study area, with reeds and a portion of grasses coming from the wetland. Although locally very abundant in the delta, papyrus is only really accessible to households in the panhandle and central areas, and is used by relatively few households, with a total harvest of about 2300 bundles. Palm leaves are harvested by many households, particularly for the production of crafts. Over 9000 bundles are harvested, and some 36 500 products (mainly baskets) are produced from a combination of grass and palm leaves as well as natural dyes. Fishing is practiced by up to 34% of households in the panhandle and central areas. This is the largest fishery in Botswana, with an estimated total of 3 570 fishers and an estimated total catch of about 450 tonnes. Medicinal plant use is significant but relatively uncommon, and production of timber, pottery and honey are uncommon. The total annual private use values derived from agriculture and natural resources in the study area, including the value added in processing, are summarised in Table III. Seventeen percent of the net private value of agriculture plus natural resource use can be attributed to the delta. The total direct use value of the Ramsar site, and the portion of that value that can be attributed to the delta or wetland area, is summarised in Table 5.

Table 5: Household direct use value of the Okavango Delta Ramsar Site and of the wetland area

	Gross private value	Net private value	Cash Income	Gross Economic output	Gross value added
RAMSAR SITE					
Livestock production	79 246 782	61 165 831	43 606 492	83 209 121	39 757 628
Crop production	8 629 992	6 389 500	1 061 293	9 030 989	2 768 533
Natural resources	29 099 607	27 864 257	7 290 048	30 554 587	29 183 420
Total	**116 976 381**	**95 419 588**	**51 957 833**	**122 794 697**	**71 709 581**
WETLAND					
Livestock production	1 604 947	1 205 482	391 050	1 685 195	869 980
Crop production	1 132 546	942 410	96 983	1 189 173	588 568
Natural resources	14 959 880	14 199 610	5 063 923	15 707 874	15 052 296
Total	**17 697 373**	**16 347 502**	**5 551 956**	**18 582 242**	**16 510 844**
% contribution by wetland	15%	17%	11%	15%	23%

Indirect use value

Five main ecosystem services were valued as follows:

Groundwater recharge: The Okavango Delta provides a conduit for the recharge of groundwater aquifers which are utilised around the perimeter of the wetland. Some 5.8 Mm^3 of groundwater is extracted from the study area, worth an estimated P16 million. The marginal supply costs are used as the unit value (under-estimate).

Carbon sequestration: Vegetation sequesters carbon, which contributes to the amelioration of damage caused by climate change by reducing atmospheric carbon. Based on published values and sequestration rates obtained from the literature for different habitat types in the study area, it is estimated that the carbon sequestration function is worth about P86 million in the delta and P158 million for the entire Ramsar site. The estimate is based on the estimated carbon sequestration per ha of different eco zones and a reasonable average of the carbon abatement and storage costs and the carbon trading price.

Wildlife refuge: The Okavango Delta (and Chobe) wetlands provide refuge for certain wildlife species that migrate to other parts of the Ramsar site and beyond, generating benefits and use value in those areas. The value of use of these species used beyond the wetland area is estimated to be P77 million. Of this, use beyond the entire Ramsar site is worth about P30 million. This estimate is based on the hunting quota dependent on the Okavango and their estimated market value (as derived from literature and internet sites).

Water purification: the wetland area has the capacity to absorb or dilute wastewater, thus saving on treatment costs. Relatively little wastewater finds its way into the wetland, however, and the service is valued at about P2.2 million. The value used is the unit costs of wastewater treatment.

Scientific and educational value: The wetland are frequently used for research and educational purposes. Based on the expenditure involved, the annual scientific and educational value is estimated to be at least P24 million for the Ramsar site, of which P18 million is attributed to the wetland area. This estimate is based on primary data collection (gross values).

Option and non-use value

No studies have been conducted to estimate the option and existence value of the study area or the Okavango Delta. One study has estimated that tourists to the delta have a willingness to pay to preserve the area of at least P13 million (net present value). However, this provides a very low-end estimate, since it only includes users. The national and global willingness to pay to preserve this internationally renowned feature is likely to be orders of magnitude higher. Further research is needed in order to highlight the full trade-offs made in policy decisions.

The value of the Okavango Delta in the economy of Botswana

The Okavango Delta generates an estimated P1.03 billion in terms of gross output, P380 million in terms of direct value added to gross national product (GNP) and P180 million in resource rent. The direct use values of the Okavango Delta are overwhelmingly dominated by the use of natural wetland assets for tourism activities in the central zone. Households in and around the delta earn a total of P225 million per year from natural resource use, sales, salaries and wages in the tourism industry, and rents and royalties in CBNRM arrangements. The total impact of the direct use of the resources of the Ramsar site is estimated to be P1.18 million in terms of contribution to GNP, of which P0.96 million is derived from use of the wetland itself. Thus the Ramsar site contributes 2.6% of the country's GNP, with the wetland contributing most of this (2.1%). The multiplier effect is greater for the formal sector than for the poorer components in society, because the former activities have greater backward linkages and households are primarily engaged in subsistence activities. The natural capital asset value of the Ramsar site is estimated to be about P3.9 billion, of which the Okavango Delta is worth P3.4 billion.

7.8.3 Water valuation in commercial farming in Namibia

Source: Lange, 2006.

Lange estimated the value of water in three commercial farming blocks.

In Stampriet, commercial farmers combine mixed livestock production (mostly sheep with some cattle and other animals) and irrigated crop production. Farmers rely on groundwater as rainfall is 200 mm per annum. Water use amounts in practice to open access as the regulatory system is poorly implemented and consequently water consumption is not monitored. Current abstraction rights have been issued for a maximum of 9.9 MCM and farmers pay the full financial costs of groundwater abstraction.

In the Orange River area (rainfall of 50 mm p.a.), commercial farming mostly engages in irrigated crop farming, especially grapes. Farmers use a mixture of drip, micro and flood irrigation. Water consumption is not metered; government plans to introduce a volume water charge of N$ 0.0056/m^3.

In the Hardap area, some 2 200 ha of irrigation is done with dam water from the Fish River. Farmers mostly use flood irrigation because of its low costs. Farmers purchase water from Namwater at N$ 0.02147/m^3. As water meters are dysfunctional, most farmers are charged on an area basis.

Lange used the residual value or net income method. She estimated the amount of non-water inputs and their marginal value (or opportunity costs). Furthermore she estimated the amount of water used and the total value of the output. The marginal value of water was then estimated as (the value of the output – the costs of non-water inputs) divided by the amount of water used. This required the collection of farm data on income, variable farming costs, labour costs, water use and capital costs.

The results were as follows:

- Stampriet:
  - Residual financial value of water ranges from N$ 0.53 – 0.63/m3 (depending on the assumed rate of return on capital)
  - Residual economic value of water ranges from N$ 0.43 to 1.03/m3
- Orange River:
  - Residual financial value ranges from negative (melons) to almost N$ 1/m3 for grapes
  - Residual economic value ranges from negative (mangoes and melons) to over N$ 2/m3 for grapes. Farmers can afford the planned water charges if they grow tomatoes and/or grapes.
- Hardap area:
  - All farmers can pay more than the current water charge but not all could afford the full costs of water (N$ 0.31/m3)

The case study shows that the valuation methods can be successfully applied to commercial farming. However, the results depend on the sample size and on the assumptions made. Therefore, sensitivity analysis is recommended to verify the robustness of the results. In this case study, the results were highly sensitive for different assumptions (e.g. return on capital and shadow labour costs). In this particular case, the results of the valuation study were used to check on the farmers' affordability of new water charges.

7.8.4 Value of water resources in the Pangani Basin, Tanzania

This section is based on a report by Turpie *et al*, 2005. The study focused on the direct use value of water resources in the river basin. The Pangani River basin covers some 43 000 km^2, mostly in Tanzania but a small part is located in Kenya. The population is estimated to be around 4 million. The basin covers a variety of woodlands and grasslands. The main source of water is rainfall on the Kilimanjaro mountain. Water is used for:

- irrigation (coffee, sugar, flowers and small scale irrigation);
- human consumption;
- hydro electric power (3 schemes with 97 MW capacity supplying 17% of domestic electricity);
- industrial use.

The Pangani Basin Board manages the water resources and allocates water abstraction rights.

Water resources are under threat of the melting of the ice cap, forest degradation, increasing water demand and shortages of electricity. Alternative water uses include irrigated agriculture, coffee estates, sugar estates, flower industry, small scale irrigation, traditional furrow ploughing, livestock, domestic use.

The area was divided into four sub areas: highlands, upper basin, Kirua Swamp and Pangani Estuary.

The water value was estimated as follows (Table 6). Table 6 shows that the development benefits of a unit of water are much higher in coffee and flower production than in sugar production. Small scale irrigation and livestock also generate more value added than sugar plantations. In terms of areas, household incomes benefit most from the water in the estuary (fishing) and swamps. Therefore, upstream water abstraction could significantly affect households incomes in the estuary and swamp.

Table 6: Value of water by activity in Pangani River Basin

Acticity – water use	Valuation approach	Av. Value added/m3	Income/hh
Large scale coffee plantation	Net income approach using export prices	Tsh 723 to 6 205/m^3 depending on efficiency	
Sugar estates	Net income approach using export prices	Tsh 32 to 101/m^3	
Flower	Net income approach using export prices	Tsh 3 500 – 5 300/m^3	
Small scale irrigation	HH involved Production Price of products	Tsh 109 – 1 400/m^3 depending on the system	
Livestock	HH involved in livestock Number sold and products Av. Price per product	Tsh 479 to 2 263/m^3 depending on area	
Domestic use	Consumption/ hh Unit price of traded water	Tsh 1 200 – 1 500/m^3	
Natural resources			Highlands: Tsh 2 183/hh Upper basin: Tsh 7 915/hh Kirua Swamp: Tsh 43 560/hh Pangani estuary: Tsh 787 793/hh
Food & medicines	HH involved in harvesting Amount collected/hh Value of unit of product		Tsh 63 to 2383 / hh depending on the area
Reeds, sedges and grasses	HH involved in harvesting Amount collected/hh Av. Bundle price sold Value of unit of product		Tsh 0 – 2852/hh
Palms (leaves, brooms, baskets, mats)	HH involved in harvesting Amount collected/hh Av. Bundle price sold Value of unit of product		Leaves: Tsh 0 – Tsh 66 115/hh Other products: Tsh 0 – 20 606
Mangrove (poles, fuelwood and boat ribs) & salt	HH involved in harvesting Amount collected/hh Av. price sold		Tsh 0 7 890/hh
Reptiles, mammals & birds	HH involved in harvesting Amount collected/hh Av. price sold		Tsh 0 – 8/hh
Fisheries	HH involved in harvesting Amount collected/hh Value of unit of product		Tsh 0 -693 012/hh
Hydro-electric power			Tsh 3.8 to 30.7/m3 water (depending on the efficiency of the plant)
Industry & mining	Important but not covered due to time constraints		

Source; Turpie *et a*l, 2005

The study recommended among others, that more research should be done on water uses and productivity, the estimation of the marginal use value of water in different sectors, and estimation of the marginal value of water for the environment. Furthermore, a system of tradable water use and pollution rights should be considered in combination pilots for payment of environmental services.

7.9 Special valuation issues

7.9.1 Data limitations

According to the synthesis report (AEGIS, 2010), data availability varies across countries and river basins. Information on the costs and value of water, particularly on its storage and distribution infrastructure is not readily available. Subsidies tend to be high but the level cannot easily be assessed. Clearly, SADC-MS countries do not yet fully treat water as an economic good. In contrast, data on water tariffs are widely available, but not for raw (untreated) water.

These limitations have restricted the development of monetary accounts in Botswana, Namibia and South Africa and will restrict current WA development efforts. However, extra efforts to collect and publish such data will relax the data constraint in future and allow WA improvements. Several data issues are particularly important:

- Use of standardised categories, e.g. for economic sectors.
- Compiling and cross checking the consistency of water data based on grey data (e.g. a task of water regulators).
- Consistency in efforts to compile annual data. WA derive part of their value from the time series results.
- Avoid double counting. For example, water losses (or UAfW) may be included in production and consumption figures.

7.9.2 Annual value or discounting future net benefits

The value can be based on the actual value that is generated by the resource in that particular year (static) or by the expected future net benefits that it may generate (dynamic). The latter is theoretically better but also more demanding as future costs and benefits need to be predicted. In that case, the resource value is the present (discounted) value of the stream of income (rent) it is expected to generate in the future, or what is called the Net Present Value. There are two steps in calculating the net present value of mineral assets:

- calculating the rent per unit of output generated by current production;
- calculating the economic value of minerals as the discounted value of future rent (usually based on assumptions relative to current rates of rent).

In order to calculate the NPV, a time period has to be chosen for which the costs and benefits are assessed (e.g. 15-20 years). Moreover, the discount rate needs to be selected. The discount rate is the rate by which a benefit or cost is discounted in one year. Most government have a prescribed discount rate (e.g. 10%) or a range of possible discount rates (e.g. 8 – 12%).

7.9.3 Uncertainties & risks

Most valuation studies make a large number of assumptions and/or transfer data from other valuation studies. While every effort should be made to ensure that assumptions are realistic and that transferred data are relevant or adapted to the new circumstances, uncertainties exist that need to be acknowledged.

If valuation is pursued through the estimation of future net benefits, predictions have to be made about the volume of benefits and costs and their value. The longer the time horizon is, the greater the uncertainties will be. While theoretically a long time horizon is better as it incorporates more costs and benefits, in practice it is better to restrict the time horizon to a period where reasonably certain predictions can be made.

Sensitivity analysis is a good method to deal with the consequences of uncertainties. Sensitivity analyses should be carried out for key variables and assumptions. If the results do not vary significantly, the results are robust and fairly certain. In contrast, if the results vary significantly, the value estimate is 'soft' and strongly dependent on the assumption.

7.10 Group Work

Purpose of exercise: to understand the difference between tariffs and value and to understand the suitability of different valuation methods.

Participants need to be divided into groups of 5 - 7 participants.

Group tasks

- For water provided to final consumers such as households:
- How many service providers exist in your country/ river basin?
- Make an inventory of the tariffs and analyse possible causes of difference in tariffs?
- Which valuation method would you consider for valuing water use by domestic users? Why and which data are needed?
- For water use by agriculture and industries, how many service providers exist in your country or river basin?
- What are the tariffs and analyse the possible causes of differences in the tariffs?
- Which method would you apply to value water for agricultural and industrial use? Why?
- Discuss how the Contingent Valuation Method could be used for EAWU in your country or river basin? Would you have the means to use the method? Identify possible the constraints and strengths.

7.11 Selected References & Resources for further reading

Arntzen,J. and T.Setlhogile, 2008. Compendium of environmental economic case studies. Centre for Applied Research www.car.org.bw & Department of Environmental Affairs.

Arntzen,J and S.Masike, 2006. Introduction in environmental economics. Centre for Applied Research (www.car.org.bw)

Cap-Net, 2008. Economics in sustainable water management. Training and facilitator's guide. GWP, UNDP, EUWI. (www.cap-net.org)

EGISBCEOM, 2010. Baseline synthesis report (draft) SADC/EDF Economic accounting of water use.

Environmental Protection Agency, 2009. Valuing the protection of ecological systems and services. Report from the Scientific Advisory Board.

Hackett, S.C., 1998. Environmental and natural resources economics: theory, policy and sustainable society. Sharp, new York and London.

IUCN, Nature Conservation and World Bank, 2004. How much is an ecosystem worth? Assessing the economic value of conservation.

Lange,G.M., 2006. Case studies of water valuation in Namibia's commercial farming areas. In Lange & Hassan, 2006a, ib id., pp.237 – 254.

Lange,G.M. and R.Hassan (with J.Arntzen,J.Crafford & E.Mungatana), 2006a. The economics of water management in southern Africa: an environmental accounting approach. Edgar Elgar.

Lange, G.M., and R.Hassan, 2006b. Methodologies for valuation of water services. In: Lange & Hassan, 22006a, ibid, pp. 203- 236.

Rojas,M and B.Aylward, 2003. What are we learning from experiences with markets for environmental services in Costa Rica? Interantional Institute for Environment and Development (IIED), London

Statistics New Zealand, 2004. Water: monetary stock account report.(www.stats.gov.nz)

Sulse,T.B., C.Ringler, T.Zhu, S., Msangi, E. Bryan, M.W.Rosegrant, 2009. Green and blue water accounting in the Limpopo and Nile Basins. IFPRI Discussion paper 00907.

