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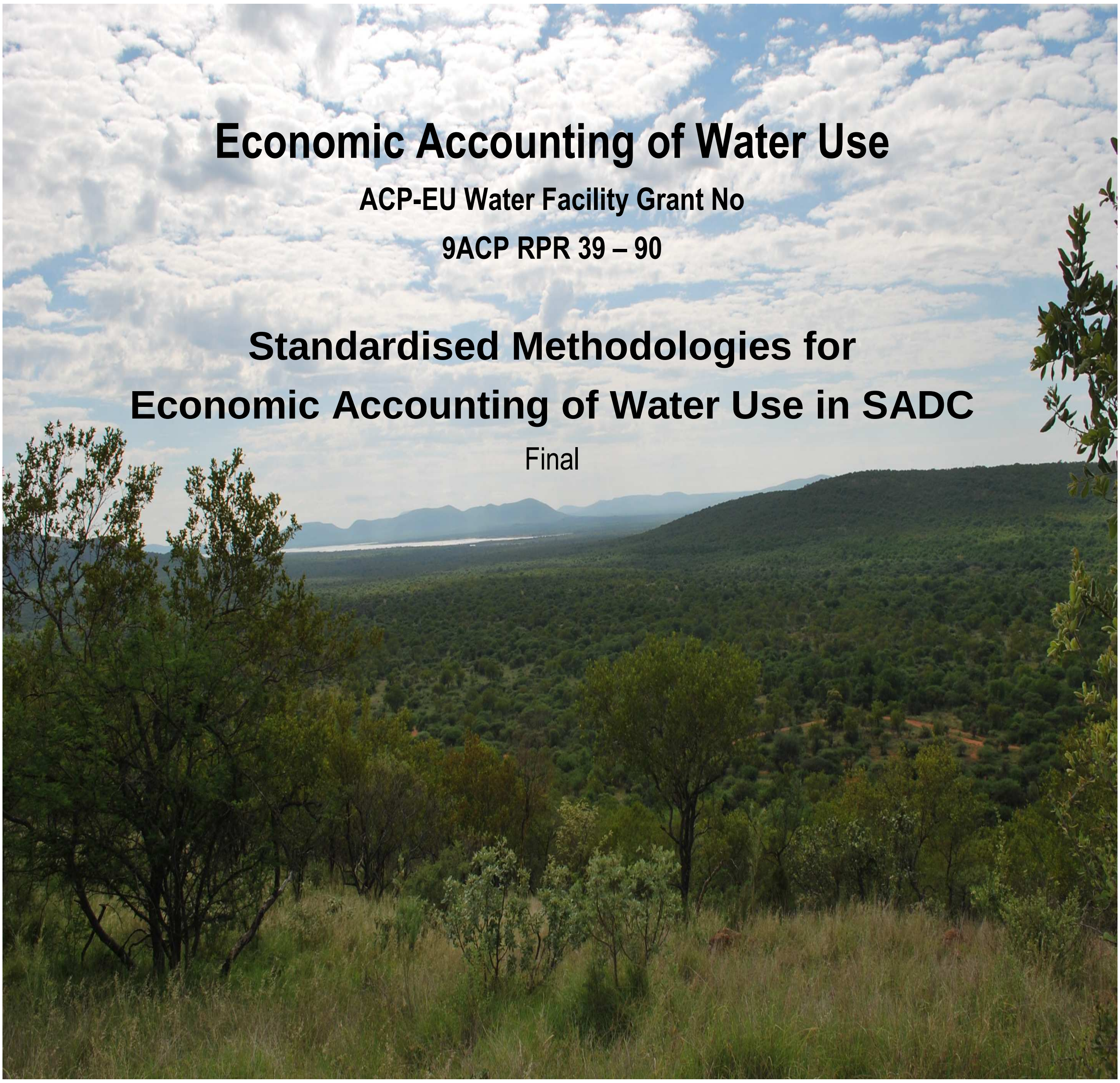

Economic Accounting of Water Use

ACP-EU Water Facility Grant No

9ACP RPR 39 – 90

Standardised Methodologies for Economic Accounting of Water Use in SADC

Final

September 2010

Commissioned by: Federal Ministry for Economic Cooperation and Development

In Delegated Cooperation with: UKaid from the Department for International Development

gtz

Global Water Partnership Southern Africa

SADC Economic Accounting of Water Use Project

Methodologies for Economic Accounting of Water in SADC

Produced by the project consultant Egis Bceom International

Funded 75% by the European Union and 25% by the Transboundary Water Management Programme in SADC which is implemented by GTZ and funded by the German and British Governments

SOUTHERN AFRICAN DEVELOPMENT COMMUNITY

EUROPEAN DEVELOPMENT FUND

ECONOMIC ACCOUNTING OF WATER USE PROJECT

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STANDARDISED METHODOLOGIES

ECONOMIC ACCOUNTING FOR WATER IN SADC

Prepared For SADC

by

Dr Gift Manase

Egis Bceom International

Acknowledgements

These standardised methodologies were developed for SADC by Egis Bceom International. The report is one of the products of SADC's regional project on "Economic Accounting of Water Use". The primary author of the report is Dr Gift Manase who is a Water Resource Economist and Team Leader for Egis Bceom International team of consultants.

Egis Bceom International greatly appreciates input from experts who reviewed these methodologies as well as representatives of Member States and River Basin Organisations who attended the first and second regional workshop to review the methodologies. In addition, the consultant would like to thank Project Steering Committee (PSC) members, national task teams and other stakeholders in the countries and river basins where these methodologies were piloted. Specifically the consultant would like to thank the following PSC members for their strategic guidance and advice:- Ms Mphatso Nyekanyeka and Mr Richard Malata (Malawi); Mr D.L Deepchand and Mr Phokhun Rajeshwar (Mauritius); Ms Lily Nomboro (Mozambique), Ms Florance Sibanda (Namibia); Mr Leshoboro Nena (Lesotho), Mr Kalaote Kalaote (Botswana); Mr Mahomed Vawda (South Africa); Mr Sakhiwe Nkomo and Ms Daisy Dhlamini (Swaziland); and Mr Christopher Chileshe (Zambia). The pilot of the methodologies in four member states (Malawi, Mauritius, Namibia and Zambia) and two river basins (Maputo and Orange-Senqu) would have not been possible without their strategic guidance, support and input.

Special acknowledgement goes to colleagues at **Egis Bceom International**, the **World Bank**, **United Nations Statistics Division** and the **Australian Bureau of Statistics** (ABS) for their support, encouragement and giving these methodologies a global perspective.

Egis Bceom International greatly appreciates the guidance of Mr Dumisani Mndzebele (Project Manager, SADC), Mr Phera Ramoeli (Senior Programme Officer, SADC), Mr Christmas Maheri (RSAP Coordinator, SADC), Mr Peter Qwist-Hoffmann (Capacity Development Advisor, GTZ Transboundary Water Management in SADC), Mr Thomas Farrington (Advisor to the RAO, Programme Implementation, SADC), and Mr Andrew Takawira (Regional Project Manager, GWP-SA).

Miss Caroline Ketshabile (Program Assistant, Egis Bceom International) provided the much needed logistical support that made the production of this report possible.

Egis Bceom International gratefully acknowledges the financial support of the European Commission, and the German and British Governments through GTZ, and the Global Water Partnership-Southern Africa (GWP-SA).

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Acronyms

ABS	Australia Bureau of Statistics
CEEPA	Centre for Environmental Economics and Policy in Africa
CMA	Water Management Agencies
CSIRO	Australia's Commonwealth Scientific and Industrial Research Organisation
EAW	Economic Accounts for Water
EAWU	Economic Accounting for Water Use
EC	European Commission
GIS	Geographic Information Systems
RE	Economic Rent
GDP	Gross Domestic Product
GWPSA	Global Water Partnership Southern Africa
ICPs	International Cooperating Partners
ISIC	International Standard Industrial Classification
IWRM	Integrated Water Resources Management
MDGs	Millennium Development Goals
MOC	Marginal Opportunity Costs
MS	Member State
PSC	Project Steering Committee
PSUT	Physical Supply and Use Table
RBO	River Basin Organisation
RSAP	Regional Strategic Action Plan
SADC	Southern African Development Community
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
TNA	Training Needs Assessment
UNSD	United Nations Statistics Division
WB	World Bank

1. Introduction

This report presents the standardised methodologies for the compilation of water accounts in the Southern African Development Community (SADC) region. Given the prominence and recognition of water in the national and regional development agenda, the increasing demands from Member States (MS) for harmonisation and guidance on methods for determining the economic value of water and for benefit sharing at river basin level, SADC initiated "The Economic Accounting of Water Use" project which is part of the Regional Strategic Action Plan (RSAP) on Integrated Water Resources Management and Development. The project was implemented under the framework of the Regional Water Policy (RWP) and Regional Water Strategy (RWS), which guiding documents are aimed at facilitating the implementation of the Regional Indicative Strategic Development Plan (RISDP), the blue print of the SADC's development initiatives. The project was 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.

1.1 About the Standardised Methodologies

The methodologies in this report were developed through:-

(a) Review of international approaches, especially the System of Environmental – Economic Accounting for Water (SEEAW) developed by the United Nations Statistics Division (UNSD)

(b) Review of the water accounting methods used by the Australian Bureau of Statistics (ABS) and the Water Account System (WAS) developed by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). ABS water accounts are strong on the use of water (ABS, 2006) and these have been used to improve the Physical Supply and Use Tables in the proposed methodologies for SADC. ABS is also strong on institutional arrangements for sustainable compilation and use of water accounts to inform decision making and policy formulation. These strong points on institutional arrangements have informed guidelines on implementation of water accounting which are discussed in Section 13 of this report. The WAS developed by CSIRO is meant to address some of the weaknesses of the ABS water accounts, especially analysis of supply and demand into the long-term (Graham *et al*. 2008). However, WAS is based on modelling and is data intensive and may therefore not be applicable given the current data availability situation in most SADC countries.

(c) Practical experience of water accounting in SADC especially in Botswana, Namibia and South Africa. These experiences provide crucial information on estimating water use in situations of low data availability. The experiences also highlight important sources of water that need to be included in the accounts such as ephemeral rivers and rain-fed agriculture. South Africa has gone a step further and has attempted to implement the SEEAW in its entirety.

(d) Review of policy priorities at regional (SADC), river basin and national levels

(e) Consultations with regional and international experts

(f) Pilots in four Member States (Malawi, Mauritius, Namibia and Zambia) and two river basins (Maputo and Orange-Senqu)

The methods in this report are based mainly on the UNSD SEEAW for the following reasons:-

- One of the outstanding characteristics of SEEAW is that it directly link water accounts to national accounts by applying the same concepts, definitions and classifications as those applied in the internationally adopted System of National Accounts (SNA) which Ministries of Finance in SADC countries currently use to present national accounts
- Information is presented in a similar way to that used in National Accounts thus the water accounts are easy for economists in the Ministries of Finance and Economic Planning to understand – this is critical when presenting a case for more investment in water
- It is very comprehensive especially when supplementary tables are completed – covering all key policy aspect related to the economic value of water which SADC Member States and RBO are grappling with
- It was recommended and adopted as the International Water Statistic in a resolution adopted during the UN Statistical Commission Forty-first session 23-26 February, 2010 (the same time SADC was holding the first regional workshop on water accounting)
- All the other water accounting approaches applied in Australia, Namibia, and South Africa are also based on SEEAW although they do not apply it in its entirety
- The UNSD is now building capacities of countries to implement SEEAW as part of environmental statistics on water

However, the methods for SADC have been modified SEEAW to reflect the policy priorities of SADC, the data availability situation, lessons learnt during the pilots and input from participants during the first and second SADC regional workshop held in Gaborone. The following main modifications have been applied:-

(a) Agriculture has been expanded to separately identify livestock watering which is an important economic activity in SADC – in Botswana and Namibia for example

(b) The social aspects of water have been included by applying the concept of Disability Adjusted Life Years (DALYs) to value the opportunity cost of time spent fetching water as well as the direct and indirect costs of water-borne diseases

(c) To avoid confusion, the term “wastewater and pollutant account” is used in this report instead of “emission account” as applied in SEEAW. This was one of the recommendations made by participants at the first and second SADC regional workshops

(d) The environment has been acknowledged as a legitimate user of water by including Environmental Flow Requirements (EFR) in the tables

1.2 Organisation of the Report

The approach taken in this report is to try to be as comprehensive as possible and to look into the long-term by presenting data which SADC Member States and RBO should work towards compiling in the next 5 to 10 years instead of focusing on what can be done in the short-term based on the current data availability situation. However, we take note of the fact that SADC MS are at different levels in terms of data availability as well as experience with water accounting. Therefore, the water accounts are presented in modular form so that countries can start with certain standard water accounts depending on their data availability situation and policy priorities (the normal practice is to start with physical water supply and use accounts, followed by asset accounts, then economic accounts. To-date not many countries worldwide have attempted the difficult accounts - effluent and water quality accounts). As the data availability situation improves, countries can move from constructing standard (minimum) tables to more detailed and comprehensive supplementary tables.

In terms of outline, the report first introduces the main concepts, definitions and classifications applied in economic accounting for water. This is then followed by a detailed discussion, first, of the relatively easy accounts (water supply and use accounts, economic accounts, and asset accounts) and then the difficult ones (wastewater and pollutant, and water quality accounts).

The last chapters discuss techniques for determining the economic value of water, and present case studies. The report concludes by providing guidelines for institutionalising and implementing water accounting in practice- i.e. institutional arrangements, data collection strategy, and data dissemination to ensure that water accounts influence policy.

2. Introduction to Economic Accounting for Water

Water plays a critical role in economic growth, social development and ensuring environmental sustainability. Increasing competition for fresh water among different users and uses coupled with climate change and variability puts unprecedented pressure on water resources. The situation is further aggravated by deteriorating water quality. Since water is critical for the economy there is need to integrate hydrological and economic information. Only by integrating information on the economy and hydrology can integrated policies be designed in an informed and integrated manner. Policy makers taking decisions on water need to be aware of the likely consequences for the economy and vice versa (UNSD, 2006).

Economic Accounting for Water (EAW) describes the interaction between water resources and the economy. "*It provides a conceptual framework for organising economic and hydrological information permitting a consistent analysis of the contribution of water to the economy and the impact of the economy on water resources"* (UNSD, 2006). EAW is a satellite account of the System of National Accounts (SNA) which is the statistical standard used for the compilation of national economic statistics such as Gross Domestic Product (GDP). Therefore, EAW has similar structure to the SNA and share common definitions and classifications. EAW is outstanding in that it directly link water data to the economic accounts through a shared structure, set of definitions and classifications. Thus EAW is a tool for integrating water-economic analysis and overcomes the tendency to analyse economic and water issues independently. Furthermore, EAW covers all the important water-economic interactions, a feature that makes it ideal for addressing cross-sectoral issues such as integrated water resources management. SADC has embraced IWRM and it is not possible to promote IWRM from the narrow perspective of managing water resources; rather a broader approach that encompasses economic, social and ecosystem aspects is needed (UNSD, 2006). Since water accounts are constructed as satellite accounts for National Accounts, they are linked to a full range of economic activities with a comprehensive classification of water resources.

Economic Accounting for Water presents the following information:-

i. Stocks and flows of water resources within the environment
ii. Pressures of the economy on the environment in terms of water abstraction and effluent added to wastewater and released to the environment
iii. The supply of water and its use as an input in the production process and by households
iv. The reuse of water in the economy
v. The costs of collection, purification, distribution and treatment of water, as well as the service charges paid by the users
vi. The financing of these costs, that is, who is paying for the water supply and sanitation services
vii. The payments of permits for access to abstract water or to use it as sink for discharge of wastewater
viii. The hydraulic stock in place, as well as investments in hydraulic infrastructure during the accounting period

EAW also presents quality accounts, which describe water resources in terms of their quality. However, quality accounts together with economic valuation of water resources are still experimental and no standardised guidelines have been developed yet (UNSD, 2006).

EAW is an important tool for policy makers as it provides them with:-

i. Indicators and descriptive statistics to monitor the interaction between the environment and the economy, and progress towards meeting environmental goals.
ii. A database for strategic planning and policy analysis to identify more sustainable development paths and the appropriate policy instruments for achieving them.

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.

EAW has the following six categories of water accounts:

- Physical supply and use accounts (water resource data on water supply and discharge)
- Wastewater and Pollutant Accounts (records of pollution discharged to water by an economic unit)
- Hybrid and economic accounts (physical and monetary data on water supply and use)
- Asset accounts (stock of water resources at the opening and close of the accounting period)
- Quality Accounts (stock of water in terms of its quality)
- Valuation of water resources

3. The Framework for Economic Accounting for Water

Water plays an important role in economic and social development as well as in ensuring environmental sustainability through for example, acting as a sink for waste material. However, it is import to state here that although water plays crucial social and environmental roles, economic accounting for water is limited in that it focuses on the economic aspects of water that is water as material input into production and consumption activities and as a "sink" for waste.

EAW provides an integrated information system to study the interaction between the environment and the economy. The Framework for the System of Environmental - Economic Account for Water (SEEAW) developed by the UNSD is presented diagrammatically in Figure 3.1. It shows the interaction between water resources and the economy in the territory of reference – that is a country, river basin or catchment. The inland water resources system of a territory includes rivers, lakes, groundwater, soil water, and artificial reservoirs and natural flows between them. These resources form the water assets. The main natural inputs of water for these resources are precipitation and inflows from other territories and from other resources within the territory. The main natural flows that decrease stock of water are evapotranspiration, outflows to other water resources within the territory and to other territories. Human activities decrease and increase the water stock through abstraction and returns. The asset account describe the inland water resource system in terms of stocks and flows thus providing information on the stock of water resources at the beginning and end of the accounting period and changes therein. Asset accounts can be thought of as a description in accounting terms of the hydrological water balance (UNSD, 2006).

The lower half of Figure 3.1 shows the economy which is one of the many users of water. The economy of a territory consists of resident (that is households and institutions whose centre of economic interest is within that territory (country, catchment or RB)) water users who abstract water for production and consumption purposes and put in place the infrastructure to store, treat, distribute and discharge water back to the environment.

The inland water resource system and the economy of a given country, catchment or river basin can exchange water with those of other territories through **imports/exports** of water (exchange between economies, South Africa and Lesotho for e.g.) and though inflows from upstream territories and out flows to downstream territories (exchanges of water between inland water systems). Figure 3.1 also show exchanges with the sea and the atmosphere which are considered outside the inland water system.

The economy uses water in different ways. It can physically remove water from the environment (**direct use**) for production and consumption activities (**consumptive use**) or use water without physically removing it from the environment (**non-consumptive use**). Consumptive use of water includes abstraction of water from rivers, or the sea, use of precipitation through rain-fed agriculture or water harvesting. Non-consumptive use of water includes use of water for recreation and navigation purposes, fishing and other uses that relay on the physical presence of water(in-situ use) and, often, also on the quality of water. Non-consumptive uses do not involve a physical displacement of water and are not directly considered in the EAW. However, the impact of these activities on water quality can be capture in the quality accounts of EAW.

After using water, the economy returns it to the environment through return flows either to inland water bodies or directly to the sea. Usually, return flows have a negative impact on water quality as the quality of water in return flow is often lower than that of abstracted water.

