WATER ACCOUNTING FRAMEWORK – A CASE STUDY OF LUSAKA WATER AND SEWERAGE COMPANY

By

BEN MAKAYI,

BSc.

A dissertation submitted to the University of Zambia in partial fulfilment of the requirements for the Postgraduate Diploma in Integrated Water Resource Management (IWRM)

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Declaration

I, Ben Makayi, do hereby declare that this dissertation represents my own work, and that it has not previously been submitted for a Post-graduate diploma at this University or any other University.

Signature--------------------------------- **Date** 10TH JULY, 2010

Approval

This Dissertation of Ben Makayi has been approved as partial fulfilment of the requirements for the award of the Postgraduate Diploma in Integrated Water Management (IWRM) by the University of Zambia.

Name of Supervisor: Prof. Imasiku A. Nyambe

Signature--**Date**--10th July 2010------

Abstract

The aim of this dissertation is to compile a water account system in order to organize water information in a more efficient and consistent data collection system for Lusaka Water and Sewerage Company (LWSC) for the financial year 2009.

It then turns to an analysis of the handbook of The *System of Environmental and Economic Accounting for Water* (SEEAW), specifically looking at the Physical water Supply and Use Tables (PSUT) and how it applies in building the PSUT. The SEEAW is an international framework for organising hydrological and economic information in a consistent way and the framework allows for compilation of different "tables" which comprise the physical water accounts (PSUT). Water accounting is a useful tool for supporting Integrated Water Resource Management, by providing information on the amount of water being delivered, traded, extracted for consumptive use, and managed for environmental and other public benefit outcomes. This will help water policymakers, planners and managers make informed decisions about how to use water, and supports public and investor confidence. Just as financial accounting is essential for managing businesses, standard water accounting practice is needed to manage our water resources efficiently. PSUT provide information on the volumes of water abstracted, supplied within the economy and discharged back into the environment by economic activity and households were used. PSUT allow for the identification of the industries/sectors which put pressure on the environment via extraction and use and also indicate the industries/sectors consuming the most water.

Collection of primary data involved carrying out a survey at LWSC using self administered questionnaire. The data collected was processed using PSUT to produce an initial estimate of physical water accounts for LWSC and offers a discussion on an application of the account.

Water Account for LWSC, 2009 showed that during 2009, 87,490,000 M^3/YR of water was extracted from the environment and used within the Lusaka City's economy. Of this, 82,490,000 M^3/YR was extracted by LWSC for distribution to other users. A total of 134,940,000 M^3/YR of water was used by Lusaka City's ecomomy and a total of 98,944,000 M^3/YR of water was supplied to Lusaka City. These statistics indicate water use, abstraction and consumption by industry per capita water use which can be useful in providing a basis for setting funding and investment priorities in water infrastructure and evaluating past and current policy descisions. The statistics can also be used in making decisions about water allocations and settting water restrictions in periods of water scarcity and to able to predict future water demand.

The development and maintenance of a water account framework for LWSC will require significant resources as well as the cooperation and goodwill of many agencies and individuals. LWSC needs to adopt the ISIC reporting format for easier compilation of water accounts. Collaboration with other departments especially Department of Water Affairs (DWA) which should take the lead in implementing of water accounts will play a significant role in future advancement of water accounts by for LWSC.

Dedication

I dedicate this dissertation to my wife, Rita and my daughter Mutete, for their inspiration.

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ACRONYMS

EDP	Environmentally Adjusted Domestic Product
EMA	Environmental Management Accounting
ENRAP	Environmental and Natural Resources Accounting Project
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
GRZ	Government of the Republic of Zambia
INEGI	National Statistics, Geography and Informatics Institute
ISIC	International Standard Industrial Classification
LWSC	Lusaka Water and Sewerage Company
NAMEA	National Accounts Matrix Including Environmental Accounts
NDP	Net Domestic Product
NNP	Green Net National Product
OECD	Organization for Economic Cooperation and Development
PSUT	Physical Water Supply and Use Table
SCEEM	System of Economic and Ecological Accounts
SEEA	System of Integrated Environmental and Economic Accounts
SEEAW	System of Environmental and Economic Accounting for Water
SNA	System of National Accounting
UN	United Nations
UNEP	Nations Environment Program
USAID	United States Agency for International Development
WRI	World Resources Institute
WWDR	World Water Development Report

CHAPTER 1: INTRODUCTION

Zambia is endowed with adequate water resources unlike many other countries in the region According to the National Water Policy, 2010, Zambia receives moderate rainfall ranging from approximately an annual average of 600 mm in the south of the country to 1335.9 mm per year in the north. The country's annual average rainfall, based on 30 year period from 1976 to 2006, is 967.3 mm. The Water Policy further shows that Zambia generates an estimated 100 Km^3 per year of surface water and an estimated annual renewable groundwater potential of 49.6 Km^3 pe r year (GRZ, 2010). Most of the surface water resource is poorly distributed while groundwater is fairly well distributed.