Tietenberg, T., 2003. Environmental and Natural Resource Economics. Addison Wesley, Boston, USA.

Turpie,J.K., B.Smith, L.Emerton and J,.Barnes, 1999. Economic value of the Zambezi basin wetlands. Report to IUCN.

Turpie, J.K., Y.M.Ngaga and F.K.Karanje, 2005. Catchment Ecosystems and down stream water: the value of water resources in the Pangani Basin, Tanzania. IUCN Nature and Economics Technical Paper No 7. IUCN-WCS.

Turpie,J.K., J.,I.Barnes, J.W.Arntzen, B.Nherera, G.M.Lange and B.Buzwani, 2006. Economic valuation of the Okavango Delta and implications for management. ODMP report.

United Nations, 2005. Handbook for Iintegrated Environmental and Economic Accounting. Draft UNSO.

Relevant websites

Centre for Applied Research	www.car.org.bw	World Bank	www.worldbank.org
IUCN	www.iucn.org	Waternet	www.waternetonline.org
Cap-net	www.cap-net.org	SADC	www.sadc.int
UNDP	www.undp.org		

7.12 Notes to the Facilitator

About this Module

This module is designed to address the training needs of technical staff to mid level staff of Departments of water, environment, statistics and agriculture; water utilities; municipalities and other institutions interested or engaged in compilation of water accounts. This module facilitates an interactive exchange of opinions, perspectives and experiences of participants on some of the key issues of valuation of water resources (e.g. flows, assets, water quality and wetlands). You can allow for substantive discussion and encourage active participation by way of role playing.

Actual resource valuation, including valuation of water resources, is a rather technical exercise, which usually requires to be carried out by economists. For technical details, the technical manual on EAWU (based on the UN-IEEA handbook) deals in detail with the details of implementing valuation methods. It is, however, important that all technical staff involved in EAWU is familiar with and understand the basics of water valuation. Therefore, on completion of this module, participants will be able to:

- Understand the main valuation and cost concepts
- Be familiar with the main valuation methods and their relevance for valuing water resources
- Identify which methods and techniques are suitable for the different aspects of EAWU

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. In addition, study the other manuals to appreciate the role of resource valuation as parts of EAWU. The background papers should also be distributed to the participants well in advance. The main background papers for this module are provided in section 7.9.

Facilitation

The module is designed for face-to-face facilitation. The duration is **approximately 2.5 hours.** This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator would need to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver this module.

The group exercise is described in section 7.7. Ask participants in advance to bring relevant material from their country or river basin. The comparison between countries and river basin is an important and highly instructive element of the group work. Moreover, it is important for participants to see how the methods and techniques could be applied to the different parts of the EAWU.

It is important to structure the presentation and Q&A period for the group exercise carefully in order to allow sufficient time for a productive discussion. The Q&A period per presentation should not exceed 15 minutes.

Be sure to clarify the objective of the training and describe the agenda at the start of the session. This gives structure and direction to what you intend to do. This module brings together information generated from the other water accounts, therefore it is important to emphasise this linkage at the start.

Participant Evaluation

An evaluation questionnaire should be provided to allow participants assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your Feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to jarntzen@car.org.bw

7.13 Glossary of terms

Comparative advantage:	a comparative advantage prevails for products which have the lowest opportunity cost of production.
Discount rate:	the rate used to convert s stream of benefits and costs into its present value.
Externality:	refers to interdependence in welfare. Positive or negative externalities occur when the action of a firm or household affect the welfare of another firm or household. Environmental externalities are often negative.
Marginal cost pricing:	basing the price charged for resource use upon marginal costs.
Average cost pricing:	basing the price charged for a resource upon the average supply costs.
Net benefits:	the excess of benefits over costs resulting from a resource allocation
Opportunity cost:	the net benefit foregone because the resource providing the service can no longer be used in its next most beneficial use.
Option value:	the value people place on having an option to use a resource in future.
Existence value:	the value people place on a resource irrespective of their use of it.
Production function:	a mathematically expressed relationship between inputs and outputs.
Market failure:	occurs when the conditions for a well functioning competitive market are not met (e.g. environmental externalities exists)
Resource rent:	the remainder of the resource revenues after deduction of the supply costs, external costs and a reasonable return on capital.

The above descriptions are based on Tietenberg (2003) and Hackett, 1998.

Module 8
EAW and IWRM

Goal

The objective of this module is to close linkages between water accounting and Integrated Water Resources Management.

Objectives

The main aim of this module is to introduce the concepts of IWRM and WA, and to demonstrate the importance of WA in promoting and achieving IWRM. In addition, the module highlights policy implications of planning and implementing IWRM.

The module has the following objectives:

- Introduction to the concepts of IWRM and water demand management
- Discuss the link between IWRM and water accounts
- Discuss IWRM, use efficiency, non-conventional supply sources and water demand management
- Discuss IWRM mainstreaming into development planning

Module Structure

The module is structured as follows:

Table 1: The Module structure

Main component	Topic
IWRM and Water accounts	The concept of IWRM: principles, IWRM and water demand management vs conventional water resources approaches, IWRM implementation The concept of WA: rationale for developing water accounts, IWRM leading water management in SADC Linkages between IWRM & WA
Water efficiency	Allocative efficiency Water efficiency by sector Technical efficiency Water efficiency vs the principle of water as a social good Water efficiency vs the principle of water as an ecological good Closing water cycle Importance of M&E
Non conventional sources of water	Rain water harvesting, Waste water reuse, Desalination
IWRM mainstreaming	MDGs, WSSD, Development plans, Development of scenarios, Case study: Situational analysis of IWRM plans in southern Africa
IWRM in SADC	IWRM leading water management in SADC Transboundary water resource allocation and benefit sharing
Policy implication	National and regional levels
References and Resources for further reading	Websites Articles

8.1 Brief subject description

Water scarcity is a global challenge and the need to improve access to water has risen with the pursuit of the Millennium Development Goals (MDGs). Integrated Water Resource Management (IWRM) is globally accepted water version of sustainable development aimed at managing water resources in order to address deficiencies in conventional water resource management approaches; water wastage, poor allocative efficiency, inadequate operation of water authorities and neglect of social and environmental issues. IWRM balances water supply and demand measures and promotes access to water for all uses and efficient use of water. In order to manage a resource it important to understand it and assessment of the resource is useful in this regard. In the case of water, it important to know the amount and the quality available and the water uses. Water Accounting (WA) provides a basis for understanding water resources and their uses. WA is a system that indicates physical stocks (stock accounts) and uses of (use or flow accounts). Water scarcity is exacerbated by inefficient allocation of water. Water accounts provide information about allocative efficiency and thus contribute to achieving IWRM.

With regards to policy, IWRM calls for developing policies and priorities that take water resources implications into account. For example, macro-economic policies may lead to high water demand especially if the economic policy promotes production of economic goods that requires large volumes of water in their production process. In most cases, such economic policy seem unrelated to water and IWRM calls for involvement of all stakeholders including those that do not directly deal with water planning and development. Therefore, is important to ensure water planning and strategies are integrated into broader social, economic, and environmental goals.

8.2 Summary of the Module

The integrated development and use of water resources in the SADC is seen as a basis for economic integration, development and eradication of poverty. IWRM is central to SADC's water policy and strategy documents. The main aim of the module is to introduce the concepts of IWRM and WA, and demonstrate the importance of WA in promoting and achieving IWRM. The module defines the concepts of IWRM, water demand management (WDM) and WA. The module also provides a synopsis of IWRM implementation based on the Global Water Partnership IWRM Toolbox. The IWRM toolbox is comprised of three tools: Enabling environment, Institutional roles and Management instruments. The link between IWRM and WA is discussed showing how WA provides a basis for implementing IWRM.

Article 26 of the World Summit on Sustainable Development Plan of Implementation identifies two ways to implementing water efficiency:

- Reduce water losses through improved water infrastructure and improve recycling of water
- Promote allocation of water amongst competing uses giving priority to water for basic human needs, for preserving the ecosystem integrity, domestic needs, industrial and agricultural needs. This also highlights maintenance is good drinking water quality.

The module discusses three aspects of water use efficiency:

- Technical efficiency,
- End user efficiency and
- Allocative efficiency

Achieving water efficiency is important in reducing water scarcity because water scarcity is partly due to misuse and inequitable distribution of water resources. Water resources are an integral part of sustainable development planning and the implementation of IWRM is important for achieving Millennium Development Goals (MDGs). The module highlights the importance of mainstreaming IWRM into development planning.

8.3 Introduction

Water scarcity is situation whereby the demand for water for domestic, industrial and agricultural uses exceeds the available water resources. This affects about 1.6 billion people with majority in Africa. Demand for water has grown significantly with population increasing threefold and water withdrawal increase seven times (GWP, 2000; UN-Water, 2007). Water scarcity is to a great extent relates to how we use and manage water resources. The scarce resource is not allocated efficiently, pollution reduces water quality, and service providers fail to serve the public with social and environmental issues left unaddressed (Xie, 2006). The conventional water resource management approaches are sectoral leading to water wastage, poor water efficiency, poor operation and environmental liabilities. These problems are caused by supply-driven approach to water management which ignores the limits of water systems. As water resources become scarcer the need for alternative water resource management approach increased and Integrated Water Resource Management (IWRM) has emerged as an approach to address global water challenges. IWRM calls for collaboration amongst all stakeholders in water management.

8.4 The concept of IWRM and Water accounts

IWRM is a broad concept and the notion of IWRM is that different water uses are interdependent. Elements of IWRM include; participation of stakeholders, IWRM is a coordinated process, focuses on water as an economic good, social equity and welfare, ecosystem protection and proper water governance. Global Water Partnership (GWP) defines IWRM as "*a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*."

IWRM principles

IWRM principles, known as Dublin Principles, were agreed to at the International Conference on Water and the Environment (ICWE), held in Dublin, Ireland in 1992 to guide global management and development efforts. Dublin principles:

- Ecological - Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment. Water managers should reserve a portion of the flows in a river for support and to maintain the ecosystem. The reserved amount of water for the ecosystem is known as environmental flow requirement.
- Decentralised management - Water development and management should be placed at the lowest effective level of administration.
- Participatory and involvement of women - Women play a central part in the provision, management, and safeguarding of water. Therefore, there should be involvement of stakeholders in planning and management decisions.
- Economic good - Water has an economic value in all its competing uses and should be recognized as an economic good.
- Social good – water is essential for life and water for basic needs such cooking, drinking and bathing should be accessible to all.

Short exercise:

- Are these principles relevant to your country?
- Are they implemented and what are the challenges?

Table 2: Contribution of WA to IWRM principles

Principle	What WA contribute
Ecological good	Indicate the amount of water needed to maintain ecosystem integrity Discharges of treated waste water in the environment Amount of evapotranspiration thus contributing to the hydrological cycle
Participatory and stakeholder involvement	WA show a comprehensive list of water users and water uses Stakeholders should be involved in discussing main water accounts based scenarios
Economic good	Value added per cubic metre of water by sector Water use by sector Water accounts link resources to economic accounts
Decentralised water management	WA shows accounts at levels of management e.g basin, regional, national levels
Social good	Identifies levels of basic use and subsidies

IWRM, water demand management and conventional water resource management (WRM) approaches

The sectoral nature of conventional water resources management approach is partly blamed for water scarcity problems. Conventional approaches often break up the water sector between numerous government agencies and institutions, that often and without consulting each other make decisions on matters that affect water resources and how others use that resource. As a result, water resources are managed to meet the limited interests of specific groups rather than holistically to meet everyone's needs appropriately and sustainably. IWRM approach addresses this limitation through integrated water resource management that includes all stakeholders in planning and decision making. This leads to coherence amongst water users and planners including those outside the water sector. Three components of IWRM are useful in this regard (to be discussed under sub section IWRM Implementation).

The conventional water resource management approach focused more supply management, that is, meeting demand through developing conventional water sources such as building dams, water transfer schemes and other water sources. IWRM emphasises demand management and development of non-conventional sources of water (non conventional sources of water are discussed later under section 8.2.4.3). Water demand management (WDM) and IWRM are intertwined. WDM is an approach aimed at conservation and efficiency use of water resources. WDM is achieved through use incentives that promote efficient and equitable use as well as equitable allocation (IUCN, 2004).

WDM targets four different stages of the water management cycle and can affect different groups of stakeholders associated with each phase of the cycle:

- Water resource management (e.g. types of supply, allocation)
- Water distribution methods (e.g. cutting distribution losses)
- Consumer demand management (e.g. decrease wastage)
- Return flow management (e.g. consider the merits of direct use of return flows) (IUCN, 2004).

What is the rationale for introducing WDM? Factors that led to the introduction of WDM include; economic, environmental sustainability, social and the need to achieve equitable distribution of water resources. These are summarised in Table 3.

Table 3: Motivational factors for WDM

Environmental	▪ Reduce current or future water scarcity ▪ Reduce vulnerability to droughts ▪ Avoidance or postponement of the negative environmental impacts ▪ Social and environmental impacts of dams and well fields
Economic	▪ Lower costs compared with new supply schemes ▪ Possible savings on operation and maintenance costs ▪ Increased competitiveness of enterprises and countries that adopt WDM ▪ Use of saved water to promote economic growth
Equity	▪ Use of saved water to provide water to more people ▪ Increased water security and risk aversion ▪ Lower costs leading to improved affordability
Empowerment and growth	▪ Building upon indigenous knowledge and resource management systems ▪ Incentive for technology development and innovation ▪ A means to meet water and sanitation policy goals ▪ Opportunities for re-use and recycling

Source: WDM Module – IUCN 2004

Table 4: Characteristics of Conventional and IWRM approaches

Conventional WRM approaches	IWRM
Sectoral approach; limited coordination, inefficient management, no emphasis on interdependence	Holistic approach; coordinated planning, recognises interdependency amongst water uses
Centralised management,	Decentralised management to the lowest level
Over subsidised distorting value of water	Recognises water as an economic good and calls for user pay and polluter pay principles whilst recognising the importance of water as a social good.
Supply management oriented	Emphasis on demand management and calls for use on non-conventional sources of water e.g. desalination, rainwater harvesting and waste water reuse

8.4.1 IWRM implementation

There is no specific blue print for implementation of IWRM given the broad nature of IWRM process. However, GWP has developed an IWRM Toolbox to support the application of IWRM approaches. The Toolbox (www.gwptoolbox.org) is an IWRM knowledge sharing and distribution tool made up of on line case studies, reference documents, partnerships with other organisation and materials for water resource management. These documents have been peer reviewed and are submitted by a wide range of contributors. There are 54 implementation tools providing practitioner with a variety to choose from according to the needs. The toolbox is comprised of three tools:

- <u>Enabling environment</u>: It has three sub-categories of policies, legislative framework and financing and incentive structures. Enabling environment highlights the importance of legislative framework that embraces the principles of IWRM. It also highlights the need for funding to finance implementation of IWRM.
- <u>Institutional roles</u>: Two aspects of creating an organisational framework and building institutional capacity define this sub-category. Implementation of IWRM requires a shift towards decentralised management of water resources and strengthening of institutions to deal with required changes. It is important to build human capacity in IWRM through training courses and
- <u>Management instruments:</u> it is made of several sub-categories of water resources assessment, plans for IWRM, efficiency in water use, social change instruments, conflict resolution, regulatory instruments, economic instruments, and information exchange. Water resources assessment provides a basis for institutions to understand its resources. This can be done through data collection and analysis. Water accounts (to be discussed in the next module) are important way of documenting resources. Developing IWRM plans provide roadmap and allows for monitoring progress in implementing IWRM. Water efficiency relates to efficiency in use and supply system. Water efficiency is an important component in IWRM because IWRM seeks to address allocative inefficiencies of conventional approaches. Social change instruments include water issues in the education curriculum, communication strategies and awareness raising aimed at changing behaviour towards water efficiency and conservation. Conflict management tools are intervention tools for dispute management. They relate to facilitation, mediation fact-finding and arbitration. Regulatory instruments are statutory dealing with protection a of water resources whilst economic instruments are price and tariff as well as user charges tools for management of water. Information exchange advocates for proper information storage systems and sharing of IWRM data and experiences.

Advantages of the IWRM approach

IWRM provide a basis for solving water-related problems such as flooding, water-borne diseases and conflicts over water. Failure to solve such problems is in some cases is because solutions to such problems may fall outside the normal scope of agencies tasked to solve them. This, therefore, calls for cooperation of other sectors and IWRM approach helps to identify and implementation of effective solutions.