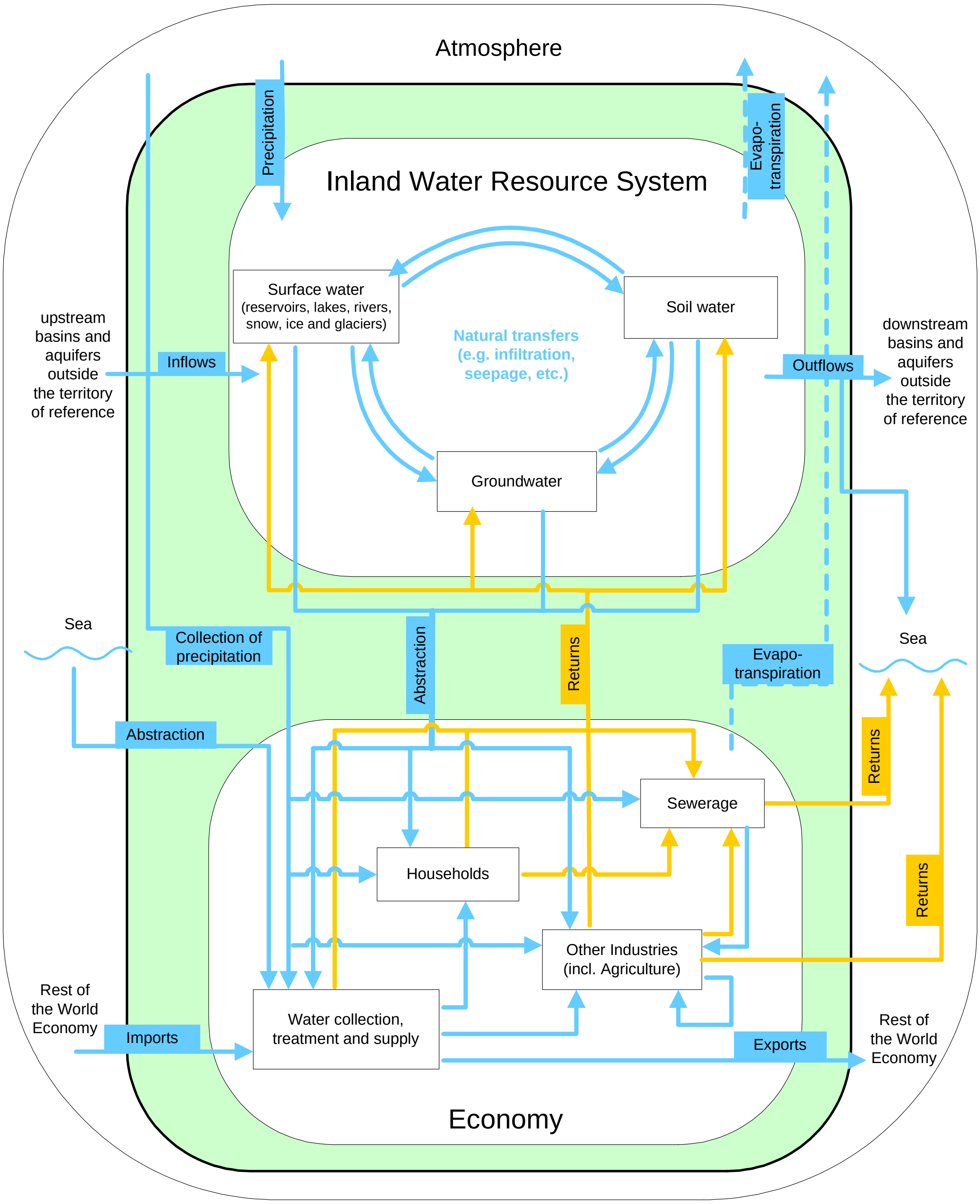
Figure 3.1 shows the flow of the inland water resource system and the economy and the water flows captured by water accounts. For simplicity, Figure 3.1 does not capture all exchanges within the economy which are included in economic accounts of water. Additional information which is not illustrated in the diagram but captured in water accounts include:-

- Monetary transactions related to water exchanges including: (a) costs of collection, treatment and supply of water and costs of sanitation services; (b) fees and taxes paid for water and sanitation services; (c) payments for access to the resource (e.g. water permits) as well as for discharging wastewater; and (d) the financing of these services (i.e. the sectors bearing the costs of services);
- Costs for environmental protection and resource management. They describe the economy's efforts to prevent environmental degradation or eliminate part, or all, of the effects after pollution. They include actual expenses incurred (current and capital) by industries, households and the government as well as the financing of these expenditures;
- Investment in infrastructure. They describe (a) the costs of new investment; (b) the depreciation of old investment; (c) the costs of maintaining the water-related infrastructure; and (d) the financing of these investments;
- The discharge of pollutants into the environment. They allow for the identification of pressure on the environment by the various economic agents, namely industries, households and the government.

Each economic unit either abstracts water directly from the environment or receives it from other industries. Once water enters the economic unit, it is used, returned back to the environment or supplied to other industries for use (reused water), or supplied to a treatment facility (sewerage in Figure 3.1). In addition, during use or transportation, water can be lost through leakages or processes of evaporation and evapotranspiration.

During use, some water may be retained in the product produced by the industry or evapotranspirated. In these cases, water is *"consumed"* by the industry. The word consumption in this context refers to water that is not returned to the environment and is different from water *use* which denotes water that is received by an industry or household.

Figure 3.1: Main flows within the environment and the economy



Source: UNSD, 2006

3.1 Links between Economic Accounting for Water and National Accounts

EAW is designed to link the economic information with hydrological information in order to provide the users with a tool for integrated analysis. EAW takes the perspective of the economy and looks at the interaction of the economy with the hydrological system. SADC MS use the SNA to report economic performance – GDP for example. EAW is a satellite account of the System of National Accounts (SNA) in the sense that it expands the analytical capacity of national economic accounts by addressing water-related concerns without overburdening or disrupting the central system. As a satellite account of national accounts, EAW 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 EAW 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. EAW allow 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.

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 MS. 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.

3.2 Types of Water Accounts

EAW consists of flow accounts, asset accounts and valuation of water which are described briefly below and detailed in Chapter 5-10.

3.2.1 Flow Accounts

Flow accounts describe the movement of water between the environment and the economy as well as within the economy. They provide information on the contribution of water to the economy and the pressure exerted by the economy on water resources in terms of abstraction and pollution.

3.2.1.1 Physical supply and use tables (SUT)

The physical supply table describe the flows of water within the economy (e.g. from water utility to households) and flows from the economy to the environment (discharge of sewage to water bodies). The physical use table describes flows of water from the environment to the economy (water abstraction by water utility) and flows within the economy (e.g. water received from another industry).

3.2.1.2 Wastewater and pollutant accounts

Wastewater and pollutant accounts provide information by industry, households and government on the amount of pollutants added to wastewater which is either discharged into the environment (with or without treatment) or discharged into a sewage network.

3.2.1.3 Hybrid Accounts

Hybrid accounts present, in a consistent manner, physical and monetary information on the supply and use of water by juxtaposing the standard (monetary) National account supply and use tables with the corresponding physical tables. The monetary part of the hybrid supply and use table explicitly identifies water-related products and industries. These accounts provide a comprehensive picture of the economics of water and can be used to derive indicators such as the productivity of water in the various economic sectors.

Monetary accounts for government expenditure on water-related activities as well as hybrid accounts for the collection, treatment and supply of water as well as sewerage provide information on government expenditures related to water supply and sanitation, the contribution of water-related activities to the economy, and the financing of the water sector.

One outcome of the compilation of economic accounts for water is the construction of the financing table, which allows for the identification of the units which bear the costs of production of water supply and sanitation services and of those which receive transfers from other economic units, government and donors (UNSD, 2006).

3.3 Stock Accounts

3.3.1 Assets Accounts

Asset accounts measure stock of water resources at the beginning and end of the accounting period as well as changes in stock that occurs during that period. 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.

3.3.1.1 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 mobilise and treat water.

3.3.1.2 Natural Water Resources

The describe the volume of water in its various asset categories, at the beginning and end of the accounting period and all the changes therein due to natural causes (precipitation, evapontranspiration, inflows, outflows etc.) and human activities (i.e. abstraction and discharge). The asset boundary for water resources includes, in principle, all inland water bodies (rivers, lakes, artificial reservoirs, glaciers, snow and ice) groundwater and soil water. In practice it is difficult to compile asset accounts for all these categories.

3.3.2 Quality Accounts

These measure assets in terms of their quality. They describe stocks of water at the beginning and end of an accounting period according to their quality.

3.4 Valuation of water

In SADC water is usually not traded in the market or its economic value is distorted due to subsidies. Valuation of water presents economic techniques for determining the value of water beyond the tariffs paid by households or for irrigation water. Various techniques for valuing water are presented in section 5.

3.5 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

3.5.1 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.

3.5.2 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).

4. Concepts, Definitions and Classifications

Economic accounting for water use and integrate concepts, definitions, classifications and frameworks from hydrological sciences and environmental, economic, demographic and social statistics. This section provides a brief overview of the main concepts related to water in the environment, in the economy and in the society, the concepts related to inland water resources.

4.1 Main Concepts

4.1.1 The Environment and Water

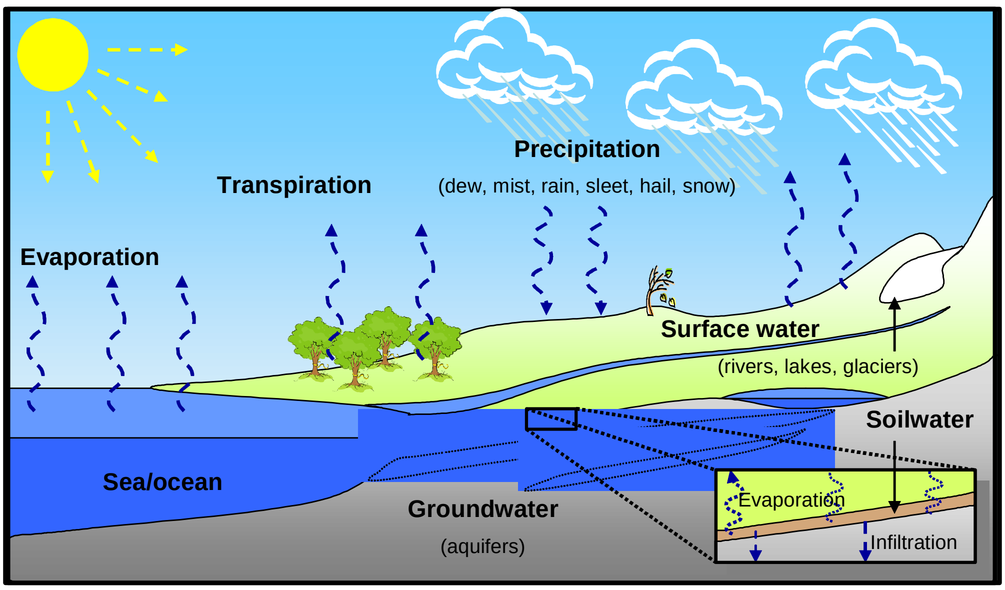
The environment is the physical surroundings, the living organisms and the interactions within and between the physical surroundings and living organisms. The earth's environment is seen by ecology and other physical sciences as comprising four principal spheres:

- The atmosphere: the gaseous layer surrounding the planet;
- The biosphere: the collection of all living organisms together with the decaying matter produced by them;
- The hydrosphere: the water found on and below the planet's surface in seas and oceans, lakes, wetlands, rivers, soils, snow and ice and in aquifers (groundwater);
- The lithosphere: the upper layer (100 km) and surface of the planet's solid mass.

Within the environment water occurs on the land's surface in lakes, rivers, artificial reservoirs, snow, ice and glaciers, etc., below the land's surface (in groundwater and the soil), in the seas and oceans, the air (e.g. as clouds), as well as in living organisms (e.g. in plants and animals). Natural processes create flows of water between the inland water resources, the atmosphere, the seas and oceans. The natural processes of water movement are referred to as the hydrological cycle or the water cycle.

Figure 4.1 shows the main components of the hydrological cycle, which are reflected in the definition, classification and characteristics of the inland water resources.

Figure 4.1: The hydrological Cycle



Inland waters include all types of water regardless of quality (e.g. all freshwater, brackish water, saltwater and polluted water). Water quality is a key determinant of the health of the plants, animals and other life forms (including human health). Water quality is also a key factor determining the use of water in the economy.

4.1.2 The economy and water

The economy, its entities, transactions and boundaries are defined in the System of National Accounts (SNA, 2008). In general, an economy is the sum of economic activities of production, consumption and accumulation undertaken by entities within an economic territory. The entities include the economic units that can engage in economic transactions and are capable of owning assets and incurring liabilities on their own behalf. The total economy of a country is defined as the entire set of resident economic units. The residence of each economic unit is the economic territory with which it has the strongest connection, in other words, its centre of predominant economic interest. For water accounting, the economy includes all resident economic units that abstract or receive water for production, consumption and accumulation purposes or put in place the infrastructure to store, treat and distribute water and to discharge it back to the environment.

The economic territory of a country includes the land area, airspace, territorial waters, including jurisdiction over fishing rights and rights to fuels or minerals. In a maritime territory, the economic territory includes islands that belong to the territory. The economic territory also includes territorial enclaves in the rest of the world (ROW). These are clearly demarcated land areas (such as embassies, consulates, military bases, scientific stations, information or immigration offices, aid agencies, central bank representative offices with diplomatic immunity, etc.) located in other territories and used by governments that own or rent them for diplomatic, military, scientific, or other purposes with the formal agreement of governments of the territories where the land areas are physically located. Any units with a centre of interest outside of this territory are part of the economy of the rest of the world.

4.1.3 The society and water

A society is defined as the aggregate of people living together in a more or less ordered community or a particular community of people living in a country or region, and having shared customs, laws, and organizations. Water is essential for the functioning of the environment, societies and the economy. Drinking water is needed to sustain the life of the population, while clean water is essential for a healthy population and is needed for sanitation, bathing, cooking, etc. Water is also essential for the production of the food that supports the population, the production of other goods and services used by societies as well as for transport and recreation. As such water scarcity can affect the production of food, other economic activities, and the health of the population. While the supply of households with water and sewerage services is recorded by economic statistics, there are many water related social issues that are also in the realm of social and demographic statistics, such as, for example, the access to safe drinking water and sanitation or the various diseases caused by the use of unsafe water in human populations.

Data on societies and their use of water are collected by a variety of means and often as part of a program of demographic and social statistics conducted by national statistical offices, such as for example, via population and housing censuses and household surveys. The *Principles and Recommendations for Population and Housing Censuses Revision 2*[32] have been developed to support statistical activity in this area, while the Joint Monitoring Program for Water Supply and Sanitation (JMP) deals specifically with water aspects of household surveys.

4.1.4 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". 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.

4.1.5 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. These concepts are used as a basis for many international water indicators regarding inland waters.

4.1.5.1 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).

4.1.5.2 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 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 removed37. See Annex III for more information on the calculation of IRWR and overlap for example.

4.1.5.3 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 neighbouring 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.

4.1.5.4 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 neighbouring 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.

In assessing the external flow of a country FAO distinguishes between natural incoming flow and actual incoming flow from neighbouring territories. "Natural" inflow is the average annual amount of water that would flow into the country in natural conditions, i.e. without human influence. "Actual" inflow is the average annual quantity of water entering the country, taking into account that part of the flow which is secured through treaties or agreements and possible water abstraction in upstream countries.

4.1.5.5 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.

4.1.5.6 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.

4.1.5.7 Aquifers

Aquifers are underground zones that contain sufficient saturated permeable material to yield significant quantities of water to wells and springs. It is important to note that aquifers receive water from surface water bodies and precipitation that infiltrates into the ground, and from other parts of the groundwater system such as aquitards.

4.1.5.8 Soil water

Soil water is defined as water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface, that can be discharged into the atmosphere by evaporation of soil water and transpiration from plants that take up soil water. When this water is used in agriculture production (i.e. rain-fed agriculture) this water is sometimes termed ***green water***.

4.2 Classification of economic units

(a) Enterprises and establishments

An enterprise is an economic unit in its capacity as a producer of goods and services. An enterprise may operate one or more establishments, and may produce a variety of goods and services. In the course of the production other goods and services will be consumed. The goods and services produced and consumed include water and sewerage services.

An establishment is an enterprise or part of an enterprise that is situated in a single location and in which only a single (non-ancillary) productive activity is carried out or in which the principal productive activity accounts for most of the value added. Establishments are classified to industries using the International Standard Industrial Classification (ISIC Rev. 4) on the basis of their principal productive activity. Establishments also include government (i.e. a government office is an establishment).

(b) Households

A household is defined as a group of persons who share the same living accommodation, who pool some, or all, of their income and wealth and who consume certain types of goods and services collectively, mainly housing and food.

(c) Residence principle

The residence principle is used to allocate economic units to an economic territory of reference. While each unit will have a physical location, which can be assigned to a spatial reference (e.g. a geo-code, administrative area, country, river basin or accounting catchment), it is also necessary to determine if the unit is a part of a country's economic territory. The residence of each unit is the economic territory with which it has the strongest connection, in other words, its centre of predominant economic interest.

(d) Classification of industries: the International Standard Industrial Classification (ISIC))

An industry is a group of the establishments within the economy that are engaged in the same, or similar, kinds of production activity (i.e. the type of activity undertaken to produce certain goods or services). The ISIC distinguishes the following groups which are important for water accounting:-

- ISIC 1-3 Agriculture, Forestry and Fishing
- ISIC 5-33, Mining and quarrying
- ISIC 41-43 Manufacturing and construction
- ISIC 35 Electricity, gas steam and air conditioning supply
- ISIC 36 Water collection, treatment and supply
- ISIC 37 Sewerage
- ISIC 38, 39, 45-99 Service industries

Now that we have explained the main concepts, definitions and classifications, the following sections describe in detail the methods for compiling the various water accounts.

5. Standardised Methodologies for Constructing Water Accounts in SADC

This section presents the methodologies for compiling water accounts. The methodologies are based on the System of Environmental – Economic Accounting for Water (SEEAW) developed by the United Nations statistics Division (UNSD) but adopted to reflect the policy priorities and data availability situation in SADC by, ***(a)*** expanding agriculture to separately include livestock watering since this is an important economic activity in some SADC MS; ***(b)*** including environmental flows; and ***(c)*** including the social dimension of water by using Disability Adjusted Life Years (DALYs)[1] to value the impacts of poor access to safe drinking water such as the opportunity costs of time spend queuing for water, low productivity due to water borne diseases such as diarrhoea and cholera.

5.1 Physical water supply and use tables

5.1.1 Introduction

The Physical water supply and use tables developed by the UNSD were modified in this manual to separately identify livestock watering which is of vital importance in SADC Member States - Botswana and Namibia for example. Physical water supply and use tables (SUT) describe water flows, in physical units, within the economy and between the environment and the economy. These accounts follow water from its initial abstraction from the environment by the economy, its supply and use within the economy, to its final discharge back to the environment, all expressed in quantitative terms (UNSD, 2006). Physical SUT have the same structure of the monetary SUT compiled as part of the standard national accounts compilation.

One of the strong features of the SUT presented in this manual is that the physical information is organised using the same framework as the monetary accounts thus making it linked directly to national accounts and making it easy to understand for economists in the Ministries of Finance and Economic Planning.

The compilation of the physical water SUT allows for: (a) the assessment and monitoring of the pressure on water quantities exerted by the economy; (b) the identification of the economic agents responsible for abstraction and discharge of water into the environment; and (c) the evaluation of alternative options for reducing the pressure on water. In combination with monetary information on value added, indicators of water use intensity and productivity can be calculated.

The objective of this section is to provide a comprehensive overview of physical supply and use tables. The section starts by describing the distinction between flows from the environment to the economy (i.e. abstraction), flows within the economy (i.e. supply and use of water between two economic units) and from the economy back to the environment (i.e. returns). This distinction is used to construct physical water supply and use tables and to show the basic accounting rules applied in SUT. The section concludes by presenting the standard physical SUT that countries are encouraged to compile.

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[1] The Disability Adjusted Life Year or DALY is a health gap measure that extends the concept of potential years of life lost due to premature death (PYLL) to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability (1). The DALY combines in one measure the time lived with disability and the time lost due to premature mortality. One DALY can be thought of as one lost year of 'healthy' life and the burden of disease as a measurement of the gap between current health status and an ideal situation where everyone lives into old age free of disease and disability

5.2 Type of flows

When constructing a supply and use table for water resources, the SEEAW implicitly takes the perspective of the economy as it describes the interactions between the environment and the economy. It describes: (a) flows from the environment to the economy; (b) flows within the economy; and (c) flows from the economy to the environment as described in Figure 2.1. Note that flows within the environment will be described under asset accounts. For each type of flow, the origin of the flow (supply) and its destination (use) are clearly identified. The supply and use tables are constructed for each type of flow in such a way that the basic accounting rule, that supply equals use, is satisfied.

(a) *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 asset classification, see chapter 6), and from other sources. Abstraction from other resources includes abstraction from the sea (for example, for direct use for cooling, or for desalination purposes) and collection of precipitation (which occurs, for example, in the case of water roof harvesting). The supplier of these flows is the environment and the user is the economy, more specifically, the economic agents responsible for the abstraction. It is assumed that the environment supplies all the water that is used (abstracted), hence the equality between supply and use is satisfied.

The use of water as a natural resource excludes the in-situ or passive uses of water, which do not entail a physical removal from the environment. Examples include the use of water for recreation or navigation. In-situ uses of water, although not explicitly considered in the supply and use tables, could be included as supplementary items in the accounts, in particular in the quality accounts as they can have a negative impact on water resources in terms of water quality. In addition, in-situ uses can also be affected by activities of abstraction and water discharge: for example, upstream over-abstraction may affect navigational and recreational uses of downstream waters. Thus, when allocating water to different users, consideration of in-situ uses of water resources is generally made.

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.

(b) Flows within the economy

Flows within the economy involve water exchanges between economic units. These exchanges are usually carried out through mains (pipes), but other means of transporting water are not excluded. The origin and destination of these flows corresponds to those of the monetary Supply and Use Table (SUT) of the National Accounts (SNA), namely the agent providing water is the supplier and the agent receiving it is the user. There is only one exception to this correspondence with the monetary SUT, which involves the flows of wastewater: the industry collecting wastewater is a "user" in the physical SUT while in the monetary tables it is a "supplier" of wastewater collection and treatment services.

Most of the water is generally supplied by the industry ISIC 36, *Water collection, treatment and supply*; however, it can also be supplied by other industries and households. This includes the cases, for example, when water is supplied by industries and households for further use or is supplied to treatment facilities before being discharged into the environment. Note that the physical supply of water by households generally represents a flow of wastewater to ISIC 37, *Sewerage*.

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. The corresponding monetary transaction is recorded instead in the opposite way: ISIC 37 supplies the service of wastewater collection and treatment which is in turn used by the economic units who physically generate 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 losses of water. 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.

(c) 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 receiving media: 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.).

5.3 Physical supply and use tables

Physical supply and use tables for water describe the three types of flows mentioned above: (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).

Physical supply and use tables can be compiled at various levels of detail, depending on the policy concern of a country and data availability. Simplified standard SUT, which SADC countries are encouraged to compile are presented in Tables 5.1 and 5.2 and contain basic information on the supply and use of water and provides an overview of water flows. In addition, all the information contained in the tables is balanced: i.e. supply equals use. As a second step, a more detailed SUT can be compiled, with a more detailed breakdown of items in the simplified SUT.