Cost savings by loss reduction and better investment strategies. Efficient use of water will lead to reduced water bill. Many water suppliers experience water losses in the distribution system, often known as unaccounted for water. Reducing these losses will save water suppliers the cost of delivering water. For example, if a supplier experiences water losses of up to 22% and reduces this to 12% it means that the suppliers the cost of cleaning and pumping water will be reduced.

It important in averting poor investments decisions based on sectoral and short term planning. The approach encourages inclusion of all sectors and the cost and benefits of an investment is based on long term perspective. The vulnerable members of a community and the environment normally bear the brunt of poor decision making. IWRM calls for inclusion of all stakeholders in planning and decision making taking into account the social and environmental needs.

IWRM helps in addressing weak allocative efficiencies through strategic reallocation. Strategic allocation requires evaluation of different sectors based on the broader goal of a society. That is, how does a sector's use of water assist in achieving the broader development goal of a society? Strategic allocation uses instruments such pricing, incentives and subsidies to encourage water efficiency.

Disadvantages of the IWRM approach

IWRM presents a challenging approach. It is multi disciplinary and cuts across institutions. It calls for coordination between different institutions and developing a platform to allow for coordination is not an easy task. It involves reforming institutions, policy and legal environment as well as human behaviour towards water use and management. Similarly, institutional reform and strengthening in major undertaking that requires expertise and financial resources. Furthermore, IWRM requires political support and commitment to implement.

In some developing countries water sector is informal characterised by self providers and local institutions that are not under direct influence of public institutions. In such cases, the capacity of legal provisions and formal institutions to influence water use patterns is limited.

8.4.2 The concept of water accounting

Water accounting presents a comprehensible picture of water resources at different water administration levels indicating the source of water, where it is going, how it is used and how much remains. The water accounts show uses that are otherwise not shown on national accounts because they have no economic use for instance they indicate the amount of water lost to evaporation at source and water for ecological purposes, often referred to as environmental river flow. This is amount required to sustain the integrity of the ecosystem.

Water accounting is a component of Natural Resource Accounting (NRA) which calls for inclusion of the value of environmental goods and services in the System of National Accounts (SNA). The SNA focuses on the production and use of manufactured goods and assets that are sold on the market ignoring the environmental services and non-produced natural assets. A system of NRA emerged to close gap in conventional SNA (refer to Module 3).

The rationale for developing water accounts

The purpose of environmental accounting, and water accounting in particular, is to link information about water use to economic information contained in the National Accounts (NA). It provides better insight in the sustainability of economic development by taking into account changes in water stocks and water quality. If economic growth coincides with water depletion, development cannot be sustained. This can be estimated through the "green national income' or the net genuine savings index.

Water accounts can be used in making decisions based on the actual water available taking into consideration potential impact on other uses.

- Analyses consumption trends, production and water losses
- Identify opportunities for saving water and increasing water productivity
- Conceptualize and test interventions in the context of multiple uses of water
- Develop effective strategies for allocating water among different users
- Assess the scope for the development of additional water resources
- Water accounts show time series and trends that provide an opportunity to develop scenarios for future development planning.

8.4.3 IWRM leading water management in SADC

The SADC Regional Water Policy framework is informed by; the SADC Declaration and Treaty, The Southern Africa Vision for Water, Life and Environment, Revised SADC Protocol on Shared Watercourses, and The principles of IWRM. The policy identifies nine thematic areas used to tackle water resource management issues such as lack of access to safe water, extreme poverty, weak policy framework, poor information systems and lack of effective public participation. The thematic areas are: Regional cooperation in water resources management, Water for development and poverty reduction, Water for environmental sustainability, Security from water-related disasters, Water resources information and management, Water resources development and management, Water resources institutional framework, Stakeholder participation and capacity building and Financing IWRM in the region (SADC, 2006).

> *"IWRM is the fundamental approach that has been adopted by the SADC Water Sector, which is enabled through development, capacity building, stakeholder participation, information management, integrated planning, conflict resolution and environmental management. Each of these objectives and tools is addressed in the policy, with IWRM being the common thread that links each to the other" (SADC Water Policy, page 8)*

Regional Water Policy (2006) and Regional Water Strategy (2007)

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.

Regional Strategic Action Plan for Integrated Water Resource Development and Management in SADC countries (1999-2004)

A wide range of instruments is mentioned to support WDM, including water tariffs, pollution charges, water quota, water banking, auctions, licenses, water quality and product norms, and WDM-demonstration projects. The RSAP recommends block tariff water pricing for water conservation. It is recommended that water authorities in SADC countries systematically analyse demand side options to increase allocative and user efficiency.

The RSAP identified thirty-one priority areas for the seven objectives. All objectives and priority areas fit into IWRM. Four priority areas are directly linked to WDM, i.e. balancing demand and supply, water conservation, best management practices and shift towards most efficient use of water resources. The water accounts project is a project of the RSAP.

8.4.4 The link between IWRM and water accounts

The link between water accounting and IWRM is apparent. Water accounts provide a holistic picture of all water sources, water uses including non market uses and water use by economic sector. Water accounts provide a framework or information base for IWRM to implement allocative efficiency and can be used to monitor and evaluate implementation of IWRM at national and RB levels. Water accounting provides a conceptual framework for a comprehensive analysis of the contribution of water to the economy as well as the impact of the various economic activities on water resources which supports the IWRM objective of fostering a coordinated development and management of water, land and related resource in order to optimise economic and social welfare without compromising environmental integrity.

Water accounts and water use efficiency

Water accounts indicate physical stocks and uses of water by different sectors. Water scarcity is exacerbated by inefficient allocation of water. Water accounts document value added per cubic meter of water by economic sector and this indicates which sectors use water efficiently. This could assist policy makers and decision makers in identifying which are wasting water and develop demend management plans to reduce water wastage. Water accounts are therefore important for improving allocative efficiency.

Decision making

Water accounting provides planners and policy makers an opportunity for informed decision making based on information on water uses. The physical stock accounts show the volume water available which is needed to determine abstraction levels and this helps planners in determine the appropriate development plans. The water use accounts show the amount of water used by different economic sectors and this information helps planners to determine development of new sources of water and also influences policy decisions on water efficiency. Realising the limited stocks available and diminishing opportunities for constructing water reservoirs or dams, Botswana has shifted its policy from supply oriented towards water demand management.

Water accounting provides a foundation for decision making because it shows the amount of water flowing in and out, and consumption rate of each user. It differentiate between beneficial and non-beneficial uses hence provides opportunities for improved allocative efficiency

One of the most valuable applications for water accounting is in identifying opportunities for saving water and increasing its productive use.

Ways of improving water use efficiency:

Increasing the productivity per unit of water used: in agriculture changing crop variety (developing crop variety with same yields but use less water), crop substitution, changing irrigation techniques from sprinkler to drip irrigation.

Reallocation of water uses (reallocation of water between sectors from lower to higher value uses

8.4.5 Water efficiency

This module discusses three key aspects of water use efficiency: technical efficiency, end user efficiency and allocative efficiency. Technical efficiency relates to service providers. Service providers experience losses in their water distribution system and the water lost is often referred to as unaccounted for water. Technical efficiency measures water losses from source of production up to the end user and the service provider is technically efficient when there are minimal losses in the distribution system. End user efficiency relates to how end users such as households, industries and agriculture, use water. An end user is inefficiency when there is over consumption, excess water use than is required and unnecessary wastage of water. An industry is inefficient when it is uses excess than is required in the production process. Allocative efficiency is how water is distributed to different uses. Allocatice efficiency is achieved when water is put to utmost valued use. Water efficiency ensures optimal use of a country's existing water resources and reduces water scarcity. Efficient use of water could postpone new investments in water infrastructure, increase production and keep water affordable.

Article 26 of the World Summit on Sustainable Development Plan of Implementation identifies two ways to implementing water efficiency:

- Reduce water losses through improved water infrastructure and improve recycling of water
- Promote allocation of water amongst competing uses giving priority to water for basic human needs, for preserving the ecosystem integrity, domestic needs, industrial and agricultural needs. This also highlights maintenance is good drinking water quality.

Water efficiency a multi-faceted approach taking into account social and technical issues. Water efficiency concepts are interrelated and need to consider as whole. Practical approaches to improving water efficiency include improving infrastructure, reducing leakages, and changing user behaviour.

The figure 1 summarises key efficiency concepts:

Figure 10: Efficiency concepts

Technical efficiency is a measure of the quantity of water delivered from production to the end user. All water service providers experience water losses in the supply system due to leaks, bursts and illegal tapping of water. A service provider is technically inefficient when water losses in the system are high, for example 40% of water is lost and a system that losses 10% to 20% is considered efficient. Technical efficiency can be improved through continuous monitoring and maintenance of infrastructure.

End user efficiency relates to the quantity of water used by households, industries and agriculture. An end user is inefficient when excess water is used than is required for a service or production of goods. It is influenced by a variety of factors including user practices, maintenance of water infrastructure, plumbing products, availability of water reuse options, and irrigation systems.

Allocative efficiency: The allocation of resources needed for the “production” of water products and services, and the allocation of available water resources among competing uses, so as to maximize the net benefits from their use. In the latter case, allocative efficiency means the efficiency with which a country allocates water and related resources to achieve its sustainable development goals.

Water accounts documents water production, consumption trends, water losses and different users as well as their value added per cubic metre of water. This is vital for identifying opportunities for saving water and increasing water productivity.

Source: Adapted from GWP Technical Brief 4.

8.4.5.1 Allocative Efficiency

The concept of allocative efficiency relates to the distribution of the available water resources among competing uses such as agriculture, domestic, industry and ecosystem use. A country allocates water resources to different uses to achieve its development goals and the allocation is efficient when the net benefits gained from the uses of water are maximized. In other words, a shift in water use would not lead to extra gains. Allocative efficiency calls for allocating water to the highest value uses and this should be done taking into account the economic, social and environmental issues. Therefore, it is important to balance the need to achieve highest value out every drop of water and ensuring that access to water for groups of society and ecosystem is not compromised. Water accounting is important in identifying water uses and their value to economic development. Water use accounts show water consumption by economic sector and the contribution of each sector to the economy. Water accounts use a combination of water consumption and the output by sector as an indication of the efficiency of water consumption in each economic sector. This provides an opportunity for decision makers to evaluate and realign water allocation that meets society’s sustainable development goals.

In most cases water efficiency is low with agriculture consuming more water and contributing less to the economy, this is the scenario in Botswana.

Case study: Value added per m^3 by sector in Botswana

Table 5(a) shows the amount of water used by economic sector whilst Table 5(b) shows the value added per cubic metre by sector. The agricultural sector is the largest consumer over the selected years followed by the household and then the mining sector. On the other hand, the value added per cubic metre in the agricultural sector is by far the lowest estimated at P5-6 per cubic metre. The manufacturing industry, mining and government sectors also record lower value added per cubic metre.

Table 5(a): Water use and value added per m^3 by sector in Botswana

a. Water use by economic sector (Mm^3)

User category	1992	1996	2000	2003
Agriculture	72.9	70.6	76.0	63.4
Mining	12.8	14.4	24.1	26.8
Manufacturing	3.9	2.1	4.0	5.1
Water + electricity	0.0	0.8	0.5	0.7
Construction	0.0	0.4	0.4	0.4
Trade	0.2	0.7	1.0	1.2
Hotels and restaurants	0.2	0.5	0.8	0.8
Transport + communication	0.0	0.2	0.2	0.3
Insurance, banking, business	0.0	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	0.0	0.0
Grand total	140.3	141.3	168.6	170.3

b. Value added per m^3 by sector (1993/94 Pula)

User category	1993	1998	2002	2003
Agriculture	6	6	5	4
Mining	274	257	257	260
Manufacturing	194	219	144	138
Water + electricity	190	357	942	654
Construction	2,294	4,890	2,395	2,468
Trade	1,116	1,800	1,543	1,445
Hotels and restaurants	276	373	334	321
Transport + communication	2,448	3,221	2,441	2,428
Insurance, banking, business	2,421	2,884	2,577	2,666
Social and personal services	382	494	1,247	1,282
Government	236	237	270	271
Grand total	*76*	*91*	*93*	*106*

Source: Botswana Water Accounts Report (2006)

Water efficiency can also be measured by the number of jobs created per m^3. In 2003, an average of 2 807 paid jobs were created for each Mm^3. The service sectors create the largest number of jobs (20 to 50 000 per Mm^3) with government creating around 25 000 jobs for each Mm^3 consumed. Efficiency in terms of paid employment creation is much lower in industry (several thousands), mining (365) and agriculture (83). Most jobs in agriculture are self employment of farmers and informal employment. If those would be included, water efficiency in terms of employment would exceed 1 500 jobs per Mm^3.

Source: Botswana Water Accounts Report (2006).

Information from water accounts shows a comparative economic contribution of water use in three SADC countries: Botswana, Namibia and South Africa. These countries share the Orange-Senqu River Basin together with Lesotho. The agricultural policies of the countries influenced the results on Table 6; Botswana has relatively little agriculture whilst Namibia and South Africa have subsidised irrigated agriculture Lange (2003). The water accounts are also useful in transboundary water resources use and management. Water accounts can be shown at basin level hence they provide a basis for negotiating and allocation of net benefits from shared water courses.

Table 5(b): Value added per m3 of water by sector in Botswana, Namibia, and South Africa (1996 Botswana Pula per m3)

	Botswana	Namibia	South Africa
Agriculture	9	6	2
Mining	420	54	44
Manufacturing	437	189	98
Trade, Services, Government	724	542	302
GDP per m^3 of water input	124	45	20

Note: Calculated as water input divided by sectoral value added

Source: Lange at el 2000 quoted in Lange 2003: 30

Reallocation of water can lead to emergence equity and social concerns. For instance, considering the importance of agriculture to national food security and its role in rural economies of most developing countries policy shifts towards reducing water allocated to agriculture is unlikely to receive public and political support. Water efficiency in the agricultural sector can be achieved through switching to crops with higher economic value or less-water-consuming crops, and developing crop varieties that can provide high yield with water consumed. Investment into water saving irrigation facilities can also improve water efficiency, for instance, replacing sprinkler irrigation with drip irrigation.

Water efficiency is an important policy consideration and water accounts provide a holistic picture of water use in relation to economic. Water accounts provide planners and policy with options and information useful in planning and development.

8.4.5.2 End user efficiency

The water user, inefficiency is due to poor user practices such as wastage and over consumption of water. This inefficiency may also be due to water infrastructure such as large water cisterns, automatic urinal systems, and sprinkler irrigation system. User efficiency can be achieved through changes in user behaviour towards cautious use of water. The GWP toolbox identifies three social change instruments:

- Education curricula on water management – the tool advocates for incorporation of sustainable water management into pre-school, primary, middle and high school education. This encourages learners to understand water concepts and effects of their own behaviour on water, its quality and the ecosystem. This can be achieved in many ways such as developing and using water textbooks, developing water modules, using local water case studies and taking learners to water works and treatment plants.
- Communication with stakeholders – this instrument emphasis is on communication and sharing of information as well as experiences amongst diverse water stakeholders on water issues and IWRM. This can be achieved through, taking into consideration appropriate settings for different types of people, conferences, workshops, internet, one-on-one exchanges, printed and electronic media, field day and demonstrations to exchange best management practices.

- Raising public awareness – public understanding of water issues is important for them to support water efficiency and conservation measures. Public awareness raising can be done through water campaigns and this can be achieved through print media, radio, television, organisation of large events with public figures to help spread the message and through existing networks such as NGOs and religious networks. The public can also be empowered through access to information. In the case of water use, companies or organisation are required to publish information on their water uses. Since the information is public organisation or companies are likely to use water efficiently. Product labelling is an important tool for awareness raising. This is labelling and rating products that use water efficiently. Labelling water use products can encourage consumer behaviour or consumption patterns and encourages producer industries to be innovative.

Efficient use of water can also be encouraged through incentives and disincentives. These incentives and disincentives can be economic and legal. Economic incentives such as subsidies and rebates offered to efficient users of water and disincentives such as charges and tariffs for wasteful and undue consumption of water. One of the principles of IWRM is that water is a social good implying that water for basic needs should accessible to all. Therefore, targeted subsidies can be implemented to ensure that all groups of society get access to water. Regulations and bye laws are legal instruments that are used to prohibit wastage of fresh water. The legal instruments may be used to restrict non-essential water using activities during drought, for instance. Regulations maybe reactive and specific to certain situations such as droughts and they can also be proactive, long term and may not necessarily be water related. For example, there are other legal instruments that do not necessarily deal with water resources but indirectly having a bearing on water management. For example, building regulations can be reviewed to incorporate water conservation by providing for water saving buildings and associated fittings. It is worth noting that the use of legal instruments requires extended political support and legislative changes take time to change.

Case study: Water Efficiency Labelling and Standards (WELS) Scheme

WELS is Australia's water efficiency labelling scheme which allows consumers to compare the efficiency of different products. The rating system has six stars and the more stars the better the products. The labels also show a water consumption or water flow figure. The scheme applies to the following products: Plumbing products (showers, tap equipment), sanitary ware (toilet equipment, urinal equipment) and white goods (clothes washing machines and dishwashers). Compliance and enforcement activities are provided for under the Water Efficiency Labelling and Standards Acts of 2005. The Act provides for deterrent sanctions and this normally starts with written undertaking where a WELs Regulator may document in writing what the supplier is required to undertake to be WELS compliant. If the supplier does not comply ten the WELS Regulator may apply to the Federal Court for order to enforce.

Water efficient products will help Australia save water, reduce energy and water bills. By 2021 Australians could save more than $600 million through reduced water and energy bills by choosing efficient products. By 2021, it is estimated that using water efficient products will help to:

- Reduce domestic water use by five percent or 87,200 megalitres per annum and
- Save about 610,000 megalitres (more water than in Sydney Harbour).

It is estimated that half the water savings will come from more efficient washing machines, 25% from showers and 22% from toilets.

Source: www.waterrating.gov.au

The WELS case study shows the use of public awareness strategies, improved technology, subsidies and incentives coupled with legislative instruments used to set standards for water use appliances or equipment.

8.4.5.3 Technical efficiency

The other part of inefficiency is in the water supply system. All water providers experience varied water losses in their distribution system, particularly from the starting point in the supply system to the user. For example in Botswana, districts have different water losses; Ngamiland 15%, Central 35% and South East 55% of water lost in the distribution system. Water losses are due to pipe leakages, pipe bursts, illegal use of water from the system and poor meter reading as well as poor monitoring. Losses due to system leakage are not directly attributable to the use of water by any specific economic sector. Unaccounted for water may be used for an economic activity but lack of information makes it difficult to tie it to a specific economic activity. Even though water losses are inevitable, they can be controlled, managed and reduced.

A reduction of these water losses will save water authorities money and reduce the need to invest in building dams or transfer schemes. In order to address the distribution system inefficiency, it is important to undertake an assessment of the infrastructure (water audit) to identify areas that need rehabilitation. Some leakages are small and it is often not cost effective to repair them (WDM Cook Book). Leakages are mainly influenced by pressure such that increase in pressure leads to increase in leakages especially where there are existing leaks, at joints for example. Pressure also influences the number of pipe bursts. Therefore, water losses due to leakages and burst can be reduced through pressure management, reducing pressure during low demand periods.

In some cases poor meter reading can lead increase in unaccounted for water (the WDM Cookbook suggest the use of non-revenue water as opposed to unaccounted for water). Inaccurate meter reading maybe under or over recording of water use and this distorts the actual amount used. Under recording leads to loss of revenue for the service provider whilst over recording increases the customers' water bill. The decision to replace dysfunctional meters several factors and the water audit helps to establish these factors. Factors include; the number of dysfunctional meters and their rate of inaccuracy. If the number of faulty meters is high and their rate of inaccuracy (under recording in this case) is high then it is cost effective to replace the faulty meters because the payback period for the investment is shorter. However, if there are fewer under recording meters with low rate of inaccuracy, it may not be cost effective to replace meters because that may not lead to significant loss reduction and income for the service provider.

Short exercise:

Do you know your country's water loss figures?

How are you going to incorporate the losses into your water accounts?

Water accounts play an important role because they provide a platform for making comparisons on the amount of water losses amongst SADC countries. The comparisons allows for bench-marking exercise on best practices amongst SADC members.

IWRM approach is important as it considers the need to balance infrastructural and institutional investments. This is to avoid a situation where greater emphasis is on physical infrastructure that cannot be maintained or managed optimally to contribute to economic growth. The lesson here is; investment in physical infrastructure should be coupled with institutional capacity building and supporting policy and legal environment.

8.4.5.4 Water efficiency versus the principle of water as a social good

It is important to prioritise implementation of water efficiency interventions taking into consideration equitable distribution of water resources as enshrined in the IWRM principles. Water is a social good means that water is essential for basic needs such as cooking, drinking and bathing and should be accessible to all social groups. It is a human right to have access to clean water at an affordable price. In South Africa, the right to basic water supply is enshrined in the National Water Act of 1998. The term “basic water supply” is defined in the National Water Services Act as “the prescribed minimum supply of water supply services necessary for the reliable supply of a sufficient quantity and quality of water to households, including informal households, to support life and personal hygiene The basic amount is defined as 25 litres of potable water per person per day or 6 kilolitres per household per month (Bird et al. 2009). This achieved through subsidies and the 6 kilolitres per household in a month is free in South Africa.

8.4.5.5 Water efficiency versus the principle of water as an ecological good

IWRM also defines water as an ecological good. This is the minimum amount of stream flow required for ecosystem use and sustainability. This is often referred to as the environmental river flow (EFR). This is the amount required for the maintenance of the ecological integrity of the water source system. The EFR is important for the protection of the structure and function of the ecosystem and the organisms dependent on the system. In South Africa, the quantity and quality of water required to protect aquatic ecosystems in order to secure ecologically sustainable development and the use of the relevant water resource is reserved.

Allocative efficiency as discussed above should only be applied to the available water resources **after** the basic needs and the EFR have been met. A simple example: if 100 MCM of water is available and the basic needs and the EFR are 15 and 20 MCM respectively, allocative efficiency is ‘only’ applied to 65 MCM.

Case study: The ecological reserve in South Africa

South Africa’s National Water Act of 1998 requires all water users who do not receive their water from a service-provider, local authority, water board, irrigation board, government water scheme or other bulk supplier, and who use water for irrigation, mining purposes, industrial use, feedlots or in terms of a general authorization to register. This includes the use of surface and groundwater. An assessment of the environmental requirements of the rivers and streams concerned is conducted before a license can be issued. South Africa is divided into 19 water management areas and the table shows the amount of ecological reserve each water management area (Table 6).

Table 6: Natural mean annual run-off and ecological reserve (million m3/a)

Water management area	Natural mean annual run-off [1]	Ecological reserve[1,2]
Limpopo	985	156
Levuvhu/Lebata	1 185	224
Crocodile West & Marico	855	165
Olifants	2 046	460
Inkomati[3]	3 539	1 008
Usutu to Mhlatuze[4]	4 780	1 192
Thukela	3 799	859
Upper Vaal	2 423	299
Middle Vaal	888	109
Lower Vaal	368	48
Mvoti to Umzimkulu	4 798	1 160
Mzimvubu to Keiskamma	7 241	1 122
Upper Orange	6 981	1 349
Lower Orange[5]	502	69
Fish to Tsitsikamma	2 154	243
Gouritz	1 679	325
Olifants/Doring	1 108	156
Breede	2 472	384
Berg	1 429	217
Total	**49 228**	**9 544**

Source: Department of Water Affairs and Forestry, South Africa. 2006/2007 South Africa Yearbook 23

Notes:

1 - Quantities refer to the water-management area under consideration only (water that originates or is required in that water-management area).

2 - Total volume given, based on preliminary estimates, impact on yield being a portion of this

3 - Includes Komati catchment in Swaziland (mean annual run-off = 517 million m/a)

4 - Includes Pongola catchment in Swaziland (mean annual run-off = 213 million m/a)

5 - Includes contributions from Sengu and Caledon rivers in Lesotho (mean annual run-off = 4,765 billion m/a)

8.4.5.6 Closing the water cycle

Conventional water resource management approaches' orientation towards supply has led less use of treated waste water. Water accounts framework includes waste water accounts. Waste water accounts shows the sources of waste water, amount of water treated, its use by sector. This provides an opportunity to increase reuse of treated waste use through incentives and identifying uses that do not require freshwater and encourage those organisations to use treated waste water. Optimal reuse of treated waste water will help close the water cycle. In Botswana, about 20% of treated waste water is reused particularly in landscaping, gardening and irrigation. The remainder is discharged into the environment.

8.4.5.7 Importance of WA in Monitoring and Evaluation

Monitoring and evaluation calls for development of indicators that can be used to evaluate the use and management of water resources. Monitoring and evaluation is important in examining progress made and whether water resource use is meeting the development objectives. It helps to evaluate the impact of water use efficiency in meeting IWRM principles and goals such equitable access to clean water for all groups of society. Water accounts provide a foundation for monitoring and evaluation. The ultimate goal of water accounts is assist in monitoring, management and use water resources.

Monitoring and evaluation, often ignored, is important aspect in sustainable development. Water accounting provides essential indicators for monitoring water resource use and management. The stock accounts show the quantity of surface and groundwater in water administrative level, either at river basin, national or regional levels. For example the groundwater accounts indicate the opening volume, amount of abstraction, rate of recharge and closing volumes in given accounting period. Updating this information over time provides water authorities with a clear view of the sustainability of groundwater resources. For instance, the accounts will indicate the rate of recharge vis-a-vis the rate of abstraction hence appropriate action will be taken if the sustainability of the groundwater resource is compromised.

The major challenge for monitoring and evaluation is general lack of the culture of evaluation and the negative attitude towards it.

8.4.6 Non conventional sources of water supply

With diminishing conventional sources of water supply, IWRM calls for exploitation of other sources of water supply, often referred to as non-conventional sources of water supply. This section discusses some of the non conventional sources of water supply including rain water harvesting, waste water reuse and desalination.

8.4.6.1 Rain water harvesting

Rain water harvesting (RWH) refers to wide variety of interventions to retain and use rain water. The collection and storage strategies include; tanks placed under tops, small dams, and preserving soil moisture. RWH increases available water and the stored water is useful during dry seasons. RWH is not a new concept and different communities have utilised over many centuries.

> *"Traditionally, in Uganda and Sri Lanka rainwater is collected from trees, using banana leaves or stems as temporary gutters; up to 200 litres may be collected from a large tree in a single storm"*
>
> *(www.practicalaction.org)*

Water accounts documents stocks in aquifers, rivers, dams and waste water treatment plants and do not document on-site stocks. In most cases RWH is done on-site in households, for example. However, on-site RWH has indirect benefits such as reducing demand of freshwater resources from aquifers and dams. Build up areas provide an opportunity for large scale storm water harvest with a potential for direct benefits. An example of storm water harvesting with a short period payback on invested capital is shown on figure 2.

Figure 2: Storm water harvesting in Orapa (Botswana)

Diamond mines in Botswana are located in water-scarce areas. Orapa and Letlhakane Mines in central Botswana commissioned a 1MCM storm water dam. Orapa Township is mostly paved providing an advantage to harvest rainwater from roof tops and running water. The collection dam is 350, 000 cubic metres while the transfer dam is 650, 000 cubic metres. The cost of the project is P58million (equivalent to about USD 8.1million) and has the project potential to recover the total project cost in about two years. In its first year, the project generated total cost benefit amounting to P38, 917, 633 (USD 5, 440, 685).

Source: Mmegionline, Vol. 27 No.73, Tuesday 18th May 2010

Choosing a rain water harvesting methods involves several considerations such as the cost of the facility and installation, amount and intensity of rainfall, and per capita requirements. For instance, individual households may find purchasing a storage tank not cost effective particularly in areas with reticulated water supply. Therefore, public investment into RWH may require subsidies.

RWH is important in reducing peak runoffs that may result in flooding and maintain soil moisture reduces soil erosion. It is important in augmenting available water resources thus reducing pressure on existing freshwater resources. In Japan and South Korea, RWH is used to reduce vulnerability of community during disasters, for example earthquakes, as in most cases disasters lead to disruption in water supply.

RWH can be encouraged through public education and awareness raising campaigns and providing subsidies when purchasing and installing water tanks, for example. Rain water harvesting can also be encouraged through legislative reforms particularly buildings regulations can be developed to provide for rain water storage facilities. This requires political support because legislative reforms are often tedious and time consuming exercise.

"the rainwater harvesting interventions are not widely recognised in water policy or in investment plans, despite the broad base of cases identifying multiple benefits for development and sustainability. By introducing policies recognising the value of ecosystem services and the role of rainfall to support these systems, rain water harvesting emerges as a set of interventions addressing multiple issues on human well-being and improved ecosystems services. The extensive interventions of rainwater harvesting in for example India, China, Brazil, and Australia have occurred where governments and communities jointly make efforts in enabling policies and legislation, together with cost-sharing and subsidises for rainwater harvesting interventions"

Source: UNEP/SEI (2009), Rainwater harvesting: A lifeline for human well-being, A report prepared for UNEP by Stockholm Environment Institute

8.4.6.2 Waste water reuse

Treated waste water reuse has been usually confined to reuse for agricultural purposes. To a certain extent treated waste water has been indirectly used for potable uses as most of the treated effluent is discharged into natural water courses hence end up recharging aquifers or downstream water source used for drinking and for environmental requirements. During this time it loses its identity as waste water.

Reclaimed water is widely used for aquifer recharge, during which time it loses its identity as sewage water. Water Factory 21 in Orange County, California, is a prime example, where reclaimed water is injected into the aquifer to prevent saline intrusion into the fresh water aquifer. This water ultimately re-enters the drinking water stream in an indirect manner (du Pisani, 2005)

The increased demand for fresh water has led to the realisation that waste water provides an alternative to fresh water. The technology and case studies of reclamation for potable use exist, the major stumbling block to harness this resource is public perception to reuse of waste water for potable uses.

"Water should be judged not by its history, but by its quality" (Dr L. Van Vuuren, pioneer of water reclamation (du Pisani, 2005)

The advantage of waste water is that it is available where demand is and there is no need for water transfer. The supply of waste water is growing with the development of waste water treatment plants (WWTP) and the major challenge is to treat it properly.

The water accounts document waste water. Waste water accounts indicate the supply, use and stock. The waste water supply accounts show the source of waste water such as industries and domestic sectors whilst the waste water stock accounts indicates the amount stored in WWTP. The waste water use accounts show how the treated waste water is used and the amount discharged into the environment as well as losses in the treatment process.

Figure 3: Case study - Goreangab Reclamation Plant

The world's first direct potable reuse plant was commissioned in 1969 in Windhoek, Namibia. In 1958, the Goreangab Dam (capacity of 3.6MCM) was built and a conventional treatment was constructed to treat water from the reservoir to potable standards. The treatment plant was converted to also treat final effluent from the city's waste water treatment, hence the origin of Goreangab Reclamation Plant. The initial capacity was 4300m^3 a day and the reclaimed water (mainly from domestic and business waste water, with industrial effluent diverted elsewhere) was mixed with water from well field. However, the city and its informal settlements are located in the catchment of Goreangab Dam making the quality of water entering Goreangab reservoir worse than industrial effluent rendering it unfit for reclamation. The Plant was upgraded overtime until 1997 and the capacity was 7500m^3 a day then.

Post 1990 independence, Windhoek experienced population growth of 5% a year. Nearby water resources had been fully exploited, demand management measures have been implemented and extended reclamation was the only remaining alternative. The City of Windhoek constructed a new reclamation plant with a capacity of 21,000m^3 per day next to the old plant. The new plant supplies 35% of daily potable requirement of Windhoek.

It is important to monitor quality in order to retain public confidence. The quality of water is continuously monitored through on-line instrumentation and composite samplers after every step process. In case a parameter is exceeded, the plant goes into recycle mode and the water is not delivered. Reclamation information is widely publicised through print and television.

Source: du Pisani (2005)

GWP encourages adoption of an inclusive approach that takes into account the whole water cycle; the water resources available and water supply, treatment, and reuse options. It is vital to consider the following:

- Incorporate wastewater reclamation and reuse into sustainable development, climate change adaptation and integrated water resources management strategies.
- Consider the various reuse options from the outset in the design of treatment plants, as well as in their operation, and define corresponding standards.
- Ensure that guidelines and policies encourage communities to determine the most appropriate and cost-effective wastewater treatment solutions based on local capacities and reuse options – rather than imposing solutions or severely limiting them through overly strict regulations
- Ensure financial stability and sustainability by;
    - Linking waste management with other economic sectors for faster cost-recovery, risk reduction
    - and sustainable implementation.
    - Developing mixed public/private, public/public sector solutions for investment, service delivery,
    - and operation and maintenance.
    - Considering social equity when defining cost-recovery mechanisms.