Note that Tables 5.1 and 5.2 are split just for presentation purposes otherwise this is a continuation of the same table. The breakdown of the economic activities, classified according to ISIC Rev.4, distinguishes the following groups:

- ISIC 1-3 which includes Agriculture, Forestry and Fishing;
- ISIC 5-33, 41-43 which includes: Mining and quarrying, Manufacturing and Construction;
- ISIC 35 - Electricity, gas, steam and air conditioning supply;
- ISIC 36 - Water collection, treatment and supply;
- ISIC 37 - Sewerage;
- ISIC 38, 39, 45-99, which corresponds to the Service industries.

Note that irrigation and livestock have been separately identified due to their importance in SADC. The environment has also been acknowledged as a legitimate user of water and a column has been added on the right hand side of Table 5.1. Also ISIC 35, 36 and 37 have been separately identified because of their importance in the use and supply of water and water-related services. In particular, ISIC 36 and 37 are separately identified as they are key industries for the distribution of water and wastewater. Cost-recovery policies and policies aiming at improving the access to safe drinking water and sanitation are examples of policies involving almost exclusively these two economic activities.

ISIC 35 is a major user of water for hydroelectric power generation and cooling purposes: it abstracts and returns into the environment enormous quantities of water. Aggregating information on water use and supply by ISIC 35 with that of other industries would provide misleading information as the water use (and returns) of ISIC 35 alone may outweigh any other industry's water use (and returns).

Table 5.1 Physical use table

Million m^3

		Industries (by ISIC categories)												Environmental flow Requirements (ERF)	Households	Rest of the world	Total
		1 Agriculture				5-33	41-43	35		36	37	38,39, 45-99	Total				
		Irrigation	Livestock	Forestry	Fisheries			Total	*of which is Hydro*								
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 5.2 Physical supply table

Million m^3

		Industries (by ISIC categories)												Environmental flow requirements (ERF)	Households	Rest of the world	Total
		1 Agriculture						35									
		Irrigation	Livestock	Forestry	Fisheries	5-33	41-43	Total	*of which hydro*	36	37	38,39, 45-99	Total				
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)																
	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)																	
7. Consumption (=3-6)																	

The following paragraphs describe in detail each flow of water in the simplified standard physical supply and use tables, Tables 5.1 and 5.2.

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. Water used for hydroelectric power generation, is also considered as abstraction. In Table 5.1 water abstraction is disaggregated according to the purpose (abstraction for own use and for distribution) and type of source (abstraction from water resources – surface water, groundwater and soil water as in the asset classification - and from other sources which include sea water and precipitation).

Water is abstracted either to be used by the same economic unit which abstracts it, **abstraction for own use,** or to be supplied, possibly after some treatment, to other economic units, **abstraction for distribution**. Most of the water is abstracted for distribution by ISIC 36, *Water collection, treatment and supply*; however, there may be other industries which abstract and supply water as a secondary activity, mines for example usually abstract water for own use.

Abstraction from other sources includes the abstraction of sea water and the direct collection of precipitation for production and consumption activities. Water is generally abstracted from the sea either for cooling purposes - the corresponding wastewater flow is generally returned to the original source of water (i.e. the sea or ocean) – or for desalination processes. In the latter case, desalinated water could be returned to the inland water resource and constitute a resource. A typical example of collection of precipitation is roof rain harvesting by households.

Abstraction from soil water includes water use in rainfed agriculture. This is computed as the amount of precipitation that falls onto agricultural fields. The excess of water, e.g. the part that is not used by the crop, is recorded as a return flow to the environment from rainfed agriculture. It is important to record this flow for several reasons: it shows, for example, the relative contribution of rainfed and irrigated agriculture for food production. In addition, considering the importance of rainfed agriculture worldwide (more the 60% of all food production in the world is produced under rainfed conditions), this information can be used to assess the efficiency of rainfed agriculture (e.g. crop production per volume of water used) and to formulate water policies.

Within the economy, the **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. This water is usually delivered through mains (pipes), but other means of transportation are not excluded (such as artificial open channels, etc.). The **use of water received from other economic units** by the rest of the world corresponds to the **exports** of water. It is generally the industry, ISIC 36, which exports water.

The **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. It might be perceived that water abstracted for distribution is counted twice: first as a use when water is abstracted by the distributing industry and then when water is delivered to the user. However, water abstracted for distribution is a water use of the distributing industry even though this industry is not the end user of this water.

The **supply of water to other economic units** refers to the amount of water that is supplied by an economic unit to another. It includes the supply by one establishment to another. The supply of water is recorded net of losses in distribution. The supply to other economic units generally occurs through mains, but can also occur through artificial open channels, trucks and other means. The supply of water by the rest of the world corresponds to the **import** of water.

The supply of water to other economic units can be disaggregated in several categories. However, in the standard tables only **reused water** and **wastewater to Sewerage** are explicitly identified given their importance in water conservation policies. The concept of reused water is linked to that of wastewater. **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. Wastewater can be discharged directly into the environment (in which case it is recorded as a return flow), supplied to a treatment facility (ISIC 37) (recorded as wastewater to Sewerage) or supplied to another industry for further use (reused water). Total wastewater generated by an economic unit is obtained from Table 5.2 as the sum of the supply of reused water, wastewater to Sewerage and returns into the environment.

Reused water, defined as wastewater supplied to a user for further use with or without prior treatment, excludes recycling within industrial sites. It is also commonly referred to as *reclaimed wastewater*. It is important to record this flow as the reuse of water can alleviate the pressure on water resources by reducing direct abstraction of water: for example, watering golf courses and landscaping alongside public roads can be done by using (treated) wastewater instead of surface or groundwater. Also some industries, such as power-generation plants can use reclaimed wastewater (a lot of water is needed to cool power-generation equipment, and using wastewater for this purpose means that the facility does not use higher-quality water that may be best used somewhere else).

In order to avoid confusion, it should be noted that, once wastewater is discharged into the environment, its abstraction downstream is not considered as a reuse of water in the accounting tables, but as a new abstraction from the environment.

As already mentioned, reused water excludes the recycling of water within the same industry or establishment (on site). Information on recycled water, although very useful for analysis of water use efficiency, is not generally available. Thus the simplified standard tables do not explicitly report it. However, a reduction in the total volume of water used, while maintaining the same level of output, can provide an indication of an increase in water use efficiency which, in turn, may be due to the use of recycled water within an industry.

Within the economy, water can be exchanged between water producers and distributors before being effectively delivered to users. These water exchanges are referred to as **intra-sectoral sales**. These are the cases, for example, when the distribution network of one distributor/producer does not reach the water user and has to sell water to another distributor in order for the water to be delivered. These sales artificially increase the physical supply and use of water within the economy, but do not influence the global (physical) balance of water with the environment, and thus they are not recorded in the physical supply and use tables.

Total returns include water that is returned to the environment. Total returns can be classified according to the receiving media (i.e. water resources - as specified in the asset classification - and sea water) and to the type of water (e.g. treated water, cooling water, etc.). The standard tables report only the breakdown according to the receiving media so as to ensure the links with the flows in the asset accounts. More detailed tables can be compiled to show returns of different types of water.

The **total water supply** (row 6 in Table 5.2) is computed as the sum of the amount of water supplied to other economic units (row 4 in Table 5.2) and the amount of water returned to the environment (row 5 in Table 5.2).

Storage of water - water can be temporarily stored in the economy, e.g. in water towers, in closed cooling or heating circuits, etc. Therefore, when comparing the situation at the beginning and end of the period, some changes in inventories may occur. However, they are generally rather small (as water is a bulky commodity and thus costly to store) in comparison with the other volumes and thus not reported in the physical supply and use tables.

Tables 5.1 and 5.2 can be supplemented with information on the number of persons with sustainable access to an improved water source and with access to improved sanitation. This is discussed in detail under the section on social dimensions of water. Information on access to water is particularly important for the management of water resources and for poverty reduction: it used to monitor progress towards Target 10 of the Millennium Development Goal to "halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation". Presenting all water-related information, including social information, in a common framework has the advantage of allowing for consistent analyses and scenario modelling. For example, an analysis of the impact of investing in water infrastructure on the number of people having access to improved water sources could be easily undertaken if the information is organized according to the accounting framework.

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. This happens because during use part of the water is incorporated into products, evaporated, transpired by plants or simply consumed by households or livestock. The difference between the water use (row 3 in Table 5.1) and the water supply (row 6 in Table 5.2) is referred to as **water consumption**. It can be computed for each economic unit and for the whole economy. The concept of water consumption used in the SEEAW is consistent with the hydrological concept. It differs, however, from the concept of consumption used in the national accounts which instead refers to water use.

For the whole economy, the balance between water flows can be written as:

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 to other economic units equals the total water use received from other economic units, the identity can be rewritten as:

Total abstraction = Total returns + Water consumption.

Water consumption can include water that is stored, for example, in water towers, but this quantity is usually very small as water is generally stored only for a short period of time. When water consumption is computed for each industry, 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 use of water by industry *i* – Total supply of water by industry *i*

If we take the perspective of the inland water resource system, the discharges of water into the sea should also be considered as lost water since this water, once in the sea, is not directly available for further use as it would be in the case, for example, of discharges into a river, where discharged water becomes a resource for downstream uses. The concept of *inland water consumption* is introduced to give an indication of the amount of water that is not returned to the inland water system. Inland water consumption is thus calculated as:

Inland water consumption = Water consumption + Returns to Other sources (e.g. sea water).

Losses in distribution - within the economy, water supply is recorded net of losses in distribution. Losses in distribution are recorded in the tables as follows:

- They are allocated to the supplier of water
- Losses due to leakages are recorded as return flow to the environment
- Losses due to evaporation when, for example, water is distributed through open channels, are recorded as water consumption as they do not directly return to water resources
- Losses due to illegal tapping and malfunctioning metering are included in water consumption

It should be noted that losses in distribution are generally calculated as a difference between the amount of water supplied and that received. In this case, losses in distribution include not only real losses of water (evaporation and leakages) but also apparent losses which consist of unauthorized water use (such as theft or illegal use) and all inaccuracies associated with production and customer metering.

There are cases where illegal tapping – that is the illegal removal of water from the distribution network – is significant in magnitude and affects not only the efficiency of water distribution network but, at times, could cause major problems within the network (e.g. cause contaminants to enter into the mains via back-siphonage). Specific analyses may be required to determine the extent of this phenomenon. It may be useful, for countries in which illegal tapping is significant, to identify the units (households or industries) responsible for illegally connecting to the distribution network as well as the amount of water used by these units. This can easily be shown as a supplementary item in the table. This information would be very useful for policy purposes as it provides a more accurate indication of the actual water use by industries and households. When linked to the monetary accounts, the information could be used for pricing policies.

Consistent with the National Accounts, where illegal tapping is not considered as a transaction (use) in the supply and use tables, the EAW does not explicitly record it in the standard tables.

The methodologies were piloted in 4 countries and two river basins. Table 5.3 and Table 5.4 present examples of PSUT for Mauritius and Maputo River Basin, respectively. Detailed examples are presented in 6 separate pilot reports on Malawi, Mauritius, Namibia, Maputo River Basin and Orange-Senqu River Basin.

Table 5.3 Physical Supply and Use Table for Mauritius

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			Total	*of which is Hydro*								
From the environment	**1. Total abstraction** (=1.a+1.b=1.i+1.ii)	434	0.24				10.0	285.0	285.0	182.0			911.2			911.2	911.2
	1.a. Abstraction for own use	434	0.24				10.0		285.0	0.0						0.0	
	1.b. Abstraction for distribution	0								182.0						0.0	
	1.i. From water resources:												911.2			911.2	
	1.i.1 Surface water	412	0.24						285.0	69.0			766.2			766.2	
	1.i.2 Groundwater	22					10.0			113.0			145.0			145.0	
	1.i.3 Soil water															0.0	
	1.ii. From other sources												0.0			0.0	
	1.ii.1 Collection of precipitation															0.0	
	1.ii.2 Abstraction from the sea															0.0	
Within the economy	**2. Use of water received from other economic units**	34								17.0	57.7	9.9	118.6	179.1		297.7	
3. Total use of water (=1 + 2)		468	0.24	0	0		10		285	199.0	57.7	9.9	1029.8364	179.1	0.0	1208.9	1208.9

Million m3

		Industries (by ISIC categories)												Households	Rest of the world	Total	
		1 Agriculture				5-33	41-43	35		36	37	38,39, 45-99	Total				
		Irrigation	Livestock	Forestry	Fisheries			Total	*of which hydro*								
Within the economy	**4. Supply of water to other economic units**								51.0	189.0		6.0	246.0	51.7		297.7	
	of which:												0.0			0.0	
	4.a. Reused water								51.0				51.0			51.0	
	4.b. Wastewater to sewerage											6.0	6.0	51.7		57.7	
To the environment	**5. Total returns** (=5.a+5.b)	243.8	0	0	0	0	4	0	234.0	10	33.7	0	525.5	127.4		652.9	
	5.a. To water resources												0.0			0.0	
	5.a.1. Surface water						4		285.0				289.0			289.0	
	5.a.2. Groundwater												0.0			0.0	
	5.a.3. Soil water	243.8								10.0			253.8			253.8	
	5.b. To other sources (e.g. sea water)												0.0			0.0	
6.Total supply of water (=4+5)		243.8	0	0	0	0	4		285.0	199	33.7	6	771.5	179.1		950.6	950.6
7. Consumption (=3-6)		224.2	0.24	0	0	0	6		0	0	24	3.9	258.3	0.0		258.3	258.3

Table 5.4 Physical Supply and Use Table for Maputo River Basin

Million m3

		Industries (by ISIC categories): 1 Agriculture – Irrigation	Livestock	Forestry	Fisheries	5-33	41-43	35 Total	35 of which is Hydro	36	37	38,39, 45-99	Total	Environmental flow Requirements (ERF)	Households	Rest of the world	Total	
From the environment	**1. Total abstraction** (=1.a+1.b=1.i+1.ii)	350	15	237			0	941	941	221			1758	4195	13		5965	5965
	1.a. Abstraction for own use		15	453					400	0				4195	13		13	
	1.b. Abstraction for distribution	0							541	221							0	
	1.i. From water resources:												1758				1758	
	1.i.1 Surface water	350	9	237					941	221			1758				1758	
	1.i.2 Groundwater												0		13		13	
	1.i.3 Soil water		6														0	
	1.ii. From other sources												0				0	
	1.ii.1 Collection of precipitation																0	
	1.ii.2 Abstraction from the sea																0	
Within the economy	**2. Use of water received from other economic units**	325		217			57			0			598				598	
3. Total use of water (=1 + 2)		675	15	453	0		57		941	221	0	0	2356	4195	13	0	6563	6563

Million m3

		Industries (by ISIC categories): 1 Agriculture – Irrigation	Livestock	Forestry	Fisheries	5-33	41-43	35 Total	35 of which hydro	36	37	38,39, 45-99	Total	Environmental flow requirements (ERF)	Households	Rest of the world	Total	
Within the economy	**4. Supply of water to other economic units**						32	345	345	57			434		0	164	598	
	of which:									57			57				57	
	4.a. Reused water								345				345				345	
	4.b. Wastewater to sewerage						32						32				32	
To the environment	**5. Total returns** (=5.a+5.b)	67	0	45	0	0		0	596	164	0		873	4195	13		5081	
	5.a. To water resources												0				0	
	5.a.1. Surface water								596				596				596	
	5.a.2. Groundwater												0				0	
	5.a.3. Soil water	67		45						164			277		13		290	
	5.b. To other sources (e.g. sea water)											2	2				2	
6.Total supply of water (=4+5)		67	0	45	0	0	32		941	221	0	0	1307	4195	13	164	5679	5679
7. Consumption (=3-6)		607	15	408	0	0	25		0	0	0	0	1049	0	0	-164	885	885

6. Hybrid and Economic Accounts for Water

6.1 Introduction

The formulation and evaluation of a wide range of policies related to water, such as those aiming at ***efficient water allocation*** and the ***recovery of the costs*** of water services, are at the heart of water management. In this chapter we present the economics of water, that is to describe in monetary terms the use and supply of water-related products and to identify: (a) the costs associated with the production of these products, (b) the income generated by their production, (c) the investment in water-related infrastructure and the costs to maintain them, (d) the fees paid by the users for water-related services as well as the subsidies received. The economic instruments to manage water, namely taxes on the use of the resource and permits to access it, are also discussed in this chapter.

The starting point to study the economy of water is to present the conventional national accounts together with the physical information on water abstraction, namely the use and supply (Chapter 5) within the economy, and discharges of wastewater and pollutants into the environment. These accounts are referred to as “hybrid accounts”, where the name “hybrid” refers to the combination of different types of units of measurement in the same accounts. The presentation of physical and monetary information in the same accounts 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. Using the hybrid accounts in economic models permits the analysis of possible trade-offs between alternative water policies and economic strategies. The structure of the hybrid accounts is presented in section 6.2.

Economic accounts expand the hybrid accounts (a) for water-related activities carried out for own use (that is when industries, as well as households, abstract water for their own use, or treat the wastewater they generate) and (b) for expenditure of the government for water-related services (for example, the formulation and administration of government policy, the setting and enforcing of public standards, etc.). Even though the value of these activities is likely to be small compared with the other activities, the full extent of national expenditures on water can be understood only when all these expenditures are accounted for. Economic accounts for water-related activities carried out for own use and for government expenditure for water-related services are discussed in section 6.3.

Even though they are not explicitly discussed in the SEEAW, complete stock accounts (in physical and monetary units) for water-related infrastructures can be compiled by disaggregating the relevant information from National Accounts for produced assets. The standard tables only provide information on the stocks of water-related infrastructure, such as pumps and dams, as an example of the form of such accounts. Stock accounts for water-related infrastructure, which are already part of the National Accounts, often require additional data sources and data collection activities to separately identify those assets in monetary terms in the standard national accounts, as well as to obtain information on the physical characteristics of these structures (e.g. number, capacity, lifetime, depreciation, etc.). Stock accounts for water-related infrastructure can assist in formulating and evaluating policies that aim to improve access to water and sanitations, which are highly dependent on investments in infrastructure or on infrastructures which are already in place.

Section 6.4 discusses how other monetary flows related to water, such as taxes and subsidies are recorded in the accounts. Section 6.5 presents national expenditure and financing accounts for water-related activities classified by purpose. The national expenditure accounts give an indication of the expenditure by resident units on specific activities related to water, such as wastewater and water management. The financing accounts are particularly important as users of water and water-related products do not always pay for the entire costs associated with the use. They benefit from transfers from other economic units (generally the government) which bear part of the costs. Similarly, investments in infrastructures are also often partly financed by units other than the one that benefits from its use. The analysis of the financing of the use of water and water-related products, as well as investments in water-related infrastructures, provides information on how the expenditures are financed: by which agent and by means of which instrument (sales of services, environmental taxes, etc.). This information is relevant, for example, for assessing the implementation of the polluter/user-pay principle as the accounts for financing show the portion of the total cost paid by the polluter/user.

6.2 Hybrid supply and use tables

Hybrid supply and use tables (SUT) juxtapose the standard National Accounts supply and use table with the corresponding physical tables, described in chapters 5. In so doing, the physical and monetary data share the same structure, classifications and concepts. Physical information is juxtaposed to the monetary supply and use tables. This includes: (a) water abstraction, use and supply within the economy, and returns into the environment; and (b) emissions of pollutants. 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. In this way, hybrid accounts build a bridge between (aggregate) policy assessment and (underlying) policy research.

Hybrid accounts can be presented in different ways: one based on supply and use tables and the other on input-output tables. This section focuses on the supply and use table presentation of the hybrid accounts. The starting point for hybrid SUT is the 1993 SNA supply and use tables. As the term suggests, these tables record the value of the production (supply) and consumption (use) of products. The supply and use tables show, by row, products classified according to the Central Products Classification (CPC) Ver. 2.0 (UN, 2006a). The industries are classified, by column, according to International Standard Industrial Classification of all Economic Activities Revision 4, ISIC Rev. 4 (UN, 2006b).

The simplified standard hybrid SUT explicitly identifies the following two water-related products in the monetary part of the table:

- Natural water - CPC 1800, which is primarily associated with the output of ISIC 36, Water collection, treatment and supply. In the monetary supply and use tables, natural water corresponds to the exchanges of water between economic units (mainly between ISIC 36 and the other economic units such as other industries, households, and rest of the world). This class is very broad and it covers very different types of water exchanged in the economy including reused water.
- Sewerage, sewage treatment and septic tank cleaning services - CPC 941. This group includes Sewerage and sewage treatment services (CPC 9411) and Septic tank emptying and cleaning services (CPC 9412). These services are primarily associated with the output of ISIC 37, Sewerage.

Depending on data availability, other products related to water could also be explicitly identified in the tables. These include: *Operation of irrigation systems for agricultural purposes*, which is part of CPC 86110 and is primarily (and uniquely) associated with the output of ISIC 0161, *Support activities for crop production*; *Water-related administrative services*, which are part of CPC 91123 and primarily associated with the output of ISIC 8412; and *Site remediation and clean-up services* for surface and ground water (CPC 94412 and part of CPC 94413) primarily associated with the output of ISIC 3900.

Economic activities, classified according to ISIC Rev.4, are identified by column in the supply and use tables. The level of disaggregation of industries depends on the country's situation and data availability. The simplified standard tables identify a limited number of groups of industries for ease of compilation. These include the following groups:

- ISIC 1-3 - Agriculture, forestry and fishing;
- ISIC 5-33, 41-43 - Mining and quarrying, 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 – the so-called Service industries.