Source: GWP-TEC Technical Brief 10, Managing the other side of the water cycle: Making waste water an asset

8.4.6.3 Desalination

Some areas (e.g. coastal areas) may have abundant water resources but the quality of such water may render it unusable and in most cases the water is salty. About 97% of planet water is salty and unusable for industrial or domestic purposes. The salty water goes through desalination to improve the quality. Desalination is a process of removing salt (sodium chloride) and other mineral from brackish water to produce potable or drinkable water. Desalination is not new concept but has been available for many years. Desalination plants exist in the SADC region: The Trekkopje plant in Namibia and Sedgefield plant in South Africa.

> *"16 billion gallons are produced daily by the world's 14,450 desalination plants' (National Geographic, April 2010, Vol 217, No 4.)*

There is a variety of desalination methods used around the world (Table 7). Improved technology has led to the reduction of the cost of desalination. However, energy prices to a great extent take the bulk of the cost of desalination and reducing energy cost is important.

Table 7: Desalination methods: Existing and upcoming

Methods		Brief description
Existing methods	Brute-force distillation	Brackish water is heated until it turns to steam, leaving its salt behind and then it is condensed
	Reverse osmosis	Water is forced through a membrane that catches the salt. Pumping water to pressures of more than a thousand pounds per square inch takes less energy than boiling it.
Upcoming methods	Forward osmosis	Water molecules migrate by natural osmosis, without energy input, into a more concentrated “draw solution” whose special salt is then evaporated at low-grade heat.
	Carbon nanotubes	An electric charge at the nanotube mouth repels positively charged salt ions. The charged water molecules slip through with little friction, reducing pumping pressure.
	Biomimetrics	Water molecules pass through channels made of aquaporins, proteins that efficiently conduct water in and out of living cells. A positive charge near each channel’s center repels salt.

Source: National Geographic, April 2010, Vol 217, No 4

Figure 4: Case study: Desalination in Cyprus

Cyprus is a water scarce island in the Mediterranean Sea with a population of 1 million people. Water scarcity is caused by population increase, tourism growth, mining of groundwater, recurring droughts and climate change. Cyprus opted to undertake desalination because it was more effective and faster to augment water supply as compared to other measures such as effluent reuse which requires long term planning (Tsiourtis, 2004). There are three existing desalination plants using the reverse osmosis method:

The combined total water demand for the provinces of Nicosia, Larnaca, Famagusta and Limassol is 72.3 MCM/year and the minimum yearly production from desalination plants is 46.9 MCM/year. Therefore, the three desalination plants contribute 65% of potable water demand in the three provinces. Desalination is beneficial for agriculture and urban water supply. The average power consumption for the three plants is 4.5 Kwh per cubic metre or 213.8 million Kwh per year. The selling price of water for Dhekelia, Larnaca and Moni is €0.82, €1.08 and €1.39 per cubic metre, respectively. The price of water is high and varies significantly amongst three plants. With regards to funding the Dhekelia and Larnaca plants were constructed through self finance method. The contract is the Build, Own, Operate and Transfer type. The contract uses own funds to design, build and operate the plant for ten year fixed period. The Government is committed to buy a minimum quantity of desalinated water over the ten year period. After ten years, the Plants become property of the Government.

Desalination plants in Cyprus

	Dhekelia	Larnaca	Moni
Start of Production	20th May 2007	12th July 2001	22nd December 2008
Period	20 years	10 years	3 years
Capacity/day	60.000 m^3	62.000 m^3	20.000 m^3
Minimum daily Production (m^3)	54.000 m^3	55.800 m^3	18.000 m^3
Minimum yearly Production (m^3)	19.77	21.4	6.57
Quantity m^3 2009	19.62	20.66	6.59
Production costs (€) 2009	16.182.449	22.278.970	9 039 656
Selling price/m^3	€0.82	€1.08	€1.39

Other new desalination plants in Cyprus include; New Limassol plant with capacity of 40,000m^3 a day with a period two and half years, Mobile Unit at Paphos capacity of 30,000m^3 a day, two year Vasilikos Plant with a capacity of 60,000m^3 a day and New Desalination Plant at Paphos with a capacity of 40,000m^3 a day.

Source: www.moa.gov.cy (March 2010)

The major concern with desalination plants is the possible rise in energy costs. A challenge is the impact on the environment. The plant water intake may have long term effect due to removal of small life forms such as plankton, eggs and fish larvae (Dickie, 2007). Desalination process requires high volumes of energy and this result in emission of greenhouse gases. Brine and other chemicals, by-products of, desalination plants are discharged into the sea and their accumulation can affect marine life through elevated levels of salt, for instance. In Cyprus, this impact is said to be negligible (www.moa.gov.cy, March 2010).

8.4.7 IWRM mainstreaming into development planning

Water resources are an integral part of development planning. The successful implementation of sustainable management of water resources is important for social and economic development. The implementation of IWRM is important for achieving Millennium Development Goals (MDGs). Improved access to water and sanitation is one MDGs and this is cross cutting because achieving this goal will lead to achieving other goals such improved access to education and health. Poverty eradication in rural areas is linked to equitable access to water and land resources.

The problems encountered by developing countries in both planning and implementation of IWRM approaches include the lack of political will to seriously engage in water policy change, financing and national resource allocation for water related development , awareness of water issues, weaknesses related to human and institutional capacity, and discontinued support programmes.

8.4.7.1 Millennium Development Goals (MDGs)

Improved access to water and sanitation is one of the MDGs. Efficient use of water is required to attain MDGs and access to water is linked to other MDGs as water is essential for economic growth, empowerment of women, hunger reduction, alleviation of extreme poverty, and ensuring environmental sustainability (Table 8). Environmental sustainability is threatened in water scarcity areas as water for the ecosystem is often preceded by other needs. Therefore, reducing water scarcity is vital for attaining environmental sustainability.

Table 8: How achieving water efficiency affects attainment of some MDGs

MDG	Link to improved water efficiency
Eradicating extreme poverty and hunger	Access to water for domestic and productive uses (agriculture, industry, and other economic activities), has a direct impact on poverty and food security. Improved access to water increases the capacity of the developing countries to produce cheap food with positive impacts on nutrition in urban and rural areas.
Promoting gender equality and empowering women	Improved access to water would reduce time spent looking for water hence the time can be used in other productive activities Access to water has important gender related implications, which affects the social and economic capital of women in terms of leadership, earnings and networking opportunities.
Reducing child mortality and improving maternal health	There are 4 billion estimated cases of diarrhoea each year, causing 2.2 million deaths (5 000 every day), mostly of children under the age of five often related to poor access to safe water. Improved nutrition and food security reduces susceptibility to diseases.
Ensuring environmental sustainability	Increasing the efficiency of water use and enhancing agricultural water productivity at all levels of the production chains will free some water for maintaining cosystems integrity. Investment into non-conventional water sources such as treatment and reuse of waste water will reduce the need freshwater and some of the can be used to recharge aquifers.

Source: adapted from Un-Water 2007, Coping with water scarcity, challenge of the twenty-first century

In order to achieve the MDGs through implementation of IWRM plans, GWP suggest that the IWRM plans should aligned to MDG time frame that has 2015 deadline. It is important to identify MGD-related water resource management priorities. A roadmap should have clear timeframes and associated targets. The UN Water and GWP suggest roadmaps could have MDG-linked indicators, monitored every three years: 2009, 2012 and 2015. Specific set of indicators with associated themes are suggested as follows:

- 2009: Focus principally on reviewing the extent to which key enabling conditions for the implementation of national IWRM priorities have been addressed. Note progress on specific IWRM change processes and the realization of the water-related MDGs
- 2012: Focus principally on reviewing the progress of specific IWRM change processes. Note progress on enabling conditions and the realization of the water-related MDGs
- 2015: Focus principally on assessing the extent to which improving water management through IWRM has successfully contributed to the implementation of the MDGs. Note progress on enabling conditions and on specific IWRM change processes (UN Water and GWP, page4).

8.4.7.2 World Summit for Sustainable Development (WSSD)

The 2002 Johannesburg Summit for Sustainable Development (WSSD) identified five key areas of actions that are all linked to water scarcity; water, energy, health, agriculture and biodiversity. Furthermore, the issues raised at the Summit, including poverty eradication; changing unsustainable consumption and production patterns; and protecting and managing the natural resources base of economic and social development, require attainment water use efficiency. Countries had committed themselves at the WSSD to prepare IWRM water efficiency (IWRM/WE) strategies by 2005. Un-Water 2008 survey of shows that 38% of developing countries have IWRM/WE strategies and recommends prioritisation of water efficiency interventions and to develop a set of indicators to monitor progress with implementation.

8.4.7.3 Development plans

Water is a key ingredient in social and economic development. Therefore, planning and development of water resources should be linked to a country’s national development plans. Social and macro-economic policies are often the drivers of change in water management and use (GWP Policy Brief). There is need for policy planner and makers outside the water realm, such as trade and agriculture sectors, to take into account the effect of their economic activities on water demand. For example Chile has macro-economic policies have created an enabling environment for water development and conservation (refer to Figure 5).

Figure 5: Impacts of macro-economic policies on water use efficiency in Chile

Chile adopted a development model in 1970s based on reducing inflation and foreign debt, strengthening the market role in water resource allocation and opening market for imports and exporting of goods. This has led to a surge in private-sector-led exports of new products such as copper, fresh fruit, wood pulp, lumber, salmon, and wine. These products were worth US$12.1 billion in 2001. All of these products use large volumes of water in their production processes hence increasing demand for water and putting pressure on water resources.

This situation was addressed through improved water efficiency. The agricultural sector water efficiency was improved through better irrigation systems the 1986 Law was revised to include specific provisions for poorer farmers. This has led to a sharp increase in on farm water efficiency and agricultural production rose by US$353 million. Efficient use of water in agriculture freed water to other sectors and for safe guarding the environment. In water scarce areas, increased water prices forced the mining sector to improve its water use efficiency threefold in two decades whilst water use in wood pulp production has fallen by 70% per ton produced. In addition, macro-economic policies to improve cost recovery have caused household water consumption to fall by 10%, in reaction to a 38% increase in domestic water supply charges between 1998 and 2002. This reduction in water consumption was achieved without compromising access to water by the poor, who were granted subsidies – an important principle of IWRM.

A lesson from the Chile is that policies can have both positive and negative effects on water that can vary greatly between different sectors and geographical areas, and can manifest themselves at different times. Therefore, the development of water resource management in Chile shows that IWRM strategies must be adaptable and dynamic, not fixed and inflexible.

This case study (figure 6) is based on the GWP Southern Africa IWRM Status and Survey Report of 2009. It focuses on IWRM planning from broad perspective of planning.

Figure 6: Case study: Situational analysis of national IWRM planning in SADC

There are many approaches to developing water strategies or plans and one of the approaches is developing national water master plan. The other notable approach is aligning water resource plans to national development plans. National development plans clearly spell out water management plans and the only hurdle is implementation of the plans.

South Africa, Mozambique and Zimbabwe were the first to reform their water laws whilst Angola and Swaziland appear static regarding legislative reform. However, the Swaziland Water Act encompasses the principles of IWRM. Botswana uses Water Act of 1968 but has a draft National Water policy and Malawi developed a new policy in 2005 which is yet to be formalised.

Botswana uses the Botswana National Water Master Plan Review of 2006 which provides a guiding framework for water resource management and IWRM. This study is an initial stage of developing IWRM/WE plan for Botswana. The National Development Plan 10 water issues and their implementation are modelled or are aligned to the BNWMP Review. Lesotho is yet to formalise its 2008 Water Act and has developed the Lesotho IWRM Road Map Lesotho Water Partnership takes the lead in plans to develop IWRM implementation plan. In 2008, Malawi finalised its IWRM/WE plan and it is yet to be endorsed by cabinet. However, the implementation plans are in the national budget indicating government's commitment to fostering IWRM. In Mozambique, the focus is on developing the national water master plan after completing the National Strategy for Water Resources Management in 2007. In South Africa National Water Resources Strategy (NWRS) shows how IWRM will be achieved. Catchment Management Areas are required to develop catchment management strategies in line with the NWRS. Swaziland is in the process of developing the Integrated Water Resource Master Plan after the development of a Water Resources Master Plan was combined with the formulation of the IWRM plan. This was done because the two processes were undertaken at the same time.

Source: Pegasys, 2009

8.5 IWRM in SADC

The integrated development and use of water resources in the SADC is seen as a basis for economic integration, development and eradication of poverty. The SADC Regional Water Policy framework is anchored on; the SADC Declaration and Treaty, The Southern Africa Vision for Water, Life and Environment, Revised SADC Protocol on Shared Watercourses, and The principles of IWRM. IWRM is an adopted approach and is central in the Conceptual Framework for Regional Water Policy Development. The development and existence of the Regional Strategic Action Plan for Integrated Water Resource Development and Management in the SADC Countries reaffirms the important of IWRM in SADC.

Transboundary water resource allocation and benefit sharing

It is estimated that 70% of the water resources in the SADC region are shared by two or more countries and this provides an opportunity for cooperation, poverty reduction and regional integration. Within the SADC region, the SADC Protocol on Shared Watercourses is the primary legal instrument guiding cooperative use of shared rivers. There is no internationally accepted criterion for allocating shared water resources and their benefits. Benefit sharing and resource allocation are intertwined and the major challenge is their determination. Water accounts can be used to assist the process of determining benefits in a particular basin as they deal with allocations. They also indicate the value added by different uses.

> *"The Regional Water Policy will be implemented through a Regional Water Strategy. An important vehicle for implementing the policy is the existence of well functioning river basin organisations established particularly on shared water courses, operating under sound legislation, and systems for planning and stakeholder involvement, and embracing the IWRM principle"(SADC Regional Water Policy)*

8.6 Policy implications

The SADC Regional Water policy (RWP) identifies objectives and tools for enabling water development and management. These include development, capacity building, stakeholder participation, information management, integrated planning, conflict resolution and environmental management. The IWRM approach provides the linkage between tools. The SADC member states should harmonise their policies with those of the regional policy.

The national development policies and priorities should take into account the implications of development projects and programmes on water resources. Therefore, it is important to ensure water planning and strategies are fully integrated into broader social, economic, and environmental goals.

Water accounts can offer guidance to investments in the water sector. For example, the accounts provide information about the level of water losses and re-use/ recycling of treated wastewater. If losses are high and re-use/ recycling is low, countries should seriously consider investments in these areas rather than building expensive water supply augmentation schemes.

Countries have committed themselves to developing the IWRM/WE plans at the 2002 WSSD. Currently, SADC member states are at different stages of developing and implementing IWRM/WE plans. It is important for member states to prioritise water efficiency interventions and to develop a set of indicators to monitor their implementation progress. Water accounts can provide such indicators (e.g. in hybrid accounts).

There is no internationally accepted criterion for allocating shared water resources and their benefits. The water accounts can be disaggregated to transboundary shared river basin level and could assist river basin organisations in management and allocation of benefits amongst riparian states.

8.7 Summary

At national level SADC member states should harmonise their policies with those of the regional policy. Efficient use of water, one of the principles of IWRM, is vital to achieving the MDGs and countries should speed development and or implementation IWRM plans.

The SADC countries are at different stages of developing and implementing IWRM plans. Some countries are National Water Master Plans that incorporate IWRM principles whilst others are reviewing water legislation. Water accounts are important for policy makers and implementation of IWRM because water accounts show the trends in water production and consumption thus providing an opportunity for water demand management plans. Water accounts also indicate value added by economic sector and this is important for improving allocative efficiency. The countries such as Botswana, Namibia and South Africa have developed water accounts. This provides opportunities for comparisons and sharing of good water management practices. In addition, water accounts can be disaggregated to transboundary shared river basin level and could assist river basin organisations in management and allocation of benefits amongst riparian states.

8.8 Glossary of Terms

IWRM	"a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP)
Water accounting	is a component of Natural Resource Accounting (NRA) which shows water resources at different water administration levels indicating the source of water, where it is going, how it is used and how much remains.
Water efficiency	is the optimal use of a country's water resources through creating a balance between water for economic growth and water for basic needs as well as water needed for maintaining the integrity of the ecological system.

8.9 References and Resources for further reading

8.9.1 Websites

http//www.gwpforum.org

http//www.gwptoolbox.org

http://www.iwmi.cgiar.org/waterpolicybriefing/index.asp

www.unwater.org

www.fao.org

http://www.waternetonline.org

8.9.2 Articles

GWP, Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies, Produced by the Global Water Partnership (GWP) Technical Committee with support from Norway's Ministry of Foreign Affairs.

8.9.3 References

Bird J., Arriens W. L. & Custodio D. V. (2009) Water Rights and Water Allocation: Issues and Challenges for Asia, Asian Development Bank, Mandaluyong City, Philippines.

Crystal Davis, 2007, November 2007 Monthly Update: The Multiple Dimensions of Water Scarcity, Water Resource Institute website.

du Pisani P. L 2005. Direct Reclamation of Potable Water at Windhoek's Goreangab Reclamation Plant, *Integrated Concepts in Water Recycling (2005)* -S.J. Khan, A.I. Schäfer, M.H. Muston (Eds). Namibia

GWP Policy Brief 2, Water and sustainable development: Lessons from Chile

GWP southern Africa 2009, IWRM Survey and status report; summary, Pegasys April 2009

Journal of the National Geographic Society, April 2010, Vol 217, No 4

Lange G. 2003, Policy applications of Environmental Accounting, Environmental Economic Series paper no. 88, The World Bank Department, USA.

Mei Xie, 2006. Integrated Water Resources Management (IWRM) – Introduction to Principles and Practices, World Bank Institute (WBI).

SADC, Regional Strategic Action Plan for Integrated Water Resources Development and Management in the SADC Countries (1999-2004), SADC Water Sector Coordinating Unit.

SADC 2006, Regional Water Policy, Infrastructure and Services Directorate, Gaborone.

SADC 2007, Regional Water Strategy, Infrastructure and Services Directorate, Gaborone.

UNEP/SEI 2009. Rainwater harvesting: A lifeline for human well-being, A report prepared for UNEP by Stockholm Environment Institute, UENP/SEI.

Un-Water 2007. Coping with water scarcity, challenge of the twenty-first century

WWF's Global Freshwater Programme 2007. Making water - Desalination: option or distraction for a thirsty world? Prepared for WWF's Global Freshwater Programme by Phil Dickie.

www.gwpforum.org

www.gwptoolbox.org

www.moa.gov.cy (presentation by Andreas Manoli, Water Development Department, Ministry of Agriculture, Natural, March 2010)

www.waterrating.gov.au

8.10 Exercises

Short Exercises

After introducing the concept of IWRM (under section 8.2.1) use the following questions to discuss the principles of IWRM. The objective is to share participants' experiences on the principles and IWRM challenges:

- What are the three most important IWRM challenges in your country/ river basin?
- How are these challenges being addressed and what has been the result to-date?
- How could EAWU assist in addressing the challenges?
- Are the IWRM principles implemented in your country/ river basin?
- Which of the principles do you consider successfully implemented and why?

After section 8.2.5.3 spend 5 minutes to get feedback on the percentage of water losses experienced by service providers.

Group discussion (10 minutes for discussion and 15 minutes for reporting back)

After completing Section 8.2.5.3 (Water efficiency) divide participants into 5-7 participants/group to discuss water allocative efficiency based on the following questions:

- Which sectors or users are allocated large share of water resources?
- What is their contribution to the national economy?
- How do we ensure that the principles of water as a social and ecological good are achieved?

8.11 Notes to the Facilitator

About this Module

This module is designed to address the training needs of technical staff to mid level staff of Departments of water, environment, statistics and agriculture; water utilities; municipalities and other institutions interested or engaged in compilation of water accounts. This module facilitates an interactive exchange of opinions, perspectives and experiences of participants on the IWRM and water accounting concepts and demonstrates the importance of WA in promoting and achieving IWRM. You can allow for substantive discussion and encourage active participation by way of role playing.

The module is intended to increase our understanding of the IWRM implementation and to explore ways to achieve water efficiency. Achieving water efficiency will reduce water scarcity which in turn will help SADC countries achieve MDGs. Water efficiency refers to the way we manage, allocate and use our water resources. In order to improve management of water resources, the first step is to understand our water resources and this can be achieved through water accounting. Water accounting presents a comprehensible picture of water resources at different water administration levels indicating the source of water, where it is going, how it is used and how much remains. The detailed construction of water accounts at national and transboundary levels is dealt with in Module Three. Therefore, on completion of this module, participants will be able to:

- Understand the importance of water accounting in achieving IWRM
- Identify water inefficient sectors in their countries
- Understand the link between water resources and national development planning

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. In addition, study the other manuals to appreciate the role of water accounting as parts of EAWU.

Facilitation

The module is designed for face-to-face facilitation. The duration is **approximately 2.5 hours.** This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator would need to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver this module.

The group exercise is described in section 8.7. Ask participants in advance to bring relevant material from their country or river basin. The comparison between countries and river basins is an important and highly instructive element of the group work.

Be sure to clarify the objective of the training and describe the agenda at the start of the session. This gives structure and direction to what you intend to do. This module brings together information generated from the other water accounts, therefore it is important to emphasize this linkage at the start.

Participant Evaluation

An evaluation questionnaire should be provided to allow participants assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your Feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to jarntzen@car.org.bw

Module 9

Policy Uses and Application of Economic Accounts for Water

Goal

The goal of the module is to highlight useful information and indicators from the Economic Accounts for Water and how they can inform policy decisions and analysis

Learning Objectives

At the end of the module participants should be able to:

- Identify useful monitoring and evaluation indicators from the Economic Accounts for water
- Identify statistics that can be used for detailed economic analysis from the accounts
- Appreciate relevance of the accounts in policy making process
- Appreciate use of accounts in economic analysis

Module Structure

The module is structured as follows:

1. Module Summary
2. Introduction
3. Indicators and descriptive statistics used for monitoring and evaluation
4. Detailed statistics used for policy analysis
5. Group exercise
6. Note to facilitator

9.1 Module Summary

The Module focuses on the policy uses of water accounts with examples drawn from countries that have compiled the accounts. The water accounts, like other environmental accounts and the economic accounts, provide (i) indicators and descriptive statistics for monitoring and evaluation, and (ii) detailed statistics for policy analysis. Section 9.2 introduces the Module. In Section 9.3 a description of the most common indicators used to evaluate the current patterns of water use and supply, and pollution is given. The Section begins with macro-level indicators that provide 'warning' signs of a trend that may be unsustainable or socially undesirable, often at the national level. It then progresses to more detailed indicators and statistics from the water accounts that shed light on sources of pressure on water resources, opportunities for reducing the pressure, and contribution of economic incentives (such as pricing) to the problem and possible solutions. This information sets the stage for analysis of more complex water policy issues, mostly based on economic models that incorporate the water accounts in Section 9.4. The Section demonstrates how the water accounts can be used for several critical policy issues such as projecting future water demands or estimating the impact of different water policies like water pricing reform. The module is to a large extend based on information contained in the SEEAW Manual (UNSD, 2005)

9.2 Introduction

Water resources are under pressure from ever-increasing demand for human activities, contamination from pollution, increasing incidence of water-related disease, loss and degradation of freshwater ecosystems, and global climatic change that affects water supply and demand. As the limits of domestic water resources are reached, countries are increasingly dependent on shared international water resources, raising the potential for conflict. These concerns affect both industrialized countries with highly developed water and sanitation infrastructure as well as developing countries where many people still do not have access to basic services. SADC is no exception. Social disruption, premature death and lost productivity from water-related illness impose a heavy cost on developing countries.

Under these growing pressures, water management has become increasingly difficult. Most of water statistics in the region focus on hydrology and water quality but does not pay much attention to economic and social aspects (e.g. SADC HYCOS). However, some critical policy questions require linking data about water with economic data, for example:

- The consequences for water resources of economic growth, and patterns of household consumption and international trade
- The social and economic impacts of water policy measures such as regulation, water pricing, and property rights
- The contribution of specific economic activities to pressure on water resources and options for reducing pressure

Economic accounts for water provide a unique tool for improved water management because they integrate data about both the environmental and economic aspects of water supply and use. Their ability to address jointly the environmental, economic, and social aspects of water policy is

Central to Integrated Water Resources Management (IWRM), a widely accepted approach to water management in the SADC region. This ability is also central to monitoring attainment of MDGs related to water access and sanitation. Water accounting has a unique contribution to make to IWRM because it is the only approach that integrates economic accounts with accounts for water use and supply in a framework that supports quantitative analysis. Water managers often have information about water use by broad groups of en users, but this data cannot be easily used for economic analysis because the classification of end-users rarely corresponds to the classification of economic activities used for the national accounts. The water accounts, in contrast to other water databases, links water data (use, supply, resources, discharge of pollutants, etc.) directly to economic accounts. They achieve this by sharing structure, definitions and classifications with SNA; water suppliers and end-users are classified by the same system used for the economic accounts, the ISIC.

From the foregoing discussion, water accounts provide two broad categories of information:

(i) Indicators and descriptive statistics for monitoring and evaluation
(ii) Detailed statistics for policy analysis

9.3 Indicator and descriptive statistics for monitoring and evaluation

The first step toward improved water management is usually to obtain a good understanding of current patterns of use, supply and pressure. Descriptive statistics and indicators from the accounts provide the following information:

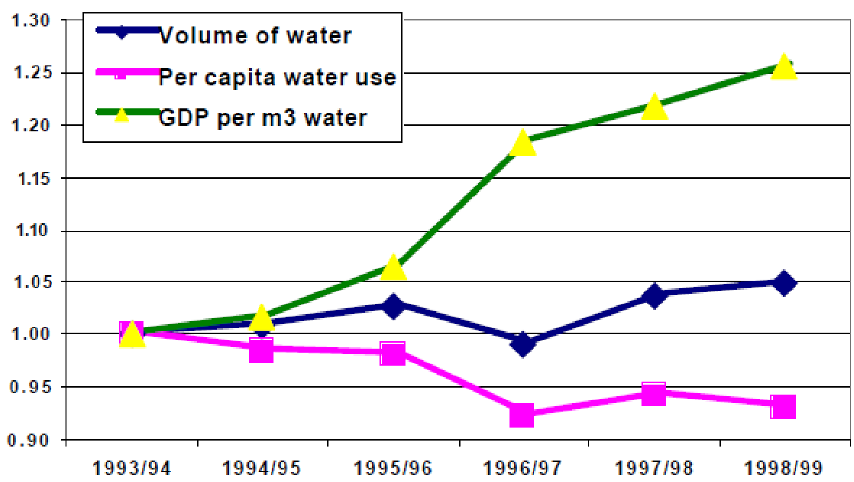
- Sources of pressure on water resources - how much does each sector contribute to particular environmental problems, such as overexploitation of groundwater or water pollution
- State of the water resources - what is the quality status of the different water bodies and, what is the proportion of water resource under threat of degradation or on the way to recovery? Are measures effective and appropriate?
- Opportunities for improving water productivity - Is water being allocated to the highest value users? What opportunities exist to increase water efficiency and productivity? How extensive are losses?
- Appropriate pricing policies - Are water providers achieving full cost recovery? Is pricing equitable across different users? Do pricing policies provide incentives for water conservation and pollution prevention, or do they encourage excessive use of water resources?

9.3.1 Sources of pressure on water resources

Although the accounts are compiled at the single time period, i.e. a year, time trends give useful indicators for evaluation and monitoring. Simple time trends of total water use and pollution reveal changing pressure on water resources and indicators of 'decoupling,' that is, separating economic growth from increased use of resources. For example, in Botswana, per capita water use and water productivity (measured by GDP per cubic meter of water used) both declined from 1993 to 1998, so that the volume of total water use increased only 5% (Figure 9.1) even though GDP grew more than 25%. For a water scarce country, this is a positive trend.

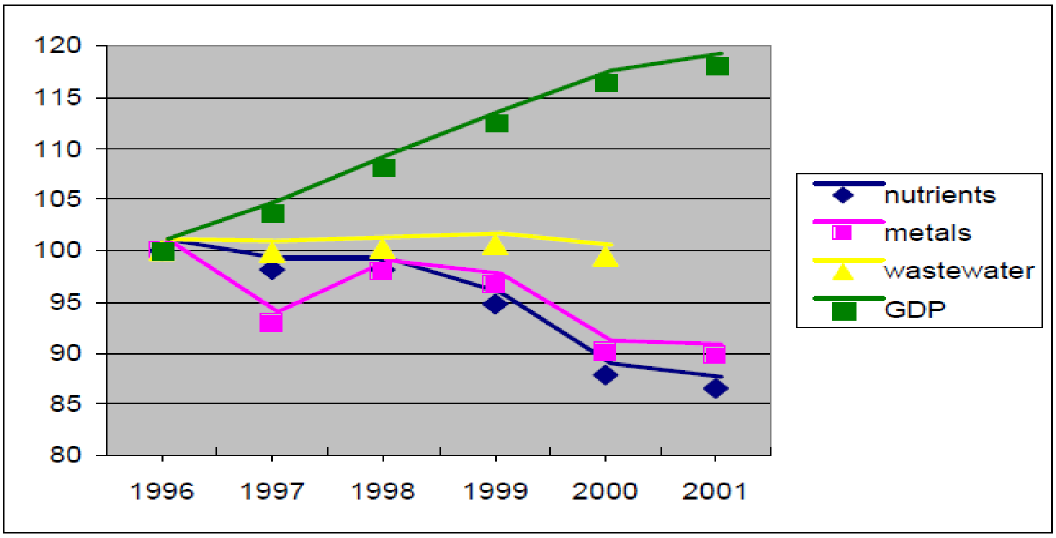
Statistics Netherlands constructed a similar set of indicators for wastewater and water pollutants (nutrients and metals) over the period 1996 to 2001 (van der Veeren at al., 2004). Even though GDP has grown considerably, the Netherlands managed to reduce the volume of water pollutants substantially (Figure 9.2). To assess the pressure on water, either as a source or a sink, these trends must be evaluated against water availability in specific places and seasons. Seasonal accounts are not yet constructed and their framework has net yet been developed.

Figure 9.1: Index of water use, population and GDP in Botswana, 1993 to 1998 (1993 = 1.00)



Source: Based on Lange et al., 2003

Figure 9.2: Index of growth of GDP, wastewater, and emissions of nutrients and metals in the Netherlands, 1996 to 2001 (1996 = 1.00)



Source: Figure 25, van der Veeren et al. (2004)

Even at the macroeconomic level, the water accounts typically make further distinctions based on characteristics of water to provide a more thorough and useful assessment of trends; some of the most common characteristics include:

- Volume of water used disaggregated by purpose such as cooling, industrial process, cleaning, etc. This is useful for identifying the potential for water conservation and improvements in water efficiency. Statistics Denmark, 1999).
- . Volume of water provided by water utilities through 'mains' compared to self-extracted and reuse of water. This distinction is important because in some countries there are significant differences among these sources in terms of water regulations, the capacity for monitoring may differ, and investment strategies for the future are affected by the source of water
- Volume of water by natural source. Overexploitation of groundwater, for example, may be a critical issue in some countries so water managers need accounts that identify trends in groundwater abstraction and the users of groundwater. Similarly, it may be very useful to identify use of water from shared international water resources when allocations from such resources are restricted
- Similar measures can be compiled for wastewater (e.g., shares that are treated and untreated) and pollution
- Status of water bodies by catchment and size class, leading to apportioning causes between point, non-point, domestic, and other sources. Identifying the roles of different sources allows identification of sound investment in corrective measures.

9.3.1.1 Comparing environmental and socio-economic performance of industries

The indicators discussed above provide an overview of the relationship between economic development and water use, but information about water use at the industry level is required to understand the trend and prioritise actions. Environmental-economic profiles are constructed to compare the environmental performance of industries, or individual companies within an industry, among each other and over time. These profiles include indicators that compare the environmental burden imposed by an industry to the economic contribution it makes. For a simple water profile, an industry's environmental burden is represented by its share of water use and/or pollution generated, and its economic contribution is represented by its share of value added. Water profiles may be used for "benchmarking" industry performance in order to promote water efficiency and water conservation. Table 9.1 shows water profile for Namibia and Figure 9.1 shows environmental-economic profiles for some Swedish industries.