It is highly recommended for analytical purposes when compiling water accounts to further disaggregate the activities related to water other than ISIC 36 and 37, namely *Operation of agricultural equipment* (part of ISIC 0161), *Remediation activities and other waste management services related to water* (part of ISIC 3900), and *Administration of water-related programmes* (part of ISIC 8412).

In some countries activities of water supply (ISIC 36) and sewerage (ISIC 37) are carried out by the same establishment and no separate accounts are kept by the establishment. 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 each of these activities. Additional information and estimation may be needed to separate these activities. As recommended by the 1993 SNA, 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.

6.3 Hybrid water supply and use table

Table 6.1 presents the hybrid water supply and use table. The table consists of five parts:

- Monetary supply table. It describes in monetary units the origin of products. This information is organized according to the 1993 SNA supply table where products are shown in rows and the producers are presented in columns.
- Physical supply table of water. It contains information on the volumes of water supplied to other economic units and discharged (returns) into the environment (which corresponds to row 5 of Table 5.2). This information corresponds to the physical supply table described in the previous chapter.
- Total emission of pollutants in physical units. It shows gross emissions by industry for the sake of simplicity. Information on net emissions could also be shown in the same table. This information corresponds to the emission accounts described in chapter 8.
- Monetary use table. It provides information on the destination (use) in monetary units of products and, in particular, water-related products. The use table shows products by rows and industries by columns as the conventional 1993 SNA use table.

- Physical use table. It contains 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 chapter 5.

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

- Output at basic prices by industries classified according to ISIC Rev. 4;
- Imports;
- Other items to derive the total supply at purchasers' prices, namely (a) taxes and subsidies on products; and (b) trade and transport margins. Trade and transport margins include trade margins plus any transport charges paid separately by the purchasers in taking delivery at the required time and place (para. 15.40, 1993 SNA). In the case of water, transport margins are generally not separately invoiced and trade margins are often insignificant.

The bulk of the supply of *Natural water* (CPC 1800) and *Sewerage services* (CPC 941) appears in the columns corresponding to ISIC 36 and ISIC 37 as they group together establishments whose principal activities are the distribution of water and wastewater services respectively. Since an establishment may engage in other activities, the SNA makes a distinction between *principal* and *secondary activity*. The *principal activity* of a producer unit is the activity whose value added exceeds that of any other activity carried out within the same unit - the output of the principal activity must consist of goods or services that are capable of being delivered to other units even though they may be used for own consumption or own capital formation (para. 5.7, 1993 SNA). The *secondary activity* is an activity carried out within a single producer unit in addition to the principal activity and whose output, like that of the principal activity, must be suitable for delivery outside the producer unit (para. 5.8, 1993 SNA).

The lower part of Table 6.1 shows the format of the standard hybrid use table. The table consists of two parts: The uses of products in Table 6.1 are described by column in terms of: intermediate consumption, final consumption, exports and gross capital formation. Each of these uses is described below.

Intermediate consumption refers to the value of the goods and services consumed as inputs in production, excluding the using up of fixed assets, which is recorded as consumption of fixed capital in value added. Intermediate consumption is valued at purchaser's prices.

In the SEEAW, **final consumption** is measured in Table 6.1 in terms of actual final consumption rather than in terms of expenditures which is the common practice in the 1993 SNA. This is done to monitor the link between physical quantities of water and the monetary values of goods and services delivered to the households: often water-related services are not purchased directly by households, but are provided to them by government and non-profit institutions serving households (NGOs) free or almost free of charge. Actual final consumption measures the value of the goods or services delivered to households, regardless of whether they are paid by households themselves or by government units and NGOs through social transfers in kind.

Actual final consumption comprises of the following two categories:

- **Actual final consumption of households** includes the costs that households actually incur for the purchase of products (this corresponds to the concept of final consumption expenditure of households) and social transfers in kind from government and NGOs. These transfers correspond to the final consumption expenditure incurred by NGO (all considered individual) and individual consumption expenditure of government.
- **Actual final consumption of government** which corresponds to its collective (as opposed to individual) consumption expenditures (SNA 15.82).

Collective consumption expenditures of the government include the value of those services provided by the government for the benefit of all members of the community or of the society as a whole, in the sense that the consumption of one individual does not reduce the supply of the product to other individuals. Although collective services benefit the community, or certain sections of the community, rather than the government, the actual consumption of these services cannot be distributed among individual households, or even among groups of households such as sub-sectors of the household sector. It is therefore attributed to the same government units that incur the corresponding expenditures (para. 9.91, 1993 SNA). In the case of water, administrative services of water control and water quality monitoring are examples of services provided to the community as a whole, and their use is attributed to the government as a collective consumer.

Gross capital formation (GCF) is the total value of gross fixed capital formation, changes in inventories and acquisitions less disposals of valuables. It is included in table 6.1 at the aggregated level for consistency of presentation with the 1993 SNA tables to show the basic identity that supply equals use. In Table 6.1, GCF of Natural water is zero as it represents the use of this product for capital formation. Only in the case in which water is stored over two accounting periods could the value of GCF for natural water be non-zero. GCF for sewerage services is not applicable.

Exports consist of sales of products from residents to non-resident units.

Table 6.1 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, trade and transport margins	Actual final consumption		Capital Formation	Total
	Agriculture				5-33, 41-43	35		36	37	38,39, 45-99	Total industry						
	Irrigation	Livestock	Fisheries	Forestry		Total	*of which*: Hydro							Households	Government		
1. Total output and supply (Billions currency units)																	
of which:																	
1.a. Natural water (CPC 1800)																	
1.b. Sewerage services (CPC 941)																	
2. Total intermediate consumption and use (Billions currency units)																	
of which:																	
2.a. Natural water (CPC 1800)																	
2.b. Sewerage services (CPC 941)																	
3. Total value added (gross) (= 1-2) (Billions currency units)																	
4. Gross fixed capital formation (Billions currency units)																	
of which:																	
4.a. for water supply																	
4.b. for water sanitation																	
5. Stocks of fixed assets for water supply (Billions currency units)																	
6. Stocks of fixed assets for water sanitation (Billions currency units)																	
7. Total use of water (Millions m3)																	
7.a. (U1) Total Abstraction																	
of which: 7.a.1- Abstraction for own use																	
7.b. Use of water received from other economic units																	
8. Total supply of water (Millions m3)																	
8.a. Supply of water to other economic units																	
8.b. Total returns																	
9. Total (gross) emissions of COD (Thousand of tonnes)																	

6.4 Further disaggregation of hybrid accounts

In order to provide a complete picture of the economy of water, the hybrid accounts presented in Table 6.1 should be complemented with the accounts for water-related activities carried out for own use and for expenditures of the government on collective consumption services related to water.

Water-related activities carried out for own use is not explicitly identified in the national accounts. Their costs are incorporated into those of the principal activity of the establishment. In the SEEAW, 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 6.1. 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.

6.4.1 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 the following activities:

- Water collection, treatment and supply (ISIC 36),
- Sewerage (ISIC 37)

Remediation activities related to water (part of ISIC 39) could also be carried out for own use. They, however, are not included in the simplified standard tables because they are usually small.

Economic units may carry out abstraction or wastewater treatment for own use. This includes, for example, mines in Botswana and South Africa, 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.

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 the SEEAW 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 6.2 presents the hybrid account for activities of W*ater abstraction* and *Sewerage* 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 (as presented in chapters 5) 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 6.2 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 6.2 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.

Table 6.2 Cost of water supply and sewerage

Millions of currency units and Millions of m3

		36	37	Total
Water supply	**1. Costs of production** (=1.a+1.b) (Millions of currency units)			
	1. a. Total intermediate consumption			
	1.b. Total value added (gross)			
	1.b.1 Compensation of employees			
	1.b.2 Other taxes less subsidies on production			
	1.b.3 Consumption of fixed capital			
	2. Gross fixed capital formation (Millions of currency units)			
	3. Stocks of fixed assets (Billions of currency units)			
	4. Abstraction for distribution (Millions of m3)			
Sewerage	**1. Costs of production** (=1.a+1.b) (Millions of currency units)			
	1.a. Total intermediate consumption (Millions of currency units)			
	1.b. Total value added (gross)			
	1.b.1 Compensation of employees			
	1.b.2 Other taxes less subsidies on production			
	1.b.3 Consumption of fixed capital			
	2. Gross fixed capital formation (Millions of currency units)			
	3. Stocks of fixed assets (Millions of currency units)			
	4. Return of treated water (Millions m3)			

6.4.2 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) (UN, 2000b). 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 (UNSD, 2006).

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.

The above COFOG categories refer to collective services of the 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 the SEEAW. 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 regulation, licensing or supervision of producers, etc. as in the case of education and health. (Based on para. 9.86, 1993 SNA.)

In the cases in which the activities of water supply and sewerage are carried out by the government and are classified under ISIC 84, *Public administration and defence*, the activities related to the production of individual goods and services carried out by the government (such as water supply and wastewater services) should be separately identified, to the extent possible, from the activities related to the production of the collective services (such as the management and administration of water-related programmes, the setting and enforcement of public standards) and classified under the relevant ISIC category.

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. This table serves as input in the compilation of the table on financing in section 6.5.

Table 6.3: 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				

6.5 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).

6.5.1 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 the 1993 SNA context 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 many countries, notably where water use is not metered, water 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 (see para. 8.54(c), 1993 SNA) 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.

The following entries, as described in the 1993 SNA, are relevant for water:

- Other taxes on production (D29) include all taxes except taxes on products that enterprises incur as a result of engaging in production. Such taxes do not include any taxes on the profits or other income received by the enterprise and are payable irrespective of the profitability of the production. They may be payable on the land, fixed assets or labour employed in the production process or on certain activities or transactions. (para. 7.70, 1993 SNA). They explicitly include taxes on pollution defined as: “Taxes levied on the emission or discharge into the environment of noxious gases, liquids or other harmful substances; they do not include payments made for the collection and disposal of waste or noxious substances by public authorities” (para. 7.70, 1993 SNA).
- Other current taxes (D59), in the secondary distribution of income accounts, which include payment by households to obtain certain licences.
- Rent is a property income receivable by the owner of a tangible non-produced asset in return for putting the tangible non-produced asset at the disposal of another institutional unit. In other words, rent is the property income received from certain leases on land, sub-soil assets and other naturally occurring assets (para. 5.91, IMF 2001).

One of the regulatory functions of government is to forbid the ownership or use of certain goods or the pursuit of certain activities unless specific permission is granted by issuing a license or other certificate for which a fee is demanded. If the issue of such licenses involves little or no work on the part of the government, the licenses being granted automatically on payment of the amount due, it is likely that the licenses are simply a device to raise taxes (and thus are recorded as other taxes on production) even though they provide a certificate or authorization in return.

Thus payments to government on access (including abstraction and exploitation) of water resources, granted with little or no work on the part of the government, are recorded as other taxes on production (1993 SNA, D29) when paid by enterprises and other current taxes (1993 SNA, D59) when paid by households (para. 5.38, IMF 2001) when the resource is owned by the government. However, when government uses the issue of license to exercise a regulatory function (for example, by carrying out some sort of control that it would otherwise not be obliged to) the sale of licenses should be recorded as a sale of services (based on para. 5.54 IMF 2001). Payment on access to water resources owned by the government units are recorded as rent (para. 5.94, IMF 2001).

Subsidies can be thought of as negative taxes on production and their impact on the operating surplus is in the opposite direction to that of taxes on production. They are current unrequited payments that government units, including non-resident government units, make to enterprises on the basis of the levels of their production activities or the quantities or values of the goods or services which they produce, sell or import (para. 7.71, 1993 SNA). Subsidies are receivable by resident producers or importers and are not payable to final consumers.

Current transfers that governments make directly to households as consumers are treated as social benefits. Subsidies do not include grants that government may make to enterprises in order to finance their capital formation, or compensate them for damage to their capital assets, such grants being treated as capital transfers (para. 7.72, 1993 SNA).

6.5.2 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.

The 1993 SNA introduced a new 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.

6.6 National expenditure and 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.

6.6.1 Environmental protection and resource management related to water Environmental protection

6.6.1.1 Environmental Protection

This section describes environmental protection (EP) activities but also products, actual outlays (expenditure) and other transactions related to water. They 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.

Environmental protection activities are production activities in the sense of national accounts (see, for example, 1993 SNA paragraph 6.15), that is, they combine resources such as equipment, labour, manufacturing techniques, information networks or products to create an output of goods or services. An activity may be principal, secondary or for own use.

Environmental protection products are:

- Environmental protection services produced by environmental protection activities; and
- Adapted (cleaner) and connected products. Connected products are products whose use by resident units directly and exclusively serves an environmental protection objective but which are not environmental protection services produced by an environmental protection activity. Adapted (or ‘cleaner’) products are defined as products that meet the following criteria: (a) on the one hand, they are less polluting when consumed and/or disposed than equivalent normal products (equivalent normal products are products that provide similar utility, except for the impact on the environment); (b) on the other hand, they are more costly than equivalent normal products (Eurostat, 2002a). The expenditures recorded are the purchasers’ prices of environmental protection services and connected products and the extra costs over and above a viable but less-clean alternative for cleaner products.

Expenditure for environmental protection includes outlays and other transactions related to:

- Inputs for environmental protection activities (energy, raw materials and other intermediate inputs, wages and salaries, taxes linked to production, consumption of fixed capital);
- Capital formation and the purchase of land (investment) for environmental protection activities;
- Outlays of users for the purchase of environmental protection products;
- Transfers for environmental protection (subsidies, investment grants, international aid, donations, taxes earmarked for environmental protection, etc.).

In the case of water, *Wastewater management* and *Protection and remediation of soil, groundwater and surface water* are considered for the protection of the environment and are part of the Classification of Environmental Protection Activities and Expenditure (CEPA-2000).

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. (Explanatory notes of CEPA-2000, SEEA-2003). 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. (Explanatory notes of CEPA-2000, SEEA-2003). *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. *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).

The management of natural resources (for example, water supply) are not included in CEPA. Even though there is no agreed classification for natural resources management and exploitation, the framework of environmental protection expenditure accounts (EPEA) can be extended to cover natural resources management and exploitation.

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.

6.6.1.2 National expenditure accounts

National expenditure accounts aim at recording the expenditure of resident units and financed by resident units in order to get a total that corresponds to the effort a nation is making out of its own resources. They are compiled for environmental protection related to water, namely *Wastewater management* and *Protection and remediation of soil, groundwater and surface water* as well as for *Water management and exploitation*. The standard tables for the national expenditure and financing accounts are compiled only for *Wastewater management* and *Water management and exploitation*. The compilation of the tables on *Protection and remediation of soil, groundwater and surface water* require additional data disaggregation of what is included in the standard tables.

This sub-section describes the component of the national expenditure for EP and illustrates the national expenditure accounts for *Wastewater management* in Table 6.4. These accounts can also be compiled for *Water management end exploitation* and *Protection and remediation of soil, groundwater and surface water*.

The main components of the national expenditure for environmental protection, described by row in the accounts presented in Table 6.4, consist of the following:

- Use of environmental protection (EP) services by resident units (except specialised producers to avoid double counting – see para. 5.70 for a detailed explanation). This is the sum of intermediate and final consumption and capital formation. Intermediate consumption includes the use of EP services for own use and EP services purchased by other producers. Only in the case of soil remediation can the use of EP services for capital formation (row 1.c of Table 6.4) be non-zero for other producers. This entry consists of improvement of land resulting from decontamination of soil. It is not included in row 2 of Table 6.4 as it is a use of the output of ISIC 39 by other producers and not an investment for production of EP services or land acquisition, which are recorded in row 2 of Table 6.4. In the case of Wastewater management, the use of EP services corresponds to the use of Wastewater services (CPC 941 and CPC 91123) for intermediate and final consumption by resident units (except by Specialised producers – in this case ISIC 37). Capital formation is not relevant for water and wastewater services thus it is not recorded under this category.
- Use of Adapted and Connected products for intermediate and final consumption. In the case of Wastewater management, adapted products include, for example, phosphate free washes and highly biodegradable products. Connected products include, for example, septic tanks, biological activators of septic tanks and services for collecting septic tanks sludge.
- Gross capital formation for producing EP services. This item corresponds to the investments made by EP producers for producing EP services. It includes gross fixed capital formation and net acquisition of land. In the case of Wastewater management, it corresponds to the gross capital formation related to wastewater management activities: e.g. the installation of sewage networks, treatment plants, etc. This corresponds to the investments made by the producers of wastewater services for collecting, treating and discharging wastewater.
- Specific transfers received for EP. Specific transfers are unrequited payments received by residents or non-resident units which contribute to the financing of characteristics activities and uses of specific products or constitute a compensation for income or losses related with environmental protection (SERIEE14 § 2039, Eurostat, 1994). This item includes current and capital transfers for EP. They are not the counterpart of the previous items in the table in order to avoid the double counting. In the case of Wastewater management, specific transfers consist, for example, of subsidies to specialised producers of sewerage and treatment services and also of transfers to the rest of the world in order to finance programs of collective sewerage and treatment in other countries (international public or private aid for development) (SERIEE § 4071).

The sum of the categories above corresponds to the *total domestic use* of EP services. Since the national expenditure aims at recording the expenditure of resident units and financed by resident units in order to get a total that corresponds to the effort a nation is making out of its own resources, the financing of the *Rest of the world* (row 6 of Table 6.4) for EP has to be subtracted from the total domestic use. In the case of *Wastewater management*, this financing consists of international aid for *Wastewater management*.

National expenditure for EP is allocated by column to the following categories of beneficiaries:

Producers, Final consumers and the *Rest of the world*. Producers are further disaggregated into *Specialised producers* and *Other producers*. *Specialised producers* which are defined as those producers which carry out an EP activity as their principal activity. In the case of wastewater management, they correspond mainly to producers classified in ISIC 37. *Other producers* as those producers that use EP services (including the use of EP services for own use) and connected and adapted products for their intermediate consumption, invest for their production of EP services for own use and receive specific transfers for EP.

Final consumers identified in national expenditure accounts include *Households* as actual consumers of EP services and connected and adapted products or as beneficiaries of specific transfers and *Government* in its capacity as consumer of collective services.

The *Rest of the world* is included by column as part of the users/beneficiaries as it may receive specific transfers for EP. In the case of *Wastewater management*, transfers to the *Rest of the world* include transfers “to finance programs of collective sewerage and treatment in other countries” (SERIEE § 4071).

Expenditure by *specialised producers* (ISIC 37) consists of gross capital formation for the production of *Wastewater services* (capital formation, row 2 of Table 6.4) and specific transfers (row 4 of Table 6.4). The entries in the other cells of the column of *Specialised producers* should not be recorded in order to avoid double counting between the output (and subsequent uses). The use of *Wastewater services* and *Connected and adapted products* for intermediate consumption by *Specialised producers* is part of the output of the *Specialised producers* and recorded as intermediate consumption of *Other producers* and final consumption of *Households* and *Government*. It is thus already included in the total national expenditure. The use of EP services for capital formation (row 1.c of Table 6.4) should also not be recorded for specialised producers as it represents the use of capital goods for the production of EP services and thus included in the gross capital formation in row 2.

Expenditure of *Other producers* includes: the use of *Wastewater services* as intermediate consumption (including also services produced for own use) (row 1.b); investments for the production of wastewater services as secondary activity or for own use (row 2); the use of *Connected and Adapted products* (row 3); and specific transfers (row 4).

Information in the row 1 and 2 of Table 6.4 is derived from the hybrid account for supply and use of water, hybrid account for water related activities for own use and government accounts on water related collective services in Table 5.5. For example, the use of *Wastewater services* by *Other producers* is the sum of the use of *Sewerage services* from Table 6.1

Table 6.4 National expenditure 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. Use of Wastewater Services						
1.a Final Consumption						
1.b Intermediate Consumption						
2. Gross Capital Formation						
3. Use of connected and adapted products						
4. Specific Transfer						
5. Total domestic use (= 1+2+3+4)						
6. Financed by the rest of the world						
7. National expenditure (= 5-6)						

Grey cell indicates non relevant or zero entries by definition

6.6.1.3 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 6.5: Financing accounts for wastewater management

Billion currency unit

	USERS/BENEFICIARIES					
	Producers		Final Consumers			
	Specialised Products (ISIC 37)	Other Products	Households	Government	Reset of the World	Total
1. General Government						
2. NGOs						
3. Corporations						
2. Gross Capital Formation						
3.a Specialised 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

7. Water Asset Accounts

For SADC Member States and River Basin Organisations to manage their water resources more effectively they need to know the stock of natural water resources as well as stock of water infrastructure for storage, treatment and distribution of water. 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.

7.1 Definition of Assets

The 1993 SNA defines economic assets as entities:

(a) Over which ownership rights are enforced by institutional units, individually or collectively; and

(b) From which economic benefits may be derived by their owners by holding them, or using them, over a period of time (para 10.2, 1993 SNA).

In particular, in the case of water, the 1993 SNA defines water resources within its asset boundary as "aquifers and other groundwater resources to the extent that their scarcity leads to the enforcement of ownership and/or use of rights, market valuation and some measure of economic control". Thus only a small portion of the total water resources in a country is included in the 1993 SNA.

The SEEA-2003 extends the 1993 SNA boundary to include all water resources that provide direct use and non-use benefits. This implies that the SEEA-2003 asset category "water resources" (classified in the category EA.13) includes all the water resources from which water can be extracted in the current period as well as other resources which may be extracted in the future. This amounts to include all water resources in the national territory.