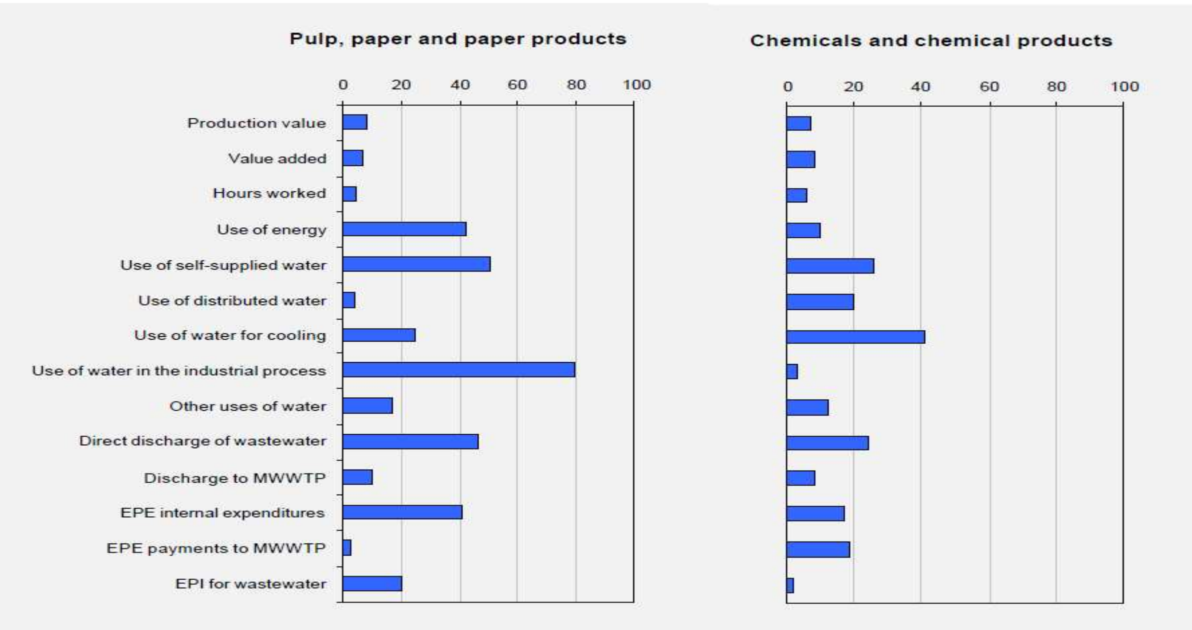
Table 9.1: Water profile for Namibia, 1997 to 2001

(Namibia $ of value-added per m3 of water use, constant 1995 prices)

	1997-98	1998-99	1999-2000	2000-01	2001-02
Agriculture	5.5	5.6	5.5	5.2	4.5
Commercial Crops	0.8	0.8	0.7	0.8	1.0
Commercial Livestock	18.5	18.6	19.2	22.2	20.9
Traditional agriculture	7.5	8.4	8.1	6.2	4.6
Fishing	14,352.5	1,573.9	936.2	983.3	991.3
Mining	130.3	132.9	172.1	174.4	167.0
Manufacturing	227.7	205.9	228.5	223.9	226.6
Services	547.7	535.9	582.7	590.2	575.3
Government	211.1	211.8	236.7	216.6	234.2

Source: Based on DWA (2005) and Lange (2006)

Figure 9.1: Environmental-economic profiles for some Swedish industries, 1995



Another important indicator in developing water use profiles for countries in water intensity. A country's water use or pollution depends on several factors: size and structure of the economy, technology, and population. Size is indicated by total GDP, structure by each industry's share of GDP, and technology by water intensity of each sector. Table 9.2 shows the distribution of water use by industry in Namibia and the water intensity of each industry. The Table shows that in 2001-2002, Commercial crop farming accounted for 43% of total water use and had a "water intensity" of 327, that is, Commercial crops require 327 litres of water to generate a dollar of output. Within the agricultural sector, water intensities vary a great deal; commercial livestock farming has water intensity of only 18 litres per dollar of output. As in most countries, Agriculture is the most water-intensive sector; all other sectors are an order of magnitude or more lower in water intensity.

Table 9.2: Water intensity and total domestic water requirements by industry in Namibia, 2001-2002

	Percent of water use	Water intensity (direct): Litres/N$output	Total domestic water requirements: litres/N$ output
Commercial crops	42.5%	326.56	350.7
Commercial animal products	9.0%	17.55	35.7
Traditional agriculture	23.1%	117.7	156.8
Fishing	0.2%	0.04	21.8
Mining	2.5%	0.96	16.9
Meat processing	0.5%	1.29	31.5
Fish processing	0.3%	0.72	18.6
Grain milling	0.1%	0.26	33.6
Beverages and other food processing	0.4%	0.42	27.4
Other manufacturing	1.4%	0.68	1.24
Electricity	*	0.17	16.3
Water	*	0.19	18.4
Construction	0.1%	0.10	31.9
Trade; repairs	0.7%	0.38	22.0
Hotels and restaurants	0.6%	1.26	21.7
Transport	0.2%	0.14	23.7
Communication	0.0%	0.05	15.9
Finance and insurance	0.2%	0.24	22.3
Business services	0.1%	0.11	18.2
Other private services	1.1%	1.95	31.8
Government services	5.0%	1.67	24.3
Households	11.9%	Na	Na
Total	100.0%	Na	Na

Note: Total domestic requirements are calculated from the physical supply and use table (Module 4) coupled with an input -output table. They do not include water embodied in imports.

*less than 0.1%

Na: not applicable

Source: Based on DWA (2005) and Lange (2006)

9.3.2 Potential for increasing effective supply and improving water productivity

Water supply and water productivity are not determined solely by natural conditions and driving forces. The way that water is managed affects the amount of water that can be utilized by end users and the productivity of water. The effective supply of water can be increased by:

- **Increasing water efficiency by individual users -** Domestic water requirements can be met with very different volumes depending on consumer behavior and technology: shower vs bath, toilet flush volumes, improved technology of washing devices, pressure washers, temporized taps, etc. In industrial processes, changes in technology, sometimes very simple, may simultaneously reduce both water use and pollution as well as provide recyclable water. A simple and effective example is the dry recovery of animal droppings in the stall areas of slaughterhouses.
- **Reducing system losses** - Losses can result from leakages due to poor infrastructure maintenance and other causes such as illegal connections, faulty water meters, and so on. In many industrialized countries, losses are fairly low. In Australia, for example, losses as a developing countries, losses can be much higher. Among the 29 municipalities in Namibia's water accounts, 3 had losses between 11-15% of supply in 2001; 12 towns, accounting for 21% of municipal water supply, had losses of 20-39%; and the rest has losses 40% or greater (Lange, 2005).
- **Increasing reuse of water** and use of return flows by directing water to storage or other uses and minimizing pollution and salinity of return flows. Reuse of water has been identified as one of the most cost-effective ways to provide water, and has been increasing steadily in water scarce countries (ABS, 2004).

9.3.3 Water pricing and incentives for water conservation

Water pricing is important for financial sustainability - a system must be able to recover its costs - and also for environmental sustainability because of the incentives pricing provides for resource utilization. Except for the minimum amount of water necessary for human survival, people will generally use less water the higher its price. Conversely, where water prices are low, there is little incentive for conservation. It is not unusual for water scarce countries to subsidize the use of water, even for low-value production in commercial agriculture.

Accounts that would reveal cost recovery - the cost of supply and water tariffs - are not compiled in many countries, or are compiled for only part of water use, mainly because of a lack of data. For water supplied by utilities through water mains, it is usually possible to compile accounts for the average cost of supply, but little data is available for self-abstraction (e.g., Statistics Sweden, 2003).

On the pricing side, municipalities may apply a single price for combined water and wastewater services, making it difficult to estimate the charge for each service. In countries with full-cost recovery (which may be defined differently in each country), the average price should equal the average cost of supply, although it is unlikely to match precisely in any given year, and sometimes researchers use this shorthand method to estimate implicit unit price and supply cost.

9.3.4 Sustainability: comparing water resources and water use

In assessing sustainability of water use, the volume of water use must be compared to the renewable supply of water, based on an assessment of stocks or estimated renewable supply. However, few countries compile water stock and resource accounts that are as comprehensive as their water SUTs. In some countries, water quality is a greater concern than water volume, so stocks that measure volume may not be a high priority. In other countries, water managers recognize the importance of stock accounts, but do not have comprehensive data, particularly for groundwater stocks. An example is provided for Namibia in Table 9.3. For informed decision making, water management requires similar figures at a more spatially disaggregated level within water management areas.

Table 9.3: Water use in 2001 compared to estimated availability of water resources in Namibia

	Estimated long term available water resources* (Mm3 per annum)	Water use, 2001 (Mm3)
Dams on ephemeral rivers	100	85
Perennial rivers	170	90
Groundwater	159	106
Other (recycled)	8	1
Total	**437**	**282**

*Based on currently installed capacity

These figures are obtained from water asset accounts (Module 2) and physical supply and use tables (Module 4)

Source: Department of Water Affairs (2005)

9.3.5 Summary of indicators and descriptive statistics for evaluation and monitoring

The following tables summarises indicators that can be used to evaluate and monitor different aspects of water.

Table 9.4: Selected indicators of water intensity and water productivity

1. Water use and pollution intensity (physical units)		
	m^3 water/unit of physical output	Water use or tons of pollution emitted per unit of output, such as --population, --number of households, or --tons of wheat, steel, etc. produced
	Tons of pollution/unit of physical output	
2. Water and pollution intensity (monetary units)		
	m^3 water/value of output	Water use or tons of pollution emitted per unit of output measured in currency units
	Tons of pollution/value of output	
3. Water productivity ratios		
	GDP/ m^3 water	
	Value-added by sector/m^3 water	
4. Water 'pollutivity' ratios		
	Sector share of pollution/sector share of GDP	

Table 9.5(a): Indicators of opportunities to increase effective water supply

1. Return flows	
Quantity of return flows by source	May distinguish return flows from treated return flows (from municipal and industrial users) from untreated return flows such as agriculture
2. Water reuse	
Reuse water as share of total industry water use	May distinguish reuse of water within a plant from water recycled by municipal water utility
Recycled water as share of total water use by sector	
3. Losses	
Losses in abstraction and treatment as share of total water production	Both the amount and the reason for these losses are usually known by the water utility
Unaccounted for losses as share of total water use	These losses occur for a variety of causes and it is usually not certain how much each cause contributes

Table 9.5(b): Indicators of Water cost, pricing and incentives for conservation

1. Supply cost and price of water	
Implicit water price	Volume of water purchased divided by supply cost
Average water price per m^3 by industry	Volume of water purchased divided by actual payments by that industry
Average water supply cost per m^3 by industry	Volume of water purchased divided by cost of supply to that industry
Subsidy per m^3 by industry	Average water price minus average water supply cost
2. Supply cost and price of wastewater treatment services	
Implicit wastewater treatment price	Volume of water treated divided by supply cost
Average wastewater treatment cost per m3 by industry	Volume of wastewater divided by treatment cost for that industry
Average wastewater treatment price per m3 by industry	Volume of wastewater divided by actual payments for treatment by that industry
Subsidy per m3 by industry	Average wastewater price minus average wastewater supply cost

Table 9.6: Indicators of access to and affordability of water and sanitation services

1. Access to water and sanitation services
Average daily water consumption by households, differentiating rural and urban households
Percent of urban households with access to safe drinking water
Percent of rural households with access to safe drinking water
Percent of urban households with access to sanitation services
Percent of rural households with access to sanitation services
2. Affordability of water
Household expenditures for water as % of total expenditures, differentiating rural and urban
Average price of water to households, differentiating rural and urban
Average price of water for subsistence agriculture (irrigation and livestock watering)

Table 9.7: Comparison of indicators derived from water accounts to alternative systems of water indicators

1. Falkenmark Water Stress Index (Falkenmark et al., 1989), has been one of the most widely used indexes. It measures the per capita amount of annual renewable freshwater (surface and groundwater) available in a country. Three levels of stress are defined:

Occasional or local stress occurs when water availability is > 1700 m^3 of water per capita

Regular water stress occurs when water availability is 1000 to 1700 m^3 per capita

Chronic water scarcity that begins to hamper economic development and human health occurs when water availability is 500 to 1000 m^3 per capita

Absolute water scarcity occurs when water availability is < 500 m^3 of water per capita

This index of water availability does not adjust for temporal and spatial variations or whether a country has the infrastructure and capacity to utilize its water endowment, and excludes the amount of precipitation used for agriculture and vegetation.

2. Water Poverty Index (Sullivan et al., 2002) is a recently developed measure, which attempts to assess poverty in relation to water availability. It is based on five attributes of water: water resource availability adjusted for reliability and quality, access to water including affordability of water, capacity (financial and human capital) to manage the system, use (shares) of water for different purposes, and integrity of the environment. The table below shows both the overall index (last column) as well as the components of the index. Australia, for example, ranks second in the overall WPI, but 4th in terms of use, while Haiti's WPI ranks last, although it is 3rd in terms of water resources.

Water Poverty Index for selected countries

Country	Resource	Access	Capacity	Use	Environment	WPI
Finland	12.2	13.5	18.0	19.3	17.4	80.5
Australia	11.9	13.7	17.6	8.6	13.2	65.0
South Africa	5.6	12.1	12.7	14.7	11.1	56.3
Jordan	0.4	12.9	14.9	18.2	5.5	51.9
Haiti	6.1	4.8	10.5	3.4	7.0	31.8

Source: Adapted from Sullivan et al. 2002.

Indicators of the Millennium Development Goals

- Proportion of urban population with sustainable access to improved water source;
- Proportion of rural population with sustainable access to improved water source;
- Proportion of urban population with access to improved sanitation;
- Proportion or rural population with access to improved sanitation

9.4 Water Accounts and Policy Analysis

Water accounts provide water managers information necessary to make critical policy analyses. For example, the benefits of current allocations of water, projections of future water demands, evaluation of different policy options for meeting those demands. Some of the most critical policy issues for water managers include:

- What are the likely future water demands under alternative economic development scenarios and are they sustainable? How do changes in agricultural, energy, forestry and other policies affect water supply and use?
- What is the impact of trade on water use and pollution?
- What are the opportunities for, costs and benefits of water demand management and other water conservation measures? Can economic growth be ‘decoupled’ from growth in water use?
- What would be the social and economic impact of pricing reform for water and wastewater?
- What are the costs and benefits of treating different sources of water pollution?
- What is the highest value allocation of water among countries sharing an international river or lake?
- How will external phenomena, like climate change affect water resources and how can the economy best prepare for these impacts?

The water accounts provide detailed information that can be used to analyze pressure on water resources, formulate long-term water management strategies and design effective policies for implementing a given strategy, such as appropriate water pricing and effluent taxes. These applications typically require linking the water accounts described in Modules 3 - 5 to economic models. For example integrating the water accounts in the Input-Output (I-O) (Box 9.1), Social Accounting Matrix (SAM) and Computable General Equilibrium (CGE) models to analyze economy-wide implications of water policies like price or pollution charges review. Information from water accounts can also be used in econometric modeling to forecast future water demands (Box 9.2).

9.4.1 Meeting future water demand

Projecting future water demand is essential for water management. For developing countries, the MDG identifies specific targets for meeting targets for water and sanitation. Future water and sanitation requirements depend on many factors, including population growth, the volume and composition of economic growth, and technological change. How the requirements are met depends on available technologies, including innovative ones like water demand management and reuse of water, and water policies such as pricing and other incentives for water conservation. Scenario modeling designed to incorporate some of these factors, especially for influencing water demand and unconventional water supply, are useful tools for water managers. These models require sophisticated economic models, often built around water accounts integrated with IO tables (Box 9.1). The consistency between national accounts and water accounts allows the easy incorporation of water accounts in many different kinds of economic models. In Australia the accounts have been used to project future demands for water (Box 9.2)

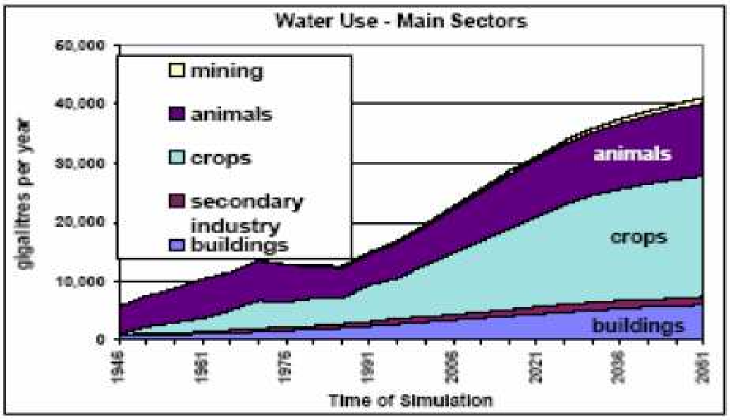
Box 9.1: Water accounts and input-output analysis

There are many tools for economic analysis and those taking a multi-sectoral approach are often built around input-output tables. Multi-sectoral models include standard input-output analysis as well as other modeling approaches, notably computable general equilibrium modeling (which uses a Social Accounting Matrix, an IO table expanded for institutions) and econometric models. Various partial equilibrium models, such as those developed for Life-Cycle Analysis also use IO.

The water supply and use tables (SUT), described in chapters 3-5, are directly linked to the national accounts supply and use tables; just as the IO table is constructed from the SUT, water IO accounts can be derived from the water SUT. In modeling, water in physical units is included in the IO table as a primary input of production. IO analysis of the water accounts themselves provides very useful information regarding the structure of the economy, driving forces, and water use & pollution, as described in the previous section. IO-based, multi-sectoral models are also widely used for projecting future water demands, or analyzing different policy options and the economic instruments for achieving them. Statistics Denmark notes that their water accounts are most extensively used for IO analysis (Statistics Denmark, 2004).

Box 9.2: Projecting water use in Australia

CSIRO, a major Australian research center, undertook a study of water use in 2050, considering options for improved technology, as well as population and income growth and the expansion of irrigated agriculture. Using a range of data, including those from the Australian water accounts, in a simulation model, total managed water usage was projected to expand from a 24,000 gigalitres in 2000-2001 to more than 40,000 gigalitres per year by 2050. This is due to a major expansion of irrigated agriculture in northern Australia as constraints on the availability and quality of water are experienced in the south. The model assumes widespread introduction of best practice technology in non-agricultural sectors. The water requirements for industry, mining and domestic use represent about 20% of the total. The water use by animals reflects the growth of the dairy industry in particular, which is relatively water-intensive. The authors note the importance of international trade in driving water use: Australia exports an estimated 4,000 gigalitres of embodied water more than it imports. This is about the same amount used each year by urban Australia.



(Source: Foran and Poldy, 2002).

9.4.2 Social and economic gains from water policy reform

To evaluate the present distribution of water, and the social and economic gains from policy changes, criteria for evaluation needs to be designed, and tools to measure them developed. Water policy concerns economic issues such as property rights and water allocation, investment in infrastructure, and pricing. Among the many possible analyses, this section discusses one important applications of water accounts to water policy, namely, Social and economic benefits of present water allocation and alternative allocations.

9.4.2.1 Social and economic benefits of water reallocation

Water consumption for production purposes, such as agriculture and industry, provide economic benefits such as incomes, employment, and foreign exchange earnings. Although these benefits do not measure the exclusive contribution of water to economic value, they are often used as indicators of broadly defined socio-economic benefits from the use of water in one industry relative to another, or in one region of a country relative to another. This indicator was introduced in Module 6 as the 'water productivity' indicator. Water productivity measures the direct income and employment generated by water use in a sector, but there may be significant additional benefits, upstream and downstream from the direct user.

It is often argued that agriculture generates relatively little direct income per unit of water input, but supplies food processing industries that in turn generate additional income and employment. An analysis of forward and backward linkages using the input-output approach described for trade and the environment provides a more comprehensive picture of the socio-economic benefits of water use in a particular activity, or a particular region. Box 9.3 describes an example of this analysis for South Africa.

Box 9.3: Evaluating agricultural water use on a catchment basis in South Africa

Water resources are under increasing pressure in post-apartheid South Africa for several reasons, notably improved access to safe drinking water for millions of previously excluded households, and the emphasis on economic growth and job creation, often in water-intensive industries. An evaluation of the socio-economic benefits generated by each economic activity relative to its water use is an essential input into good water management. Hassan (2003) provided such an evaluation for different agricultural activities within the Crocodile river catchment for the Water Research Council of South Africa. He measured the *direct* value-added and employment generated per cubic meter of water used in each activity. He also extended the analysis to consider the *indirect* benefits by measuring the value-added and employment generated by upstream and downstream linkages to each agricultural activity.

Upstream linkages consist of inputs to agricultural activities, such as fertilizer and agricultural chemicals, fuels, etc. Downstream linkages consist mainly of food processing industries, and the wood processing industries including paper and pulp, wood products, furniture, etc. These linkages are measured using a well-established economic tool, input-output analysis. The analysis revealed that a simple comparison of benefits across sectors did not provide an accurate picture of the full, economy-wide benefits.

Considering only the direct effects, both the income generated (value-added) and employment are highest for mangoes, but when indirect effects are added, pine appears the best. This is largely because there is very little additional processing that adds value for mangoes, while pinewood is used in many wood products. At the opposite end, sugar cane appears to be the least beneficial crop when only the direct income and employment are considered, but taking into account the indirect effects, sugar moves to third place.

Table Socio-economic benefits from water use for different agricultural activities in the Crocodile River catchment, South Africa, in 1998

Value-added (Rands/m3 water input)				Employment (1000 Person days/m3 water)			
Direct		Total (direct + indirect)		Direct		Total (direct + indirect)	
Mangoes	2.8	Pine	21.3	Mangoes	20	Pine	114
Oranges	1.9	Eucalyptus	13.3	Oranges	18	Eucalyptus	78
Avocados	1.7	Sugar cane	9.9	Grapefruit	13	Sugar cane	44
Eucalyptus	1.5	Mangoes	8.9	Eucalyptus	12	Oranges	39
Grapefruit	1.5	Oranges	6.6	Bananas	7	Mangoes	37
Bananas	1.3	Grapefruit	4.9	Pine	6	Grapefruit	28
Pine	1.2	Avocados	3.4	Avocados	5	Bananas	12
Sugar cane	0.9	Bananas	3.2	Sugar cane	2	Avocados	7

Source: Adapted from (Hassan, 2003 Table 7 p. 192)

9.4.3 Trade and the environment: water use and pollution

Water use and the emission of pollution is affected by water policies, but is also indirectly affected by policies in other sectors of the economy, which may not anticipate the impact on water resources. For example, agricultural trade policy may have a significant impact on what is produced in a country and indirectly the use of water. This section considers two aspects of trade and the use of water resources, namely trade in 'virtual water' and the impact of trade barriers on water allocation.

9.4.3.1 Trade in virtual water

Global water availability and use are characterized by large regional imbalances, but water itself is not a widely traded commodity. Trade in products allows trade in 'virtual water,' that is, the water used for the production of goods and services. Trade in virtual water allows a country to overcome its water scarcity by importing water-intensive goods; virtual water also provides a measure of a country's impact on global water resources (its 'water footprint') (See Champagain and Hoekstra, 2004). Distorted water pricing, including heavy subsidies to agriculture and omission of charges for ecosystem damage, means that international trade is unlikely to reflect the water 'comparative advantage' of countries. The World Water Council has recently identified virtual water as a critical issue for water management, and has launched a major initiative through its website to better define and measure virtual water (See http://www.worldwatercouncil.org/virtual_water.shtml). The measurement of virtual water should include both the direct and indirect water used in production. Direct water is the amount used during the production process; this figure is obtained from the water SUT. Indirect water is the amount used to produce all the non-water inputs to production of a given product. The difference between direct water use and total (direct + indirect) water use can be substantial: for example, very little water may be needed to produce a loaf of bread, but a great deal of water may be embodied in the grain used to make bread. The methodology for measuring total water use based on input-output models extended for direct water inputs (as described in Box 9.1) is well established in the economics literature (Førsund 1985, Miller and Blair 1985, Pearson 1989). Box 9.4 shows an analysis of trade in virtual water among Botswana, Namibia, South Africa, and between these three countries and the rest of the world.

9.4.3.2 Impact of trade policy on water allocation

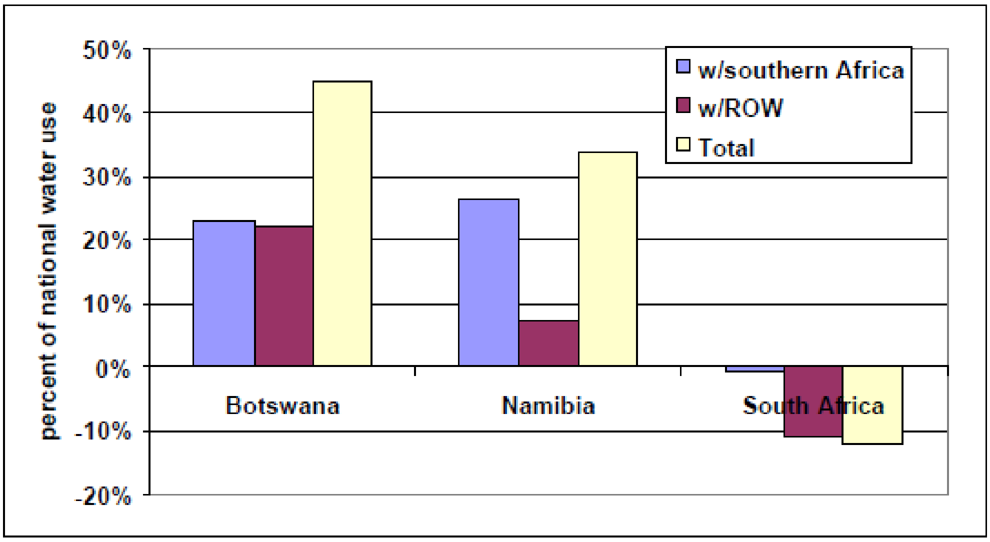
Most of the world's water is used for crop irrigation. Trade protection can result in distorted international patterns of agricultural production. When agriculture depends on irrigation, trade protection can inadvertently divert water to irrigation, increasing pressure on water resources and reducing the water available for other, often higher-value uses. Economic models, either partial or general equilibrium, are used to assess the impact of trade protection on water use and pollution, and the environmental and economic consequences.

Box 9.4: Trade and the environment: the water content of trade in Southern Africa

Botswana, Namibia and South Africa have designed strategies for economic development based in part on economic growth, diversification, and trade promotion. As in many developing countries, the structure of exports in these countries is heavily weighted toward primary commodities and processing of these commodities, which are often water-intensive. These three countries have identified water as a primary constraint to development and South Africa has already been categorized as a water-stressed country.

An input-output analysis of the total (direct + indirect) water content of trade among the 3 countries and with the rest of the world reveals that Botswana and Namibia are significant net water importers, 45% and 33% of total national water use, respectively. South Africa on the other hand, is a net water exporter, 11% of national water use in 1998.

Net water imports as percent of total national water use for Botswana, Namibia, and South Africa in 1998



Source: Based on (Lange and Hassan, 2002)

9.5 Critical issues for water accounts: spatial and temporal characteristics

Most water courses in the SADC region are shared by different regions in one country or different countries in the region and water availability and demand as well as water quality can vary a great deal over time and space. In these cases it is difficult to address sustainability on a national level when sustainability of water use is determined on a regional basis. Due to this, it is important for water managers to adopt a local or regional approach to water accounting and take into account regional and temporal variations. This principle is endorsed by IWRM. The approach however posses a challenge for water accounting because the temporal and spatial dimensions relevant to water often do not match those used for economic data in the national accounts. Notwithstanding, it is increasingly common for countries to construct water accounts on a local and regional basis, for example, Australia, the Netherlands, Sweden and Morocco. Seasonal water accounts have not yet been compiled. Box 9.5 shows an example of local water accounting in Sweden.

Box 9.5: Forecasting water use at the district level in Sweden

Under the EU Water Framework Directive, Sweden prepared forecasts of water use in 2015 at the district level. The estimates were made by using a regional economic model developed by the Swedish Business Development Agency, which allocated 289 municipalities into five water districts. The model is built from relations at municipality level and has five submodels (1) Population, (2) Labour market, (3) Regional economy, (4) Housing market and (5) Supplementary model for municipalities. The regional model first forecast population, employment and economic development until 2015 for each water district and, based on these results, forecast water use based on water use parameters prevailing in the base year, 2000. For the three most water intensive industries—Pulp & paper, Chemicals, Basic metals (NACE 21, 24, 27)—an alternative forecast (scenario 2) was made assuming increased water efficiency (water use/production value), based on the same gains in water efficiency achieved between 1995-2000.

Table. Water use in 2015 by water district, Sweden (thousand m^3)

District/Sea Basin	Water use in 2000	Projected water use in 2015	
		Scenario1	Scenario 2
Bothnian Bay	380 214	477 000	454 400
Bothnian Sea	786 846	947 300	846 700
North Baltic Sea	493 312	590 100	579 000
South Baltic Sea	637 382	750 900	713 300
North Sea	943 550	1 164 500	1 098 500
Total	3 241 304	3 929 800	3 691 900

Note: Scenario 2 assumes increased water efficiency in the most water intensive industries.

Source: Statistics Sweden, 2004

9.6 References

Department of Water Affairs. 2005. Water accounts for Namibia: technical report. Draft report by

DWA: Windhoek, Namibia.

Foran, B. and F. Poldy. 2002. The future of water. CSIRO Sustainable Ecosystems Working Paper Series 02/01, Canberra, Australia.

Hassan, R. 2003. Economy-wide benefits from water-inte nsive industries in South Africa; quasi inputoutput analysis of the contribution of irrigation agriculture and cultivated plantations in the Crocodile River catchment. *Development Southern Africa* 20(2): 171-195.

Lange, G. 2006. Water accounts in Namibia. In (Lange, G. and R. Hassan) *The Economics*

of Water Management in Southern Africa: An Environmental Accounting Approach. Edward Elgar:Cheltenham, UK. of Water Affairs, *Namibian Water Accounts: Technical Report*. DWA: Windhoek, Namibia.

2003. Water resource accounting in Namibia. In J. Arntzen, R. Hassan and G. Lange,

Groundwater and Water Accounting in Southern Africa Within the Perspective of Global Climate

Change. Report to START. Centre for Applied Research: Gaborone, Botswana.

Lange, G. and R. Hassan. 2002. Trade and the environment in Southern Africa: the impact of the userpays principle for water on exports of Botswana, Namibia, and South Africa. Paper presented at the Conference of the International Input-Output Association. 10-15 October. Montreal, Canada.

Sullivan, C., J. Maigh, and T. Fediw. 2002. Derivation and testing of the water poverty index. Report to DfID from the Centre for Ecology and Hydrology.

Statistics Sweden. 2000. Water accounts 2000 with disaggregation to sea basins. Statistics Sweden:Stockholm.

2004. Prognos över vattenuttag och vattenanvändning med redovisning på

vattendistrikt (Forecast of water abstraction and water use until 2015 by Water district). Statistics

Sweden: Stockholm.

1999. Water Accounts: physical and monetary data connected to abstraction, use and discharge of water in the Swedish NAMEA. Statistics Sweden: Stockholm.

UNSD (in cooperation with the Subgroup of the London Group on Water Accounting). 2005. Integrated Environmental and Economic Accounting for Water Resources (August Draft). UN.

Van der Veeren, R., R. Brouwer, S. Schenau, and R. van der Stegen. 2004. NAMWA: a new integrated river information system. Central Bureau of Statistics: Voorburg, Netherlands.

9.7 Notes to the Facilitator

About this Module

This module is designed to address the training needs of technical staff to mid level staff of Departments of water, environment, statistics and agriculture; water utilities; municipalities and other institutions interested or engaged in compilation of water accounts. This module facilitates an interactive exchange of opinions, perspectives and experiences of participants on the IWRM and water accounting concepts and demonstrates the importance of WA in promoting and achieving IWRM. You can allow for substantive discussion and encourage active participation by way of role playing.

The module is intended to help participants bring everything learnt in other modules together in terms of how it applies to policy. Specifically, participants are expected to be able to identify different indicators that can be used to address different water related challenges as well as statistics that can be used with other economic information to make further economic analyses. Exercises from previous modules can be used to tease out participants understanding of different indicators and their relevance in policy decisions.

Preparation

Send out letters of invitation to participants informing them of the date, time and venue. Include a brief description of what they can expect to gain from attending this session.

Study the background papers and presentations accompanying this module. In addition, study the other modules to appreciate the role of water accounting in water decision making.

Facilitation

The module is designed for face-to-face facilitation. The duration is **approximately 1.5 hours.** This timing, however, is an approximation and works best with a group of about 25-35 participants.

The facilitator would need to have significant knowledge of the concepts, as well as strong presentation/facilitation skills to deliver this module.

Participant evaluation

An evaluation questionnaire should be provided to allow participants assess the extent to which the module was relevant to their work, and the extent to which it has broadened their understanding of the issues addressed.

Give us your feedback

As a facilitator, we would also like to get your feedback on this module. Please send feedback on how you used the materials, comments on how they can be improved and suggestions on additional materials to mateteme@yahoo.co.uk

Modules and Authors

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