7.2 Asset classification

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. The SEEAW asset classification of water resources consists of the following categories:

EA.13 Water Resources (measured in cubic metres)

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 SEEAW asset classification expands the SEEA-2003 classification by including the categories EA.1314 Glaciers, snow and ice and EA.133 Soil water. While the SEEA-2003 acknowledges the importance of these resources in terms of flows, it does not include them in the asset classification because they represent only a temporary storage of 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 consists of water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface, that can be discharged in to the atmosphere by evapotranspiration.

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.

7.2.1 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.

7.2.2 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 vaporised and evapotranspired from water resources; and (c) precipitation into water resources (flow from the atmosphere into the inland water resources).

7.2.3 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.

7.3 Asset accounts

The water asset accounts describe the stocks of water resources and their changes during a period of time. 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.).

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 7.1. 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. River assets have been expanded to reflect ephemeral rivers which are important in Botswana and Namibia. Rain-fed agriculture has also been added since this is important in SADC.

Table 7.1 Asset accounts

Millions Cubic Metres

	EA.131 Surface water				EA.132 Groundwater	EA.133 Rain-Fed Agric	Total
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.1313 Rivers				
			Perennial	Ephemeral			
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in the territory							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual evapotranspiration							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the territory							
8. Other changes in volume							
9. Closing Stocks							

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.

A*bstraction* 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 evapotranspiration can only be estimated through modelling 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 7.1 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.

7.4 Definition of stocks for 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.

7.4.1 Link with Supply and Use tables

Asset accounts in physical units are linked with the supply and use tables. 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 7.1 corresponds to the Abstraction from Water Resources by the economy in the physical use table, row 1.i of Table 5.1. Similarly, the returns that appear in Table 7.1 correspond to the Total Returns to Water Resources in the physical supply table, row 5.a of Table 5.2.

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.

7.5 Accounting for transboundary water resources

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 neighbouring countries.

Table 7.2 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 7.3 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 7.2. However, for sake of simplicity of presentation, this information is not included in Table 7.3

Table 7.2 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 evapo-transpiration		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		

Table 7.3 Asset accounts for a river basin shared by two countries

Cubic Metres

	Water Resources (classified according to the asset classification)		Total
	Country 1	Country 2	
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			

8. Water Wastewater and Pollutant Accounts

Based on input from participants at the first regional workshop on economic accounting of water held in Gaborone, Botswana 24-25 February, 2010, in this manual we use the term water “wastewater and pollutant accounts” instead “emission” accounts as applied in SEEAW. Effluent, especially when discharged to fresh water bodies untreated can cause substantial water pollution. Different types of pollutants generated during production and consumption activities are discharged into water bodies. Some of the pollutants discharged into water resources are highly toxic and thus affect negatively the quality of the receiving water body and ultimately human health. Similarly, other substances, such as nitrogen and phosphorus, can lead to eutrophication, or organic substances can have negative effects on the oxygen balance thus affecting the ecological status of the receiving water body.

Wastewater and pollutant accounts describe the flows of pollutants added to wastewater as a result of production and consumption, and flowing into water resources either directly or through the sewage network. They measure the pressure by human activities on the environment by presenting information on the activities responsible for the effluent, the types and amount of pollutants added to wastewater as well as the destination of the effluent (e.g. water resources and sea). Wastewater and pollutant accounts are a useful tool for designing economic instruments, including new regulations to reduce water pollution. When analysed in conjunction with the technology in place to reduce pollution and treat wastewater, they can be used in impact studies of new technologies.

8.1 Coverage of emission accounts and basic concepts

Effluent discharge to water refer to the direct release of pollutants to water as well as the indirect release by transfer to an off-site wastewater treatment plant. In this manual, wastewater and pollutant accounts focus only on the release of pollutants into water resources through the (direct and indirect through a wastewater treatment plant) discharge of wastewater into water resources. The direct discharge to water resources of heavy metals and hazardous waste not through wastewater is not covered in the water wastewater and pollutant accounts.

Wastewater and pollutant accounts record the amount of pollutant added to water by an economic activity during a reference period (generally the accounting year) and are expressed in terms of weight (kilograms or tonnes, depending on the pollutant under consideration). They describe in terms of pollutants, the part of the water flows in the physical supply and use tables of Chapter 5 that are destined to the environment either directly or through a treatment plant. Wastewater and pollutant accounts cover: (a) pollutants added to wastewater and collected in the sewerage network; (b) pollutants added to wastewater discharged directly to water bodies; and (c) selected non-point sources emissions, namely discharge from urban runoff and from agriculture. The wastewater and pollutant accounts thus provide the description, in terms of pollutants resulting from production and consumption, of the wastewater flows discussed in Chapter 5.

8.1.1 Point and non-point source emissions

Sources of pollution are classified as point source and non-point source pollution. Point source pollutions are those pollutants for which the geographical location of the discharge of the wastewater is clearly identified. They include, for example, discharge from wastewater treatment plants, power plants, other industrial establishments. Non-point (or diffuse) sources of pollution are sources without a single point of origin or a specific outlet into a receiving water body. Pollutants are generally carried off the land by storm-water runoff or may be the result of a collection of individual and small scale polluting activities which for practical reasons cannot be treated as point sources of pollution. The commonly used categories for non-point sources include agriculture and urban areas.

Point source emissions are generally considered easier to measure since the point of emission to the water resources is clearly identified. This in turn allows for the identification of the economic unit responsible for the pollution and for the measurement of the pollution content of the discharge at the precise location. Non-point source of emissions cannot be measured directly but need to be estimated through models which take into consideration several factors including the soil structure and the climatic conditions as well as the delay with which the pollutants reach the water table. Further, it is difficult to allocate non-point pollution sources to the economic unit that generates them because of their nature.

Wastewater and pollutant accounts include all point source discharge of pollutants in wastewater and those nonpoint sources for which physical flows are recorded in Chapter 5, namely urban runoff and irrigation water. Urban runoff is described in the wastewater and pollutant accounts in terms of the pollutants deposited on urban areas and in the air, often as a result of transport or other economic activities. Returns of irrigation water and rainfed agriculture are described in terms of the pollutants which are added to the return flows from agricultural land, that is fertilizers and pesticides spread on the soil during infiltration into groundwater or runoff to surface water.

For the sake of simplicity as wells as to maintain consistency with the water flows in the physical supply and use tables presented in Chapter 5, a number of non-point source pollutants are excluded in wastewater and pollutant accounts, although they affect the quality of water resources. In a more comprehensive approach, all pollutant discharged to water would be included in the wastewater and pollutant accounts. These include, for example, pollutants that reach the water bodies after leaking from landfill sites or having passed through natural land. As precipitation passes through waste, it collects polluting compounds including ammonia, heavy metals, chloride and oxygen-depleting substances which ultimately infiltrate the soil and reach a groundwater body. The same can occur when precipitation after having absorbed pollutants present in the air infiltrate natural land.

8.1.2 Water pollutants

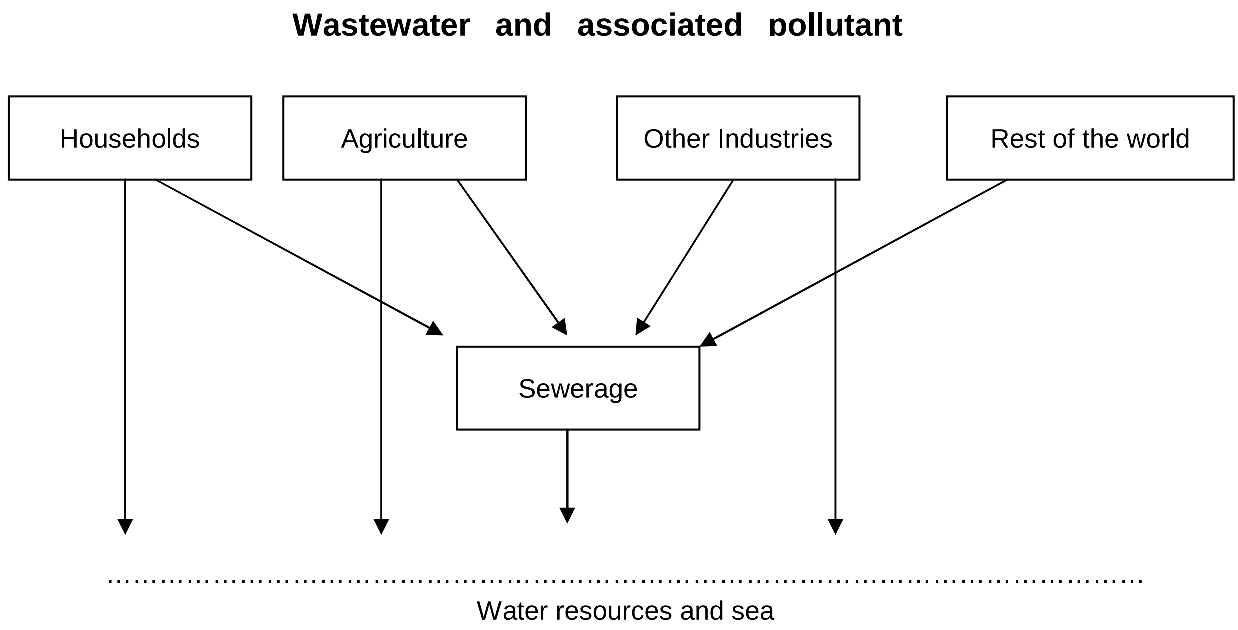
A list of pollutants has to be identified before compiling wastewater and pollutant accounts. Most often this list is based on the country's environmental concerns as well as national legislation on water and, where applicable, international agreements.

8.1.3 Gross and net effluent

The pathway of pollutants from their origin to their release into the environment helps in defining the coverage of the emission accounts. Figure 8.1 shows schematically the path that the wastewater and associated pollutants generated by an economic unit follows. The economic units identified in the figure are: households, agriculture, other industries and the rest of the world. The wastewater and associated pollutants are either discharged directly into the environment with or without self-treatment, or supplied to a wastewater treatment plant.

The fact that the discharge of pollutants to the environment can occur in one or two steps (directly or through a treatment plant - ISIC 37), leads to the distinction between gross and net effluent. ***Gross effluent*** is the pollutants added to the water by an activity, assessed at the point where the wastewater leaves the activity's site (or the dwelling, in the case of households). *Net (or final) effluent* corresponds to the pollutants discharged into water resources. When wastewater is discharged directly into a water body gross and net effluent coincide. In practice, however, an economic activity may discharge part of its wastewater directly into water resources (thus releasing the pollutants directly), and supply the rest to a wastewater treatment plant which, after treatment, discharges the 'treated' wastewater into the environment. Since treated wastewater may still contain traces of the pollutant generated by the economic activity, the net effluent of the economic unit would correspond to the sum of the direct release of pollutants into water resources and the indirect release through wastewater treatment plants.

Figure 8.1 Wastewater and associated pollutant pathway



Source: UNSD, 2006

For the whole economy, the difference between gross and net effluent totals would correspond to the pollution removed by purification processes including wastewater treatment plants. Of course the distinction between gross and net effluent is not applicable for non-point pollution (e.g. resulting from agriculture).

In the calculation of the net effluent, the release of pollutants by the sewerage industry, ISIC 37, has to be reallocated to the economic unit responsible for the discharge in the first place. This is often difficult to calculate as the industry ISIC 37 treats aggregated flows of wastewater coming from diverse users of the sewage system. In general, the allocation of effluent in the return flow of ISIC 37 to the original economic unit responsible for generating that pollution is obtained by applying global abatement rates of the treatment plant to every effluent collected by the treatment plant.

The exchange of pollutants with the rest of the world (import and export) covers only exchanges of pollutants associated with the discharge of wastewater from one economy to a wastewater treatment facility (ISIC 37) of another economy. For example, the import of a pollutant corresponds to the import of wastewater from the rest of the world with the aim of discharging it, possibly after treatment, in the national territory. Wastewater and pollutant accounts do not include 'imports' and 'exports' of pollutants through natural flows. For example, the pollutant content of rivers crossing country borders and/or flowing to the open sea. These are covered in the quality accounts in following chapter.

8.2 Wastewater and pollutant accounts

As discussed above, wastewater and pollutant accounts record the pollution added to water by an economic unit and not the total pollution discharged with wastewater. This implies that, if an industry abstracts (or receives) 1 cubic metre of water which already contains *x* kg of a pollutant and returns to a river 1 cubic metre of wastewater containing *y* kg of the same pollutant, even though the total discharge of the pollutant to the river is *y* kg, only (*y*-*x*) kg is recorded as it represents the pollution generated by the industry. This has several implications for the measurement of pollutants: the level of pollution is not given by the pollutants content of outgoing flows of water, but by the difference between the pollutants content of incoming and outgoing flows. While for drinking water the pollutant content should normally be negligible, for some other uses (e.g. cooling or process water) the pollutant content of the incoming water can be significant.

Pollution is generally measured in terms of quantity of a measured parameter released during a certain period of time. They can be expressed either directly in terms of the quantity of a parameter (for example, kilogram per year) or reported to an arbitrary unit that can represent one or more parameters. For example, population equivalent made of five-day biochemical oxygen demand (BOD5), Nitrogen (N), Phosphorus (P), Suspended solids (SS).

Information on pollution to water is organized in the accounts according to Table8.1. In order to avoid the double counting of the effluent by ISIC 37, *Sewerage*, wastewater and pollutant accounts comprise of two tables. The first table, table A, starts with a description of gross effluent by industries. In this table, only the pollutant content of the urban runoff collected and discharged by ISIC 37, *Sewerage*, is recorded under the column of ISIC 37 as ISIC 37 is the economic activity responsible for its collection and discharge.

The second table of the wastewater and pollutant accounts, table B, records the discharges to water by ISIC 37. It allows for the reallocation of pollutants of ISIC 37 to the industries generating them in the first place thus allowing for the calculation of net effluent. Table A ‘gross and net effluent’ in Table 8.1 reports the following items:

- The total amount of a pollutant generated by an economic unit (gross effluent) measured at the point of discharge (row 1 of Table 8.1). This information is disaggregated in the following categories:
    - The amount of pollutant that is released directly into water (that is, it is contained in the direct discharge of wastewater into the environment) (row 1.a of Table 8.1);
    - The amount of pollutant that is released into the sewer system (row 1.b of Table 8.1). Note that the pollutant content of the urban runoff collected by ISIC 37 is recorded in this row.
- The indirect discharge to the environment of each industry through ISIC 37 (row 2 of Table 8.1). These pollutants can be calculated once the discharge to water by ISIC 37 are identified in table B;
- The net effluent by industry (row 3 in Table 8.1) is obtained by the sum of direct and indirect discharge.

The direct discharge to water are further disaggregated according to whether wastewater has undergone on-site treatment (row 1.a.1 and 1.a.2 of Table 8.1) and/or according to the receiving media (row 1.a.i and 1.a.ii of Table 8.1) – water resources and the sea. Additional information can be presented in supplementary tables to further disaggregate effluent according to the type of receiving media, e.g. surface water and groundwater.

Table B 'effluent by ISIC 37' in Table 8.1 presents detailed information on the discharge to water by ISIC 37, *Sewerage*, and allows for the calculation of net emissions by industries. In particular, the second part of Table 8.1 presents the following information:

- Total amount of pollutant released by ISIC 37, Sewerage, (row 4 of Table 8.1), which is disaggregated to:
  - The amount of pollutant that is released directly into water after having undergone treatment (row 4.a of Table 8.1).
  - The amount of pollutant that is released directly into water without treatment (row 4.b of Table 8.1). For example, discharges of raw sewage through a sewage collecting system.

Table 8.1 Wastewater and pollutant account

tonnes

	Industries (by ISIC categories)						Households	Rest of the world	Total
Pollutant BOD or COD	1-3	5-33, 41-43	35	36	38,39, 45-99	Total			
Gross effluent (= a + b)									
a. Direct effluent to water (= a1 + a2 = b1 + b2)									
a1. Without treatment									
a2. After on-site treatment									
b1. To water resources									
b2. To the sea									
b. To Sewerage (ISIC 37)									
d. Reallocation of effluent by ISIC 37									
e. Net effluent (= a. + d.)									

Table B: Effluent to water by ISIC 37

Physical units

Pollutant	ISIC 37
c. Effluent to water (=c1 + c2)	
c1. After treatment	
To water resources	
To the sea	
c2. Without treatment	
To water resources	
To the sea	

Effluent by ISIC 37 is disaggregated according to receiving media. Additional information can be presented in supplementary tables to further disaggregate emissions by ISIC 37 according to the type of receiving media, i.e. surface water and groundwater.

In order to calculate net effluent by industry, the discharges to water by ISIC 37 (row 4 of Table 8.1) have to be reallocated to the industry responsible for the discharge in the first place. Row 2 of Table 8.1 explicitly shows the reallocation of effluent from ISIC 37 to the various industries.

When information is available, effluent from wastewater treatment plants could be further disaggregated in Table 8.1 according to the type of treatment process. Three types of treatment processes are identified by the UNSD/UNEP Questionnaire (mechanical, biological and advanced) and the OECD/Eurostat Questionnaires (primary, secondary and tertiary).

For policy purposes, it may be useful to record, in supplementary tables, additional information such as the pollutant content and volume of sludge generated by ISIC 37 and number of people with access to improved sanitation. In some countries there is legislation regulating the generation and disposal of sewage sludge which requires the collection of information on sludge production (usually in dry weight as, depending on the methods of water treatment and sludge treatment such as digestion, filter-pressing etc., the concentration of dry solids can be very variable) as well as its pollutant content.

During wastewater treatment, sewage sludge is generated as accumulated solids and is separated from water. Due to the physical-chemical processes involved in the treatment, the sludge tends to concentrate heavy metals and poorly biodegradable trace organic compounds as well as potentially pathogenic organisms (viruses, bacteria etc.) present in wastewaters. On the other hand, sludge can be rich in nutrients, such as nitrogen and phosphorous, and contains valuable organic matter that is useful when soils are depleted or subject to erosion.

The indicator on the number of people with access to improved sanitation, target 10 of the Millennium Development Goals, is an indicator of the ability of a country to prevent damages to human and environmental health originating from wastewater discharge (by avoiding, for example, the spread of excreta-related diseases and by reducing pollution of water resources). The indicator is based on the distinction between improved and not improved sanitation. Improved sanitation technologies consist of connection to a public sewer, connection to a septic system, pour-flush latrine, and ventilated improved pit latrine. Not improved sanitation technologies consist of service or bucket latrine (where excreta are manually removed), public latrine and latrine with an open pit (WHO/UNICEF). Presenting information on this indicator together with the accounts facilitates integrated analyses of emissions to water.

8.2.1 Urban runoff

The collection and discharge of urban runoff is recorded both in terms of volume (in the physical supply and use table) and in terms of pollutant load (in the wastewater and pollutant accounts). This is because it is highly polluted and there is an increasing awareness in the potential danger of discharging it into the environment without treatment. Urban runoff usually contains a great deal of litter and organic and bacterial wastes as well as oil, antifreeze, detergents, pesticides and other pollutants that get washed from driveways, backyards, parking lots and streets and are usually collected through storm sewers (drains usually at street corners or at low points on the sides of the streets).

Even though the pollution content of urban run-offs is the result of a 'diffuse' pollution and often it can be also the result of natural origins (For example, leaves in the gutters that create an organic pollution), its emissions to water are allocated to ISIC 37, *Sewerage*, since this is the economic unit responsible for its collection and discharge. When urban runoff is collected in the same sewer system that collects domestic and commercial wastewater (sanitary sewers), it may be difficult to measure the amount of pollutant, which pertains specifically to urban runoff.

8.2.2 Water collection, treatment and supply by ISIC 36

Wastewater and pollutant accounts report the direct and indirect (through ISIC 37) releases of wastewater pollutants to the environment. Thus the removal of pollutants during purification processes by the industry ISIC 36, *Water collection, treatment and supply*, does not appear in Table 8.1. In addition, water supplied by ISIC 36 can, in most of the cases, be considered almost free of pollutants as purification of water generally involves other pollutants (e.g. microbiological pollutants).

Supplementary tables can be constructed to analyse the pollutant load of the water abstracted and supplied by ISIC 36 to study the efficiency of purification processes (removal of pollutant from abstracted water before distribution).

9. Water Quality Accounts

Water quality determines the uses that can be made of it. Pollution creates health hazards, detrimentally affects biodiversity, raises the costs of treating water and increases water stress. Pollution of groundwater aquifers can potentially be irreversible if not detected at an early stage. The importance of monitoring and accounting for water quality is internationally recognized (see, for example, World Meteorological Organization, 1992, and Agenda 21 (United Nations, 1992)). International targets have been established with regards to the quality of water.

The previous chapters have focused on water in terms of an input into the production process and water availability regardless of its quality, this chapter focus on the quality of water and its link to various uses. It can be seen as a first step towards ecosystem accounting and its variants. However, it is important to note that quality accounts are not yet fully developed and internationally there is very little practical experience.

Quality accounts do not have a direct link to the economic accounts, in the sense that changes in quality cannot be attributed to economic quantities using linear relationships, as in the case of the water asset accounts presented in Chapter 8. However, since quality is an important characteristic of water and limits its use, water accounting covers the quality accounts. Further, the SEEAW covers driving forces in terms of the structure of the economy and population, pressures in terms of abstraction of water and effluent, responses in terms of environmental expenditures and taxes and fees charged for water and sanitation services. The state and impacts are represented in terms of quality accounts.

Quality accounts describe the quality of the stocks of water resources. The structure of the quality accounts is similar to that of the asset accounts. The quality accounts, however, look much simpler than the asset accounts, as changes in quality are the result of non-linear relationships. Therefore, it is not possible to distinguish changes in quality due to human activities from changes in quality due to natural causes.

Although constructing quality accounts may be simple from a conceptual point of view, there are two main issues with its implementation: the definition and measurement of water quality classes. Water quality is generally defined for a specific concern and there is little standardisation of concepts and definitions or aggregation methods. Aggregation can be (i) over different pollutants to reach one index, which measures the combined impact of pollutants on water resources, (ii) over time to address seasonal variations; (iii) over space, to reach a single quality measure for measurements at different locations.

Because of the issues outlined above, and a lack of a sufficient number of country experiences, this chapter is presented in terms of issues and lessons learnt from trial implementations instead of ready-made solutions.

9.1 Basic concepts of water quality assessment

Natural waters exhibit a wide variety of chemical (e.g. nitrate, dissolved oxygen, etc.), physical (e.g. temperature, conductivity, etc.), hydro-morphological (water flow, river continuity, substrate, etc.) and biological (e.g. bacteria, flora, fish, etc.) characteristics that result from natural processes and anthropogenic activities. Water quality is described by all these characteristics.

Quality applies to water bodies, waterbeds which contain or transport this water, and to the riparian zone. The quality of water running through a river could be very good, whereas the riverbed could be severely polluted with heavy metals that have sunk into its sediment. This chapter focuses on the quality of water bodies.

Quality describes the current state of a certain water body in terms of certain characteristics, which are called “determinands” (i.e. “what helps determining quality”). The term “determinand” is chosen over pollutant, parameter or variable (Kristensen and Bogestrand, 1996), to underscore the fact that a determinand describes a feature constitutive of the quality of a water body, and is not exclusively associated with either human activities or natural processes. Examples of determinands, as used in the French System for the Evaluation of the Quality of Water (SEQ-eau), are depicted in the second column of Table 9.1. The Water Framework Directive (European Parliament and Council, 2000), that came into force on 22 December 2000, has the following key elements:

- It expands the scope of water protection to all waters. A distinction is made between surface waters (rivers, lakes, transitional and coastal waters), groundwater and protected areas i.e. areas that are designated for water abstraction, protection of aquatic species or have recreational purposes. “Water bodies” are the units that will be used for reporting and assessing compliance with the Directive’s environmental objectives. For each surface water category, water bodies are differentiated according to their “type” (depending on the eco-region, geology, size, altitude, etc.). The main purpose of this typology is to enable type specific “reference conditions” to be defined, which are the key of the quality assessment process.
- It sets a deadline of 2015 for achieving "good status" for all waters. For surface water this comprises both “good ecological status” and “good chemical status”. Member States will report the ecological status for each surface water category into five classes ranging from high to bad. The boundary values will be established through an inter-calibration exercise. Chemical status is reported as good or failing to achieve good. For groundwater, as the presumption is that it should not be polluted at all, the approach is slightly different. There is a prohibition on direct discharges and a requirement to reverse any anthropogenically induced upward pollution trend. Besides reporting the chemical status, quantitative status is reported as either good or poor, depending on the sustainability of its use.
- It endorses a "combined approach" of emission limit values and quality standards. In a precautionary sense it urges all existing source-based controls to be implemented.

Table 9.1: Some of the indicators and their determinants included in SEQ-eau

Indicators	**Determinants***
Organic and oxidizable matter	Dissolved O_2, $\%O_2$, COD, BOD_5, DOC, NKJ, NH_4^+
Nitrogen (except nitrates)	NH_4^+, NKj, NO_2^-
Nitrates	NO_3^-
Phosphorus	PO_4^{3-}, total P

For policy purposes (such as setting objectives and checking compliance), it is necessary to define the quality of water either by specifying series of normative values for its determinands, which represent the requirements for certain uses (Train, 1979) or allowable deviations from reference conditions, in the case, for example, of the Water Framework Directive. For reasons of practicality, ease of reporting as well as the inherent uncertainty, water quality is eventually reported in the form of discrete classes.

The quality of a water body may be approached in terms of its uses/functions. There is no standard classification of water uses/functions. However, the uses/functions most commonly used are: drinking water, leisure, irrigation, and industry. France distinguishes aquatic life, drinking water, leisure, irrigation, livestock and aquaculture (Oudin and Maupas, 1999). Australia and New Zealand mention aquatic ecosystems, primary industries, recreation and aesthetics, drinking water, industrial use as well as cultural and spiritual values (although for the latter two categories no quality guidelines are provided) (ANZECC/ARMCANZ, 2000). The Millennium Ecosystem Assessment investigates functions as services supplied by the aquatic ecosystems: flood mitigation, groundwater recharge, food provision, pollution control, etc. (Millennium Ecosystem Assessment, 2005).

9.2 The structure of the accounts

The general structure of the quality accounts is the same as that of the water asset accounts in Chapter 7. The only difference is the addition of the quality dimension, which describes the volume of water. Table 9.2 below shows the general structure for quality accounts. This table shows the opening and closing stocks together with the changes in stocks that occur during the accounting period for each quality class.

Table 9.2: Quality accounts

physical units

	Quality Classes			
	Quality 1	Quality 2	Quality n	Total
Opening stocks				
Changes in Stock				
Closing Stocks				

Each column shows the volume of water of a certain quality class at the beginning and end of the accounting period. The column “total” represents the stock of the water body at the beginning and the end of the accounting period as defined in chapter 7. The row “changes in stocks” is derived as a difference between closing and opening stocks.

Since water quality is not only affected by activities in the last accounting period, but also by activities in previous (at times several) accounting periods, multi years average figures could be used for the opening and closing stock.

Table 9.2 can be compiled also for costal waters given the direct pressure of the economy through discharges of wastewater into the sea, their socio-economic importance and their links with the quality of inland water resources (affected directly by land-based pollutions).

Each entry in Table 9.2 represents the amount of water of a certain quality measured in volumes. However, for rivers this is not a convenient unit due to the flowing nature of the water. A specific unit of account has been introduced for river quality the “standardized river-kilometre” (Heldal and Østdahl, 1984) later changed into *standard river unit* (SRU). To complete the spatial aggregation at the level of a river basin, rivers are divided into a number of stretches of homogeneous quality (for instance, between consecutive monitoring sites) and water flow. The value, in SRU, of a stretch of river of length L and of flow q is the product $L \times q$. Quality accounts for rivers can be compiled by assessing the quality class for each stretch, computing the SRU value for each stretch, and summing the corresponding SRU per quality class to populate the quality accounts in Table 9.2. The different quality classes can be aggregated without double counting (para. 8.128, SEEA-2003).

The total quantity of SRU should appear in the "total" column of Table 9.2 (even though it cannot be related to the "total" column in the asset accounts for rivers, which is expressed in volume, not in SRU). This quantity strongly depends on the minimum size of rivers to be considered in a river basin. Because of a lack of adequate data, the marginal contribution of the smallest rivers is generally unknown.

In the case of France, the river system is comprised of about 10.8 million SRU for it's approximately 85,000 km of main courses and is disaggregated into 55 catchments. Estimates from the Institut Français de l'Environnement (1999) suggest that considering all rivers mapped at the 1:50,000 scale would increase by 2,5 the total SRU mapped at the 1:1,400,000 scale. Therefore, it was concluded that the total quantity of SRU should not aim at covering the entire river system, but only the part of it which is actually monitored and subject to a quality assessment. The ratio between the quantity of SRU for monitored rivers and (an estimate of) the quantity of SRU for the entire system gives an estimate of the monitoring coverage of the river system.

10. Valuation of Water Resources

Water has economic value in all its uses. The need to treat water as an economic good has been recognised in SADC as an essential component of IWRM. IWRM identifies maximizing economic value from the use of water and from investments in the water sector as one of the key objectives (Global Water Partnership, 2000). This principle was reconfirmed at the 2002 World Summit on Sustainable Development in Johannesburg, the 2003 Third World Water Forum in Tokyo, and the 2005 Millennium Project of the United Nations (UN). However, the full economic value of water is not fully appreciated in SADC consequently investment is low and use at times wasteful. National accounts for water are also limited in that water, like all other products, is valued at price of its transaction. Unlike many other products, however, the prices charged for water often provide a poor and in adequate indicator of water's economic value, a situation arising from the following certain unique characteristics of water:-

- Water is a heavily regulated commodity for which the price charged (if any) often bears little relation to its economic value or even to its cost of supply. This situation is sometimes severe in water-scarce SADC member states where water may be provided to some users at no charge. Administered prices occur in part because the natural characteristics of water inhibit the emergence of competitive markets that establish economic value.
- Water supply often has the characteristics of a natural monopoly because water storage and distribution are subject to economies of scale;
- Property rights, essential for competitive markets, are often absent and not always easy to define when uses of water exhibit characteristics of a public good (flood mitigation), a collective good (a sink for wastes), or when water is subject to multiple and/or sequential use;
- Water is a 'bulky' commodity, that is, its weight-to-value ratio is very low, inhibiting the development of markets beyond local area;
- Large amounts of water are abstracted for own use by industries other than ISIC 36, Water collection, treatment and supply, such as agriculture or mining. Abstraction for own use is not recorded explicitly as an intermediate input of water; hence, the use of water is underestimated and the value of water's contribution, for example to agriculture, is not explicit but accrues to the operating surplus of agriculture.

In SADC, the need to treat water as an economic good has been recognized as an essential component of sustainable water management. The concept of Integrated Water Resources Management (IWRM) has been embraced in SADC and globally endorsed for water management. ***IWRM identifies maximizing economic value from the use of water and from investments in the water sector as one of the key objectives along with equity and environmental sustainability*** (Global Water Partnership, 2000). This principle was reconfirmed at the 2002 World Summit on Sustainable Development in Johannesburg, the 2003 Third World Water Forum in Tokyo, and the 2005 Millennium Project Report to the UN. The prices charged for water recorded in the national accounts often do not reflect its full economic value.

The economic value of water can be useful for many policy areas, for example, to assess ***efficiency*** in the development and ***allocation*** of water resources. Efficient and equitable allocation of water takes into account the value of water used by competing end-users in the present generation, the allocation of resources between present and future generations, and the degree of treatment of wastes discharged to water or other activities that affect water quality. Water valuation can also be useful in setting water ***pricing policy*** and in the design of economic instruments to achieve better use of water resources such as ***water demand management***. Instruments for water include property rights, tradable water markets, taxes on water depletion and pollution, and subsidies for water demand management.

Economists have developed techniques for estimating the value of water. This chapter begins by introducing the concept of ***"total economic value of water",*** before reviewing the techniques for valuation highlighting consistency issues with the concept of value as applied in the National Accounts. The valuation techniques reviewed include those commonly used for the water goods and services presently included in the water accounts:

(a) Water as an intermediate input to production in agriculture and manufacturing;

(b) Water as a final consumer good;

(c) Environmental services of water for waste assimilation;

The economic value of social aspects of water such as reliability, prevention of waterborne diseases distance and timing of water availability, are addressed in the next chapter.

This Chapter also highlights limits to this monetizing approach, especially in terms of transferring economic value data across time and geographical space (river basins for example); and the existence of intangible values as cultural, historical and even ethical significance.

10.1 Conceptual Framework for Valuation of Water

Water is an essential commodity for survival – water is life therefore its economic value is infinity. That is why most SADC water policies prioritise meeting basic water needs. However, once basic water needs are met, economic valuation of water can make a crucial contribution to decision about water allocation. In economics, a commodity has value when it is scarce and its economic value is the price a person would be pay for it. Economic values of commodities can be observed at the market. If the markets are competitive (i.e. there are many independent buyers and sellers) the process of exchange establishes the price that represents the marginal economic value, that is, the value of the last (marginal) unit sold. Unfortunately, in most SADC MS markets for water are not perfect (due to government regulation that set tariffs, taxes and subsidies) and therefore the observed prices do not reflect the true economic value of water. Valuation techniques therefore, have to be applied to estimate the economic value of water. One of these techniques is called ***'shadow pricing'***. A 'shadow price' is calculated by adjusting the observed price for market distortions such as government regulations, taxes and subsidies or by estimating a price where market prices do not exist.

Economists have developed and applied many techniques to estimate shadow prices however these were for cost-benefit analysis and their application in water accounting which is based on the system of national accounts is not straightforward.

10.1.1 Marginal vs Average value

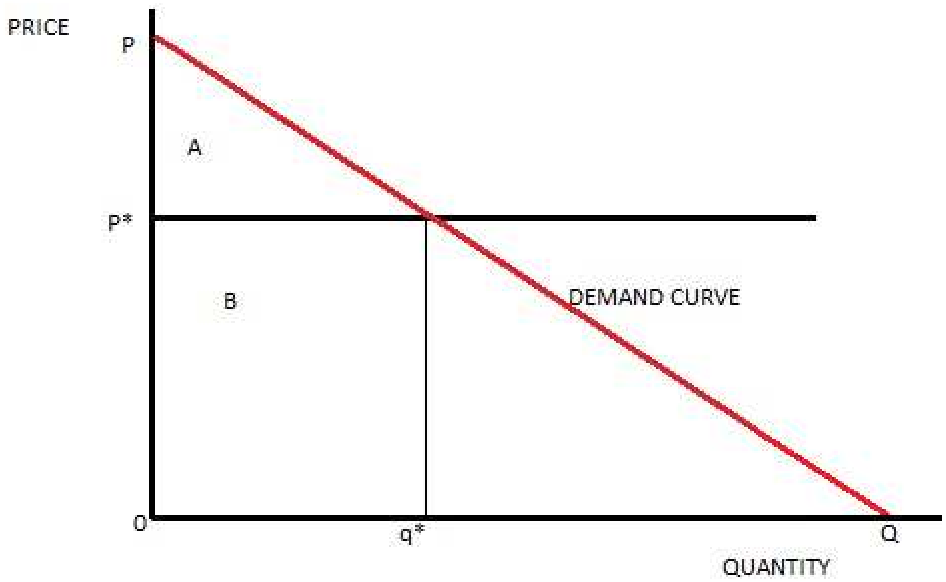
There are many valuation techniques for various water uses and, because of their foundation in cost-benefit analysis and its emphasis on economic welfare, they can produce three conceptually different measures of "value".

Marginal value is the price that the last buyer would be willing to pay for an additional unit. This value corresponds to price in a competitive market, and in principle is compatible with the National Accounts valuation.

Average value is the average price that all buyers would be willing to pay, including a portion of consumer or producer surplus, which is the maximum amount that each buyer would be willing to pay, even though they actually price they pay is different.

Total Economic Value is a measure of total economic welfare that includes consumer surplus and producer surplus, that can be used to estimate average value.

The relationships among these three concepts of economic value are illustrated in Figure 10.1. The demand curve (PQ) in Fig 10.1 shows that as the price of water increases the quantity purchased decreases. The area A is the 'Consumer Surplus' – difference between what the consumer is willing-to-pay (P) and what he actually pays (P*).

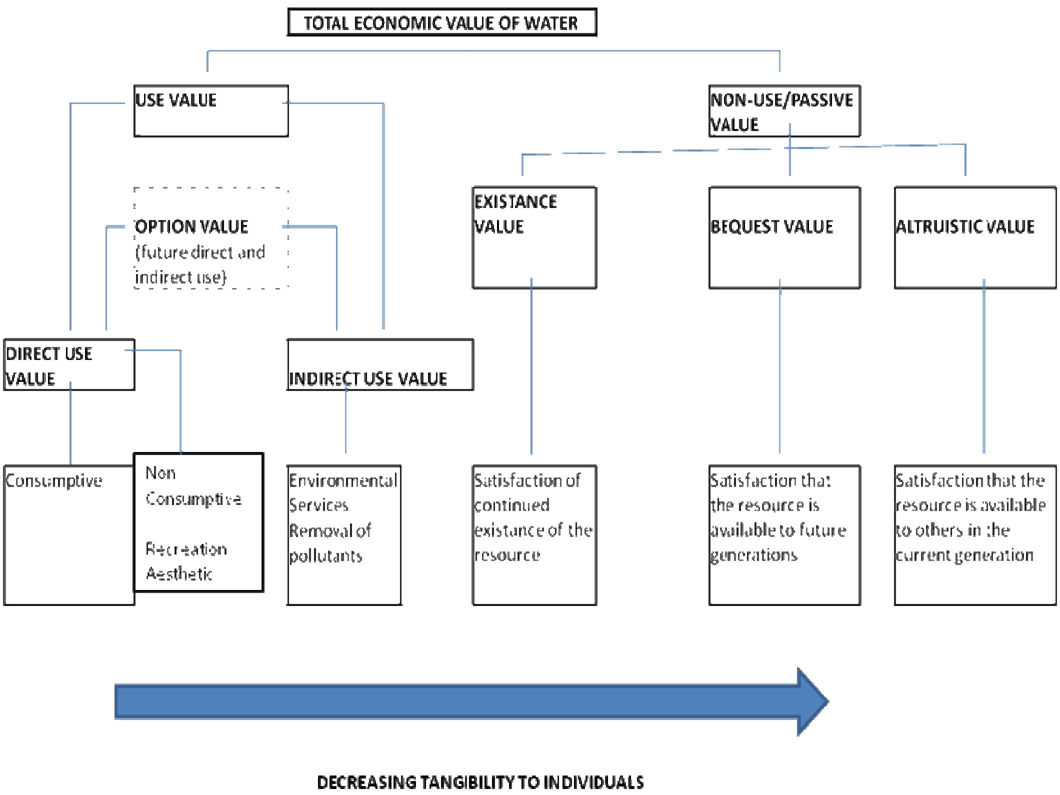


- ***Total economic value*** of water is measured as the sum of total willingness-to-pay of all consumers, and is typically displayed as the area under the demand curve. If the quantity of water purchased in q*, the total economic value of that water is the area A+B.
- The ***Average Value*** of q* M^3 of water in Fig 10.1 is calculated as $\frac{A+B}{q*}$
- P* represents the ***Marginal Value*** of a unit of water at q*. For an individual, the marginal value represents the benefit from the use of one more M^3 of water. The Marginal value is relevant for assessing the economic efficiency of the allocation of water among alternative uses. Competitive market prices equal the marginal value.

In most SADC MS water services are often provided and acquired without trade or through trade in imperfect markets and hence information is not available for specification of proper demand functions and calculation of marginal or total economic values. In such cases cost rather than benefit-based measures are used to value water.

10.2 Total Economic Value of Water

Given the multifaceted nature of benefits associated with water, there is a need for a useable typology of the associated social, economic and cultural values. In this manual we focus on the socio-economic values of water. These values depend on human preferences that are what people perceive as the impact water has on their welfare. In general, the economic value of a perceived benefit from water is defined as the amount of other resources (income for example) that individuals are willing to forgo (spend) in order to obtain more water (or maintain the status quo). Economic values are thus relative in the sense that they are expressed in terms of something else that is given up (the opportunity cost), and they are associated with the type of incremental changes to the status quo that public policies decisions are often about in practice. The extent to which the concept of economic value captures the variety of benefits from water is presented in the taxonomy below (Figure 10.1) the components of which add up to the Total Economic Value of water (TEV).



10.2.1 Definitions

10.2.1.1 Use Value

Use value can further be sub-categorised into direct and indirect use, and option value.

- Direct use values arise from direct interaction with water. They may be consumptive, such as abstraction of water for irrigation and for urban/rural water supply or they may be non-consumptive such as swimming, navigation, or the aesthetic value of enjoying a view, Victoria Falls, for example. It is also possible that "direct use" value can be derived through the media (e.g. television programs such as discovery channel), although the extent to which this can be attributed to a specific site and the extent to which it is actually a use value, are unclear.
- Indirect use values are associated with the services derived from water without direct interaction with the resource. These include environmental service such as water acting as a sink for effluent and neutralising pollutants.
- Option value is the satisfaction that an individual derives from ensuring that a service from water resource is available for the future given that the future availability of the benefit is uncertain. It can be regarded as insurance for the possible future demand for the resource rather than a distinct component of TEV.

10.2.1.2 Non-use value

Non-use value reflects value in addition to that which arises from usage. Thus individuals may have little or no use for a given water resource (Victoria Falls for example) but would nevertheless feel a loss if it were to disappear. Non-use value can be divided into the following three types of value (which may overlap):-

- Existence value is the satisfaction derived from a water resource and its services continuing to exist, regardless of whether or not they might be of benefit to others. Motivations here could vary and might include having a feeling of concern for the asset itself or a "stewardship" motive whereby the "value" feels some responsibility for the water resource.
- Bequest value is the satisfaction derived from ensuring that water resources and their services will be passed on to future generations so that they will have the opportunity to enjoy them in future.
- Altruistic value is the satisfaction derived from ensuring that water resources and their services are available to contemporaries in the current generation.

Economic value can now be combined with economic accounting for water. It is important to note that what is being valued is not the water resource (natural stock) *per se,* but rather the various services derived from the water resource. The aggregate value of these various services gives the **Total Economic Value (TEV)** of that water resource. Table 10.1 shows a list of services derived from a water resource and links them to their respective TEV components. As such Table 10.1 provides the final stage in the integrating the physical components of water and the TEV of the services derived from them.

Table 10.1: Services derived from water resources, TEV and accounting value

SERVICE (BENEFIT) TERMINOLOGY	TOTAL ECONOMIC VALUE TERMINOLOGY		ACCOUNTING TERMINOLOGY	
	USE VALUE	NON-USE VALUE	STOCK	FLOW
Domestic water supply	•			•
Prevention of saline intrusion	•		•	•
Cultural value		•		•
Historical value		•		•
Aesthetic value provision	•			•

In practice the assessment of TEV is limited to those components that are feasible to quantify. Use of TEV in the analysis of alternative allocations ensures that the full social benefits provided by water resources are taken into account. This is necessary to indicate to decision makers the welfare improvement that is offered by alternative allocations. TEV does not, however, provide an exhaustive assessment of the value of benefits to society derived from water resource. It measures the extent to which the services provided by water touch on the welfare of society, as direct determinants of individuals' well-being or via production processes. It represents two fundamental sets of value: individual values and production values. Individual values include recreational and amenity values, as well as non-use values (existence, bequest and philanthropic values) of benefits provided by water. Production values occur through the influence of wetlands on the production and cost functions of other marketed goods and services (such as use of water as an intermediate good in irrigation crop production). The effects of this influence on the prices of other inputs and marketed goods are services translate into changes in individual's welfare.

However, TEV is not exhaustive since water is essentially life therefore its value is infinite. For this reason some economists have classified water as a 'critical' natural capital (Dubourg, 1997). The values of these resources are infinite and the usual measures of value (market price, willingness to pay) do not reflect the true economic value of the resource. As a basis of hum life, water is indispensable under realistic technological and economic conditions.

10.3 Economic valuation techniques

Valuation of water is faced by numerous challenges. A wider analysis of water resources by Renzetti (2002) highlights the following four problems:-

- The paucity of market transactions in water resource benefits; even where markets do exist prices may not reflect the social marginal costs of supply
- The variety of regulations and legal instruments related to water will influence the allocation of associated benefits and, thus, distort their value, for example water as a basic human right
- In general, the value assigned to water is a function of its quality
- Difficulties related to the neo-classical valuation techniques due to the cultural and religious roles of water that are emphasised in SADC
- In most SADC MS water supply has the characteristics of a natural monopoly because water storage and distribution are subject to economies of scale

- Property rights regimes which are a prerequisite for establishment of competitive markets are usually weak or absent in most SADC MS
- Water is bulky and difficult to transport therefore its value is only determined at the local level.
- In SADC economic sectors such as agriculture and mining abstract large amounts of water for own use and this is not recorded explicitly as an intermediate input of water; hence the use of water is underestimated and the value of water's contribution, for example to agriculture, is not explicit but accrues to the operating surplus of agriculture.

Notwithstanding these challenges, a range of valuation methods and techniques exist and have been applied to estimate the value of water. The various techniques presented here include the estimation of demand curves and the areas beneath them, analysis of market-like transactions, use of production approaches that consider the contribution of water to the production process, estimation of the costs of providing alternative sources of water benefits, as well as other techniques used to estimate natural resources more generally. The methods and techniques reflect the extent to which the services provided by water touch on the welfare of society either as direct determinants of individuals' well-being (e.g. as drinking water) or via production processes (e.g. as intermediate good).

Techniques for valuing natural resources are divided into two main classes – market-based and non-market based valuation techniques also referred to as indirect and direct techniques, respectively (Manase, 2009).

Market valuation means that existing market behaviour and market transactions are used as the basis of the valuation exercise (Turner et al, 2008). The economic value of water is inferred from observed actual consumer behaviour with regards to some related commodity (the concept of compensation variation). The approach involves observing actual household behaviour in response to price changes, modelling this behaviour, and using this information to derive economic value (Griffin et al., 1995). The value of improved water supply for example, can be estimated by calculating the financial cost of investment in coping strategies such as household investment in storage tanks and private pumps, and the opportunity cost of time spent collecting water (economic cost). The minimum wage is normally used as the value of time spent fetching water (Manase, 2008). Economic costs also include wage losses due to sickness from poor water quality, time and fuel spent boiling water for safety, and management of the on-site storage subsystems though these are rarely calculated (Choe et al., 1996). Summing up the financial and economic costs gives an estimate of the resource cost of poor water supply which can be used to estimate value communities place on improved water supply.

Non-market based or direct methods are applied in situations where markets do not exist or are highly distorted. Direct methods such as the Contingent Valuation Method (CVM) and choice modelling (CM) involve presenting the respondent with a hypothetical scenario of an improved service and asking her directly how much she would be willing to pay for this service. The method is called contingent valuation (or stated preference) because the respondent's WTP is contingent upon the scenario presented to him/her. CVM is based on the fact that in most cases markets for environmental goods or services do not exist or are not well developed. CV and CM, being based on surveys that elicit (stated preference), have the potential to value benefits in all situations, including non-use or passive-use benefits that are not associated with any observable behaviour.

Table 10.1 presents the valuation techniques commonly applied to water uses included in water accounts marked with * and other techniques.

Table 10.1: Techniques for valuing water services

Valuation Technique	Type of Value	Type of Preference
Water as an intermediate input to production: Agric, Manufacturing		
*Residual Value	Average or Marginal Value of Water	Revealed Preferences based on Market behaviour
*Change in Net income	Marginal Value	
*Production Function Approach	Marginal Value	
*Mathematical Programming Models	Marginal Value	
*Sales and Rentals of Water Rights	Average or Marginal Value of Water	
*Demand Function From Water Utility Sales	Average or Marginal Value of Water	
*Hedonic Procing	Marginal Value	
Water as a final consumer good		
*Sales and Rental of water Rights	Average or Marginal Value of Water	Revealed Preferences based on Market behaviour
*Demand Function From Water Utility Sales	Average or Marginal Value of Water	
*Mathematical Programming Models	Marginal Value	
*Alternative Cost	Average or Marginal Value of Water	
*Contingent Valuation	Total Economic Value	Stated preferences during one-on-on interview
Environmental Services of Water: Waste Assimilation		
*Costs of Action to Prevent Damage	Average or Marginal Value of Water	Revealed Preferences based on Market behaviour
Travel Cost Method	Average Value	Revealed Preferences based on Market behaviour
*Hedonic Pricing	Marginal Value	Revealed Preferences based on Market behaviour
Conjoint Analysis	Average, TEC sometimes Marginal Value	Stated preferences during one-on-on interview
*Benefit from Damage Averted	Average or Marginal Value of Water	Revealed Preferences based on Market behaviour

* Valuation techniques most applied to water uses included in Water Accounts

10.3.1 Valuing water as an intermediate input to agriculture and manufacturing

10.3.1.1 Residual Value

The Residual value method is based on the idea that a profit maximising firm will use water up to the point where the net revenue gained from using one additional M^3 of water is just equal to the marginal cost of obtaining that M^3 of water. This approach assumes that if all markets are competitive except for water then the total value of production exactly equals the opportunity costs of all the inputs. When the opportunity costs of non-water inputs are given by their market prices (or their shadow prices can be estimated), the shadow price of water, then, is equal to the difference (the residual) between the value of output and the costs of all non-water inputs to production.

The Residual Value can be expressed mathematically as:-

$$TVP = \sum p_i q_i + VMP_w\, q_w \qquad (10.1)$$

$$VMP_w = \frac{TVP - \Sigma p_i\, q_i}{q_w} \qquad (10.2)$$

Where

TVP = total value of the commodity produced;

$p_i q_i$ = the opportunity cost of non-water inputs to production;

VMP_w = value of marginal product of water

q_w = the cubic meters of water used in production

While this shadow price of water is referred to as 'marginal value' it is actually an average value because VMP is measured for the total amount of production and total non-water inputs, rather than marginal output and marginal costs of non-water inputs.

Lange et al (2000) applied this technique to agriculture in Namibia and found the value of water to be N$0.51/M^3.

It is important when applying the residual value technique to note that the value of water calculated in this way includes some costs incurred by the user for abstracting, transporting and storing water as well as water tariffs. These costs are already included in the national accounts and should not be double-counted.

The Residual value technique has the advantage of being relatively easy to implement, but is sensitive to small variations in the specification of the production function and assumptions about market and policy environment. For example, if an input to production (such as family labour) is omitted or underestimated, its contribution (value) is wrongly attributed to water. There is also a need adjust for distortion such as government subsidizes and trade protection in applying the residual value technique.

10.3.1.2 Change in Net Income

The residual value describe above is suitable for a single crop or single production operation. For multiple products a variant of Residual value is applied, the Change in Net Income (CNI) technique. CNI measures the change in net income from all crops resulting from a change in the water input, rather than the value of all water used in production. It is often used to compare the value of water under present allocation to the value that would be obtained under an alternative allocation of water. It can also be used to assess a farmer's response to a policy change intended to bring about a change in crop mix or production technology. In contrast to Residual value, by measuring the impact of change, CNI measures the marginal value of water rather than the average value which is obtained with residual value technique. According to Young (1996), CNI is more often used than the single-crop residual approach.

10.3.1.3 Production function approach

This uses regression analysis, usually to a cross-section of farmers or manufacturers, to estimate a production function, or, equivalently, a cost function which represents the relationship between inputs and outputs, specifically water and crop yields. The functions are developed from experiments, mathematical simulation models, and statistical analysis of survey or secondary data. The marginal value of water is obtained by differentiating the function with respect to water, that is, measuring the marginal change in output (or reduction in costs) that results from a small change in water input.

The production function approach and mathematical programming are the most widely applied techniques for water valuation in manufacturing. The residual value method has not been used for industry water valuation because the cost share of water is quite small in most industrial applications and the residual value method is very sensitive to the quantity of water input. For example, Renzetti and Dupont (2003) used a production function approach to measure the marginal value of water in manufacturing. A similar study was undertaken in China by Wang and Lall (1999), using data for about 2,000 firms, mostly medium and large state-owned enterprises, in 1993.

10.3.1.4 Mathematical Programming

Various forms of mathematical programming models have been developed to guide water allocation and infrastructure development decisions. These models specify an objective function (such as maximizing profits or minimising costs) subject to production functions, water supply, and industrial and behavioural constraints. Optimisation models may be applied to one sector, such as agriculture to determine the optimal allocation of water among all users or a national economy (Lange and Hassan, 2006). These may be linear programming models or, simulation models, or more commonly for economy-wide analysis, computable general equilibrium (CGE) models.

Optimisation models calculate shadow prices of all constraints including water. The shadow price gives the marginal value of water for each user under the optimal allocation (i.e. the net benefit that would be obtained if the constraint were relaxed by one unit in each use). Optimisation models estimate the marginal values of water based on an ‘optimal’ allocation of water and the corresponding reconfiguration of economic activity and prices. The SNA is based on actual market prices, which are likely to be very different from the optimising economy. Therefore, the optimal values for water obtained from an optimisation analysis may not be consistent with values for the rest of the economy represented in the SNA.

Linear programming was applied to agriculture in Morocco to assist water management and water policy design (UNSD, 2006). The results show the value of water (in dirham/m^3) to be 2.36 for sugarcane, 25.02 for livestock and 92.10 for industry and services, respectively.

10.3.1.5 Hedonic Pricing

Hedonic pricing uses information on a surrogate market of another good or serve that is directly linked to a particular service of water to indirectly estimate the value of water. For example, the value of land for agriculture depends on a bundle of attributes that include soil quality, existing farm infrastructure, and water resources (UNSD, 2006). Regression analysis of land sales on the attributes of the land, both positive and negative, reveals the amount that water services contribute to the total value of land. The marginal value of water is obtained by differentiating the hedonic value function with respect to water. This technique has been widely used to estimate the recreational values of water and to a lesser extent to estimate the value of water for agricultural use (UNSD, 2006). For example, application of this technique to estimate the value of water for irrigation use in Cyprus where saltwater intrusion is a problem, show that farmers were willing to pay on average £10.7 per hectare to avoid saline ground water (UNSD, 2006).

10.3.2 Valuing water as a final good

10.3.2.1 Markets for water and tradable water rights

A few water-scarce countries have instituted markets for trading water or water rights either on a temporary or permanent basis, notably Australia, Chile, Spain, and parts of the United States (See

Garrido, 2003 for an overview of these markets and how they have functioned). Trading in a competitive market could establish a price that represents the marginal value of water. In the countries that have established water markets, market trades have generally increased the efficiency of water use by providing strong incentives for allocating water to higher-value uses and for water conservation. However, evidence suggests that the transactions prices do not represent the marginal value because the conditions necessary for a competitive market are not present (Young, 1996).

A competitive market requires, among other things, a large number of buyers and sellers and frequent transactions. In Chile, water trades accounted for only 1% of total abstractions by the mid-1990s and prices ranged from US$250 to $4,500 a share (4,250 cubic metres) (Brehm and Quiroz, 1995; Hearne and Easter, 1995). Development of water markets was greatest in areas with effective water-use associations, well-defined property rights and good irrigation infrastructure (large reservoirs, adjustable gates with flow meters); in areas without these characteristics, high transactions costs limited water market development. In a few countries tradable water rights may provide a basis for water valuation in the future, but this technique has not been applied yet.

10.3.2.2 Consumer and municipal water use

Municipal water use includes a number of distinct groups: households, government, and sometimes commercial and industrial use. Most studies focus on household demand when it can be readily separated from other users. The two most common approaches to valuing domestic use of water, above a basic survival amount, involve estimation of the demand curve either from actual sales of water (revealed preference), or using contingent valuation approach (stated preference). Both approaches estimate the average value of water.

10.3.2.3 Demand functions estimated from water sales

This approach uses econometric analysis to measure total economic value (consumer surplus), which is then used to calculate average value, based on an estimate of what the average consumer would pay. The conditions under which a demand curve can be derived are rather stringent and are often not obtained, even in developed countries. (See Walker et al. (2000) for more detailed discussion). Water use must be metered to provide accurate data about volume consumed and water charges must be based on the volume consumed, because when consumers pay a lump sum, the marginal cost is zero and their consumption does not reveal marginal value. Demand curves cannot be estimated where water is rationed or where a single marginal price is charged to all consumers. Where a single price is charged, a less reliable alternative sometimes used is to trace the real tariff over time and changes in water consumed. Walker et al. (2000) also point out that the water demand function of households with piped water differs substantially from those relying on un-piped water supply, a common situation in most developing countries. An accurate estimate of consumer demand must include both types of households. Appropriate sales data will provide two or more points to which a demand curve is fitted, usually assuming a semi-log demand function. The value of water is highly sensitive to the functional form assumed for the demand curve.

10.3.2.4 Contingent Valuation Method

The contingent valuation methodology (CVM) differs from the above described methods in that it does not rely on market data, but asks individuals about the value they place on something by asking them how much they would be willing to pay for it. This is particularly useful for eliciting the value of environmental goods and services from which there are no market prices, such as recreation, water quality and aquatic biodiversity. The CVM was first used several decades ago, but became a much more popular technique after 1993 when standardized guidelines for CVM applications were set out by a prestigious panel of economists following a disastrous oil spill of the Alaskan coast (NOAA, 1993). In terms of the number of publications, the CVM is currently the dominant method for valuation of non-market environmental services; a recent review of the CVM found more than 2000 studies (Carson).

Contingent valuation surveys often take the form of a binary-choice instrument (open-ended surveys can be more difficult to analyze). Individuals are given a choice between two quantities of environmental services, usually the status quo and the alternative that requires a payment. Different levels of payments are randomly assigned to different individuals in the sample and the response is analyzed in the same way that behavior in actual market is analyzed. A demand curve measuring total economic value is derived by econometric analysis of the results along with the other variables such as income and other factors that influence willingness-to-pay (demand). A CVM survey requires that survey respondents are well informed of an environmental good and its substitute, a large sample and face-to-face surveys. These requirements make a good CVM studies rather expensive. For example, developing materials that inform the sample population about the issue often requires the use of photographs and other means of visual display, focus groups, in depth interviews and pre-testing of surveys.

The CVM has two variants: willingness-to-pay (WTP) and willingness-to-accept (WTA); the correct measure depends on the property rights to the environmental service. Willingness to pay acquire (or avoid loss of) an environmental good. Willingness-to-accept asks how much how much a consumer would have to be compensated in order to give up voluntarily some good or level of environmental service she/he already has. Boman et al. (2003) argue that WTP is more consistent with national accounts valuation than WTA. Under WTA, respondents are not constrained by their budget when giving answers, which is not consistent with the monetary measures used in standard national accounts, that is, market prices resulting from consumer demand that is restricted by income.

The CVM typically measure total economic value from which an average value can be estimated, although it is possible to design the survey to obtain information about marginal values, that is, how much would you pay for a small change/improvement. Although the results are similar in some cases, they are quite different in others. The authors consider the revealed preference approach more reliable because it is based on actual market behaviour. They conclude that for estimating consumer water demand the CVM is not a good substitute for revealed preference (Walker et al.., 2000). A comparison of values derived from CVM and revealed preference studies for a wider range of environmental services show a similar disparity (Hanley and Spah, 1993).

Water based recreation has become very important and developed countries and is an important source of tourism revenues in some developing countries. Although the travel cost method was most often used for valuing recreational services, a review of the main economics journals in recent years revealed that its popularity has declined, and that the CVM is now much more likely to be used.

It might be expected that in developing countries with poor water infrastructure, water would pose a greater constraint to business than in developed countries such as Canada, and that the marginal value of water might be higher. Davis et al. (2001) surveyed owners of micro and small enterprises (MSEs) in towns in Uganda to determine the importance of improved water services (piped connections) to business. Most MSEs were involved in Trade and restaurants, and got their water mainly from private kiosks and water vendors. Using the CVM, the authors found that the MSEs do not perceive water supply as a constraint to business; they are not willing to pay as much as households for improved services, and less likely to pay for private connections.

So far the discussion of water value has considered only one attribute of water, water quality, but reliability is another major concern in many developing countries where water may only be available for a few hours a day and in developed countries where natural climatic variations make water supply highly variable. Increasing water reliability often requires considerable additional investment in water supply infrastructure. The CVM is used to assess consumer's willingness to pay for increased reliability.

10.3.3 Valuing the environmental services of water for waste assimilation

In many cases information on actual costs of preventing or mitigating decline in environmental quality is easier to obtain than data on observed or stated WTP (or WTA) that reflect the value people hold for (demand) such environmental quality. In such situations cost-based approaches are common. This category also includes valuation techniques that use the opportunity cost of alternative options concept (that is, opportunity of time spent on fetching water for domestic use). The SEEA identifies two principles for the direct valuation of environmental degradation: coat based and damage based. The former is based on the cost o preventing environmental degradation and has been referred to as the preventive expenditure (or maintenance cost) approach. The latter is based on the benefits of averting damage incurred from environmental degradation.

10.3.3.1 Benefits from averting damage from environmental degradation

This approach measures the value of water's waste assimilation services in terms of the benefits from averting degradation and loss of this service. Damages include human illness and premature death, increased in-plant treatment of process water required by industry, increased corrosion or other damage to structures and equipment, siltation of reservoirs, or any other damage to structures and equipment, siltation of reservoirs or any other loss of productivity attributable to changes in water quality.

The first task in providing this value is to identify standards for the waste assimilation capacity of a water body. Water standard have been established by international organizations like the World Health Organization (WHO) as well as by the national agencies in terms of concentration of substances. These concentrations are often grouped according to the maximum level acceptable for a particular use, with human consumption requiring the highest standard. Some industrial processes require extremely clean water while other may not, for example, water used for cooling, although polluted water may damage or corrode equipment. Water for irrigation also does not have to meet the highest standards.

The next step is to determine the extent of damage caused by a change in water quality. For human health damage, a 'dose response' function is used, which relates a change in a specific aspect of water quality to the incidence of human illness and death. Engineering studies provide similar concentration-response functions for damage to land, buildings, structures and equipment, and the environment. These damages must then be valued.

The value of clean drinking water can be measured, for example, as the value of water-borne disease and premature death averted. The value of health risk averted usually includes the cost of medical treatment and value of lost time, but not the value of social disruption, loss of educational opportunities for children, personal suffering a loss of leisure time. Damage to land and poverty includes, for example, the cost of declining agricultural productivity, the loss of hydroelectric power resulting from accelerated siltation of a dam, on the cost of accelerated corrosion of structures from increased salinity.

Measuring and valuing damage can be particularly challenging: damages may occur during the same accounting period as the change in water quality there may be greater uncertainty about the degree of damage caused by a change in water quality, or damages may occur further down stream, even in another country. Even when damages can be measure, it is not easy to value them, particularly environmental damages. In most instances, total costs of damages are estimated and an average damage cost per unit of pollutant is estimated. A great deal of effort has gone into estimating marginal damage functions, although these estimates are more widely available for air pollution than for water.

10.3.3.2 Cost for averting damage from water degradation

Like damage-based valuation approach, the preventive expenditure of maintenance-cost approach is also based on environmental degradation, but rather than looking at the cost of damages caused(that is, lost benefits from good environmental quality), it is based on the cost of actions to prevent damage. This method assumes that an individual's perception of the cost imposed by the adverse environment quality is at least as great as the individual expenditure on the goods or activities to avoid damage. As in the damage-approach, information needs include: the assimilative capacity of water bodies, the emission of specific pollutants by specific activities (including consumption), the relationship between concentrations of pollutants and environmental function, and the relationship between levels of activities and emissions of pollutants. Since these relationships are likely to be non-linear, they pose a significant challenge for the policy-maker.

The preventive (maintenance) expenditure approach has three variant: structural adjustments cost, abatement cost and restoration cost. Structural adjustment costs are those cost incurred to restructure economic activities (production and/or consumption patterns) in order to water pollution or other forms of environmental degradation to a given standard (targeting the source). It addresses both production activities and consumption. The level of specific activities may be reduced or entirely eliminated. Measuring cost of structural change often requires complex economy-wide modelling.

The abatement cost approach measures the cost of introducing technologies to prevent water pollution. Technologies include both end-of-pipe (for example, filters that remove pollutants from the wastewater stream), or change in process (for example, substitution with less polluting materials) solutions. At the consumer level, it includes expenditure on substitute goods, such as buying bottled water instead of using tap water, or the cost of activities like boiling water for drinking (applies to all water or the cost of activities like boiling water for drinking (applies to all water treatment and purification costs). The restoration water approach measures the cost of restoring a damaged water body to an acceptable state. The abatement cost approach is the most widely used of the cost-based approaches.

The benefit from damages averted is a widely used approach in the cost-benefit literature and the preferred technique for SEEA. Often, the results are report end as the total benefit from cost averted or average cost per statistical life saved (or illness prevented). Marginal cost, which relate potential damages averted to marginal changes in water quality (measure as the concentration of substances), are not often reported. One study that does use marginal damage cost functions is *Value of Returns to Land and Water and Cost of Degradation* by CSIRO, a report to the Australian National Land and Water Resources Audit.

The cost of preventing emissions of pollutants was used to value loss of water quality in some of the early water degradation accounts in developing countries like the Philippines (NSCB, 1998) and Korea (KEI, 1998). Pollution abatement costs were estimated using benefit transfer, which is a process of adjusting parameters, cost functions, damage functions, and so on developed at one time in setting for use in anther context. In principle, marginal abatement curves should be applied to estimate the marginal and total cost of pollution reduction in each plant. In practice, an average value per unit of pollutant was used because information about specific plants was not available.

The advantage of this valuation approach is that, at the time, it was easier to obtain estimates of the cost of technologies used to reduce pollution emissions than to estimate the benefits from reduced pollution. There is a growing body of literature on the health and industrial production impacts of pollution, which now makes it easier to estimate the damages averted from changes in quality, although many of these damages are average rather than marginal values.

10.3.4 Other techniques for valuing water

The following techniques are used to determine the economic value of water but are not commonly used to determine the value of water use included in water accounting.

10.3.4.1 Travel Cost Method

This technique is widely used to measure the value of water-based recreational services. It indirectly measures the value of water recreation services by estimating how much people are willing to pay to travel to that site. The TCM is used both as a benefit-based or cost-based method of valuation. For instance, the cost of travel (actual travel expenses) is often used to serve as a proxy for the price of enjoying this water service. On the other hand, information about travel costs and other socio-economic characteristics of users that affect demand (for example, income, distance from site, and so on) is collected through site surveys and aggregated to estimate a demand curve, or several demand curves for different zones around the site. Most costs associated with travel can be easily measured. However, there remains controversy over whether to include the visitor's time as part of the cost, and, if so, how to value it. In most studies travel time is omitted.

This valuation technique measures total economic value, from which the average value for a day's visit can be estimated. The travel cost method was developed to measure recreation service values and has been widely applied to water-based recreation. In principle, this method could also measure the value of the changing quality of a given body of water. For example, if water quality deteriorates to a degree where it is no longer deemed safe for swimming or boating, or a popular angling site no longer supports fish, there will be a drop in site visits. If estimates of consumer demand are available both before and after a decline in water quality, the difference measures the cost of degradation. The measure is one of a change in total economic value, and an average value (per day visit) can be calculated. If the relationship between site visits and water quality is continuous and the change in water quality is very small (marginal), then the method estimates marginal value. However, most changes in site visits respond only to relatively large changes in water quality.

10.3.4.2 Conjoint analysis

Recently, economists have begun using conjoint analysis (Bateman and Willis, 1999); Hajkowicz and Young, 2002), a survey technique developed by marketing experts to analyses consumer choice. The approach is basically the same as the CVM, but the survey instrument differs. The CVM poses the question 'How much are you willing to pay for a good?' or 'would you be willing to pay $X for a good?' Conjoint analysis separates out the attributes of the good and asks individuals to rank the importance of each attribute. This is done by representing a series of questions with different combinations of attributes. This attribute can be particularly useful for ecosystem valuation because ecosystems provide multiple services. For example, a lake or stream may provide swimming, boating, fishing, aesthetic beauty, wildlife habitat and hydrologic management. Each attribute has its own shadow value.

10.3.4.3 The opportunity cost approach

This method assesses the economic value of water for a given use in terms of the cost associated with alternative options for supplying the product of that use. For example, the value of water for hydroelectric power is measured as the difference between the cost of producing hydroelectric power and the cost of producing power from an alternative source, that is, thermal electric plants (netback analysis). Another example is when access to water reticulation system is lacking, consumer households employ the labour time of family members to fetch water. Estimates of the used labour time value (usually imputed wage income) are usually used as the opportunity cost of lacking access to piped water. This approach is very sit specific and there may not be information about actual alternative uses of water for comparison. For valuing raw water used in manufacturing, a firm may compare the cost of in-plant recycling to meet part of its water needs, or alternatives technologies which substitute another substance for water.

Reuse of in-plant water for instance, is based on the idea that a firm will reuse water it already has in the plat when it is cheaper than abstracting additional raw water, so the marginal cost of reuse should be similar to the marginal cost of raw water. Several factors complicate this valuation method by making the two less than perfect substitutes: re-circulated water may be of lower quality, and re-circulation may yield additional benefits such as heat, reclaimed materials or reduced effluent charges. Gibbons (1986) reported some studies that estimated the value of water in this way.

The economic value of water for hydroelectric power generation depends on the specific site: The amount of water flowing through, the distance the water drops, and the power plant efficiency. I water required to produce one unit of electricity water were removed from the hydroelectric plant, the electricity would have to be provided by an alternative source of power, such as a coal- or gas fired plant. The marginal cost of providing electricity from the alternative source is the marginal value of water for hydroelectric power. Marginal cost will vary whether the hydroelectric power being replaced is for peak or base load.

10.3.5 The asset value of water accounts

In the proceeding sections water is valued as a flowing resource service. The fact that the water is in general in continuous movement (changing location) and transformation (changing physical state) makes it difficult to measure water in stock. In many cases however, water exists in relatively stationary formations such as undergo aquifers and surface water bodies (lakes, and so on). Like the case of other natural assets, monetizing water asset account requires estimating the value of water bodies in situ. The asset value is equal to the discounted stream of net benefits it is expected to yield over its lifetime. In principle, water would be treated in the same way that asset accounts for minerals, forests or fish are treated in the SEEA. The challenge lies in estimating the stream of benefits a water body is likely to yield overtime.

This approach can be extended to provide a more realistic assessment that takes into account the impact of depletion on the water value as, for example, the water table of a aquifer falls and pumping costs increase. Given the difficulties of valuation, asset valuation is probably most useful for single-purpose water bodies such as agriculture or hydroelectric power. There is fairly extensive on valuing ground water assets and the costs of depletion of water quality in terms of losses to agricultural production (for example, Hrubovcak et al., 2000; Schiffler, 1998). Water assets with important indirect use values may be more difficult to value, as it will be difficult to establish a relationship between water quantity or quality and the value of environmental services such as recreation and waste assimilation.

10.3.6 National and Local Valuation: and Aggregation of Water Values

Water valuation has a long history in economics, mostly at the project or policy level. Projects and policies are often implemented for a designated water management area, such as river basin. There has been a little experience of aggregating these localized values to the national level.

Because water is bulky commodity and the cost of transporting and storing water are often high, the value of water is determined by local and regional site-specific characteristics and options for use. For example, the value of water as an input to agriculture will often vary a great deal by region because of differing factors that affect production costs and product value including soil, climate, market demand, cost of input, and so on. In addition the timing of water availability, water and reliability of supply are also important determinants of water value. Consequently, the value of water can vary enormously within a country, even for the same sector.

The site-specific nature means that water values estimated for one area of a country cannot be assumed to hold other areas. This poses a problem for constructing accounts for water value at the national level, because the method commonly employed for national accounts scaling up to the national level from sample data- cannot be directly applied. It's more accurate to policy-makers to construct water accounts at the level of the water management area, often a river basin, and to compile national accounts by aggregating the river basin accounts. River basin accounts will also be more useful for policy-makers because many water management decisions are taken at the river basin level, and even policy at the national level must take into account regional variations in water supply, demand and value.

10.4 Issues in the valuation of water

10.4.1 Double-counting of Water Values

Another issue with aggregation of water relates to double-counting. An example is the case of water value used as an intermediate input, which is already included in the SNA, although it is rarely explicitly identified. For instance, value added in dry land farming (including cultivated forest plantations and grazing of livestock) includes the contribution of rainfall or run-off water to economic output. This also applies to all economic production activities that are not charges for water use. Even when water charges are collected from users, the contribution of water to economic value is captured as part of the revenue to water supply institutions and the residual forms part of using activities' surplus. For industrial self-providers value water is split between costs incurred for abstraction, transport, treatment, or storage of water and industry value added. Similarly, the contribution of water as input to ecological production accrues to users of the various ecological services generated.

Damages from changes in water quality to industrial productive capacity or industries' costs of behaviour are already included in the SNA as part of the affected industries' costs of production. Some consumer averting behaviour and health costs may be included in the SNA as part of consumer expenditures, but other may not be easy to identify. The value of recreational or aesthetic water services to consumer may also be at least partly reflected in the market prices of land, housing, or tourism facilities.

Finally it is important to dispel two common misperceptions about water valuation. In some instances, the price charged by water utilities in non comparative markets is sometimes referred to as the value of water. Such a price is an indication of a *minimum* willingness-to-pay, but is likely to vastly underestimate the true economic value of water. In many countries water pricing has only recently begun to approach full cost recovery, including both capital cost and operations and maintenance costs (Johnson, 2000; OECD, 1999).

Another misperception is to treat an industry's value added per unit of water input as the (average) value of water. This is incorrect because value added includes the contributions to product value of labour, capital and other natural resources in addition to water. Economic valuation requires distinguishing the contributions by the other primary factor inputs. Although it is not a measure of water value added per unit water is a widely used indicator of water productivity and the socio-economic benefits of water (Hassan, 2003).

11. Valuing the social dimensions of water – the cost of poor access to safe drinking water

This section describe methods that use statistics on access to safe drinking water together with the concept of Disability Adjusted Life Years (DALYs) to estimate the cost of time spent fetching water and the costs of outbreaks of water-borne diseases. Low access to safe drinking water is one of the major challenges facing SADC Member States. However, low access is still considered a social problem and is seen as a result, rather than a cause, of economic growth. Few governments and households identify poor access to safe drinking water as an impediment to economic growth. Indeed, without information on the link between water supply and economic development, it is hardly surprising that water supply is sidelined and investment in the sector is low. If SADC Member States, private companies, NGOs and even households are to be convinced that expenditure on improved water supply is worthwhile, stronger evidence is needed to better understand the various impacts of poor water supply; on health, labour productivity, lost time and eventually on the economy. The Millennium Project Taskforce recognised the crucial links between water and sanitation and other aspects of development and states that "increasing access to domestic water supply and sanitation services and improving water resources management are catalytic entry points for efforts to help developing countries fight poverty and hunger, safeguard human health, reduce child mortality, promote gender equality, and manage and protect natural resources. In addition, sufficient water for washing and safe, private sanitation facilities are central to the basic right of every human being for personal dignity and self-respect".

The goal of this chapter is to present methodologies that can be used to examine the economic impacts of poor water supply, and the potential gains from improved access. Results of such analysis can show decision-makers at the various levels how the negative impacts of poor water supply can be mitigated by investing in improved water supply. In the policy dialogue, improved water supply should be recognized as both a cause and effect of economic development.

11.1 Methodology for Evaluating the Costs and Benefits of Water Improvement

The World Health Organisation has developed a methodology for evaluating the costs and benefits of improved water supply. The methodology is based on costing the Disability Adjusted Life years (DALYs) [2]. For a full discuss of this method the reader is referred to WHO. 2004.

11.1.1 Steps in Implementing the Cost and Benefit Methods

Determining the economic and social costs of poor water supply

First you need to conduct a comprehensive water impact study to examine the economic and social impacts of poor water supply on the population and the economy, as well as the potential economic benefits of improving water supply.

[2] The Disability Adjusted Life Year or DALY is a health gap measure that extends the concept of potential years of life lost due to premature death (PYLL) to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability (1). The DALY combines in one measure the time lived with disability and the time lost due to premature mortality. One DALY can be thought of as one lost year of 'healthy' life and the burden of disease as a measurement of the gap between current health status and an ideal situation where everyone lives into old age free of disease and disability.

Interventions

Decide on the range of interventions to be analysed. Interventions include the following:-

- House connection
- Standpipes
- Borehole
- Protected spring/well

Geographical focus:- Decide whether to conduct the analysis at the national or provincial level depending on data availability.

Cost Measurement:-Conduct an incremental cost analysis to estimate the cost of extending access to water supply for those in the area of analysis who currently do not have access to improved water supply. The cots include all the resources required to put in place and maintain the intervention and should be separated into investment and recurrent cots. Publication such as the Global Water Supply and Sanitation Assessment Reports can have such data on incremental costs. For example, the 2000 Assessment Report put the investment cost per capita for a standpipe in Africa at US$31. The per capita operation and maintenance cost for a standpipe is estimated at US$2.40 per year.

Health Benefits:- Knowledge of the health benefits of the proposed intervention is critical. The WHO has conducted a number of studies that quantify the health benefits of improved water supply and established routes through which pathogens end up in our food or on our body thus causing water-borne or water-washed diseases. In terms of burden of disease, water-borne and water-washed diseases consist mainly of infectious diarrhoea. The impact of the intervention on the burden of disease can therefore be measured through reduction in the incidence rates and reductions in mortality rates. The WHO publishes these data at the national level.

Population at Risk:-The number of people without access to safe drinking water can be obtained from national reports of the Global Water Supply and Sanitation Assessment Reports.

Non-Health Benefits:- There are many and diverse potential benefits associated with improved water supply, ranging from direct to indirect. The direct benefits are used to calculate the cost-effectiveness ratio (CER) in terms of cost per DALY avoided. Given the problems with data availability, you may focus on a few key benefits related to the direct economic benefits of avoiding diarrhoeal disease; indirect economic benefits related to health improvements; and non-health benefits related to water improvement.

Table 11.1: Economic Benefits from water and sanitation improvements (WHO, 2004)

BENEFICIARY	Direct economic benefits of avoiding diarrhoeal disease	Indirect economic benefits related to health improvement	Non-health benefits related to water and sanitation improvement
Health sector	▪ Less expenditure on treatment of diarrhoeal disease	▪ Value of less health workers falling sick with diarrhoea	▪ More efficiently managed water resources and effects on vector bionomics
Patients	▪ Less expenditure on treatment of diarrhoeal disease and less related costs ▪ Less expenditure on transport in seeking treatment ▪ Less time lost due to treatment seeking	▪ Value of avoided days lost at work or at school ▪ Value of avoided time lost of parent/ caretaker of sick children ▪ Value of loss of death avoided	▪ More efficiently managed water resources and effects on vector bionomics
Consumers			▪ Time savings related to water collection or accessing sanitary facilities ▪ Labour-saving devices in household ▪ Switch away from more expensive water sources ▪ Property value rise ▪ Leisure activities and non-use value
Agricultural and industrial sectors	▪ Less expenditure on treatment of employees with diarrhoeal disease	▪ Less impact on productivity of ill-health of workers	▪ Benefits to agriculture and industry of improved water supply, more efficient management of water resources – time-saving or income-generating technologies and land use changes

11.2 Examples

Results of a global study conducted by the WHO show that cost-benefit ratio of water and sanitation interventions is high when all benefits are included, standing at around US$5 and US$11 economic benefit per US$1 invested.

A detailed application of the methodology in four Asian countries revealed that Cambodia, Indonesia, the Philippines and Vietnam lose an estimated US$9 billion a year because of poor sanitation.

12. Guidelines for Implementation

Previous chapters have outlined the methods for compiling the various water accounts and for determining the economic value of water. This chapter addresses strategic issues on how to implement water accounting in practice; institutionalisation of water accounting, institutional arrangements and stakeholders including roles and responsibilities, data collection strategy, data sharing, and finally information dissemination to influence policy.

12.1 Institutionalization of economic accounting for Water

The status of water accounts should elevate to that of a decision support tool and water accounts should be published, not just as discussion documents, but rather as national statistics with equal importance as economic statistics such as GDP. In order to achieve this, SADC MS need a well defined process that will ultimately institutionalise water accounts. The following are the suggested steps towards institutionalisation of water accounts in SADC.

Sensitisation/Advocacy:- First, SADC should continue holding sensitisation and awareness raising workshops on economic accounting for water but this time widen the target audience to include directors not only of water departments but also other key departments such as statistics, environment, agriculture, finance and economic planning etc. Buy-in and support at high level is critical for sustainability and cooperation in data collection and sharing.

Establishment of water accounting units:- Second, departments of water affairs have to work towards establishment of units on economic accounting for water. This process may take two or more years since budgets have to be secured and qualified staff (Resource economists) employed. Therefore, in the interim National Task Teams and memoranda of understanding with the key departments have to be established.

Formation of National Task Teams:- Since water departments in SADC MS do not currently have units responsible for economic accounting for water (except in Botswana and Namibia where these are being formed) , there is a need to form National Task Teams (NTT) that will foster cooperation with other key departments that use or generate data for water accounts. The size of the national task team will range for 5-10 depending on the size of the country and the number of key water users. Members of the NTT should be junior managers and operational level staff nominated by the Directors of key Departments; Water, Statistics, Environment, Agriculture, Finance and Economic Planning, Industry, Water Utilities, Water Boards, Research and Academic institutions etc. Clear teams of reference for the NTT will have to be developed. These terms of reference may include providing strategic guidance, defining the scope of water accounting depending on national policy and priorities, identifying sources of data, and collecting data from their respective institutions.

Capacity development:- Once NTTs are established, SADC can organise a 4-5 days course on Economic Accounting for Water. It is important to ensure that participants from a country come as a team with a resource economist, macro-economist, accountant, hydrologist, statistician, water quality expert etc. Participants can bring with them data from their respective institutions and use this to compile water accounts during the training so that they have hands on training. Exchange programs with countries that have some experience with water accounts should be part of the capacity development.

Defining the Scope:- Data availability is a major challenge in most SADC Member States. Therefore, Economic Accounting for Water should be implemented as an integral part of improving information systems on water. It is recommended that countries with reasonable data start with

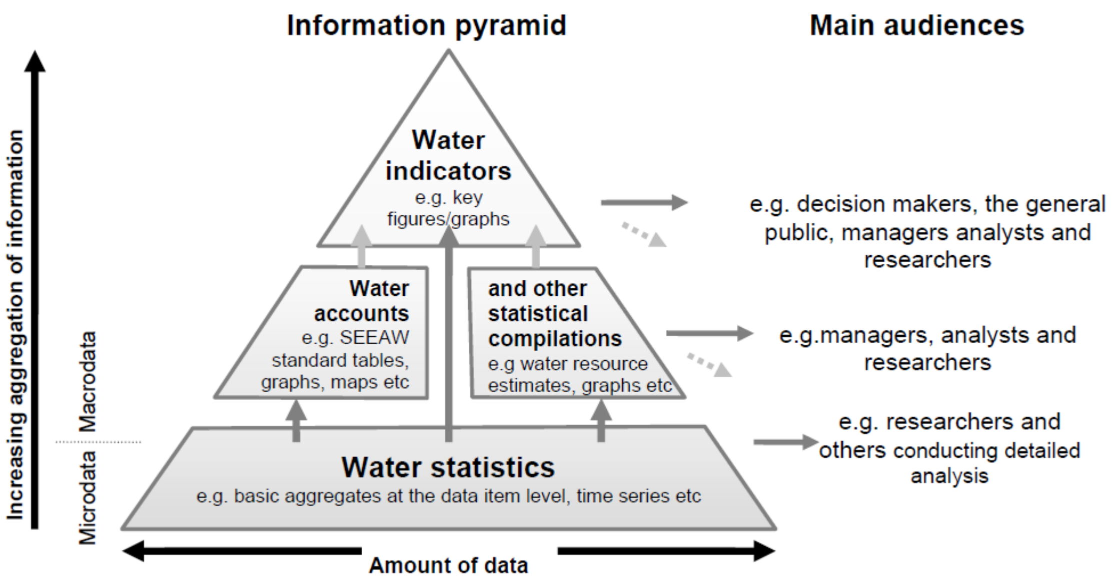
Physical Supply and Use Tables (PUT). In countries where information to compile PUT is not available, it is recommended that these countries start by working closely with statistics departments to develop questionnaires for primary data collection.

Development of data collection strategy:- The NTT should develop a data collection strategy for water accounting that provides an agreed understanding of the data needs, institutional arrangements as well as set priorities. The strategy should clearly describe the roles and responsibilities of the main water users and producers, including the institutional arrangements for ensuring the regular production of comprehensive and high quality water accounts.

12.2 Information Dissemination for Policy Formulation

As alluded to earlier, the aim should be to use water accounts as a decision support tool for planning at the sectoral level (monitoring progress in implementing IWRM) as well as at the national level (water should be an integral part of National Poverty Reduction Strategies). In order to achieve this, dissemination of indicators derived from water accounts and their policy implications to decision makers, industry and the general public is critical. One of the most important considerations when disseminating data is to understand the information needs of the target audience. The information pyramid below presents the information needs of the various target audiences.

Figure 15.1: Information pyramid and the various audiences



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