Even though Zambia enjoys having adequate water resources, an increase in competition for freshwater between sectors such as agriculture, urban and industrial use as well as population growth can result in unprecedented pressures on water resources. Several countries are already rapidly reaching conditions of water scarcity or facing limits to economic development. This situation has been exonerated by the absence of integration of economic accounts with water resources accounts. The existing database on the status of water resources in Zambia is outdated (GRZ, 2010). The absence of a reliable information management system has made it difficult for all stakeholders to make informed decisions in the country. Consequently, reliable information on Zambia's water is important for managing this essential resource. Water is important for growing food, generating energy and manufacturing goods. Having access to potable water is important for sustaining a healthy population. Any changes in the abundance, distribution and availability of water across the country will pose significant challenges to those who manage water resources.

Because water is critical and intimately linked with socio-economic development, it is necessary for countries to move away from sectoral development and management of water resources and to adopt an integrated overall approach to water management (World Water Development Report, 2006). Only by integrating information on the economy, hydrology, other natural resources and social aspects 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. Those determining the development of industries making extensive use of water resources either as inputs in the production process or sinks for the discharge of wastewater needs to be aware of the long-term consequences on water resources and the environment at large. Therefore it is important to have frameworks for measuring and reporting water stocks and flows.

1.1 System of Environmental and Economic Accounting for Water (SEEAW) – An International Framework for Producing Integrated Environmental-Economic Water Accounts

A water account provides the opportunity to show the supply and use of water in the economy, and the interaction of the economy with the environment. The System of Environmental and Economic Accounting for Water Resources (SEEAW) is an international framework for organising hydrological and economic information in a consistent way. SEEAW was developed in support of the System of Integrated Environmental and Economic Accounting (SEEA) 2003, with special focus on water. Both SEEA and SEEAW are satellite accounts of the System of National Accounts (SNA)1993, which is the standard system for compiling economic statistics and deriving economic indicators, the most notable being Gross Domestic Product (GDP). As such, both SEEA and SEEAW have a similar structure to the SNA and share many common definitions and classifications. This allows direct links between water information and economic data, thereby facilitating environmental-economic analysis in an integrated framework. The SEEAW conceptual framework describes a set of standard tables focusing on hydrological and economic information and supplementary tables covering social information. The set of tables are designed to facilitate the compilation of accounts in countries and to obtain information which is comparable across countries and over time. The SEEAW is also structured to allow for compilation of water accounts at various regional levels, depending on the amount and quality of available data. The SEEAW framework has two components. Part I comprises accounts for which there is considerable international practical experience and a consensus on best practices. It includes internationally agreed concepts, definitions, classifications, accounts and tables. The accounts included in this part include:

- Physical Water Supply and Use Tables **(PSUT)** which provide information on the volumes of water abstracted, supplied within the economy and discharged back into the environment by economic activity and households;
- Emission accounts which provide information on the release of pollutants in wastewater in physical units;
- Hybrid supply and use tables which present side-by-side economic information on the use and supply of water within the economy with the corresponding physical flows.
- Asset accounts which provide information on the stock levels of water resources in the environment and their changes brought about human activities (i.e. abstraction and returns) and natural events (such as precipitation and evapotranspiration).

The second part of SEEAW covers those accounts that are considered of high policy relevance but are still experimental because accepted international best practices have not yet emerged. One example includes quality accounts which provide information on the quality of water resources in the environment and their changes (Bourke and Bain, 2009).

However, this study focuses on **PSUT** which 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. Physical SUT have the same structure of the monetary SUT compiled as part of the standard national accounts compilation. Organising physical information using the same framework as the monetary accounts is one of the characteristic features of the SEEAW (UN, 2006).

The compilation of the physical water SUT allows for:

- the assessment and monitoring of the pressure on water quantities exerted by the economy;
- the identification of the economic agents responsible for abstraction and discharge of water into the environment; and

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 (UN, 2006).

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) will be described in the study. This distinction is used to construct physical water supply and use tables (UN, 2006).

1.2 How SEEAW Can Assist Policy Makers

The SEEAW framework is a useful tool for supporting Integrated Water Resource Management, by providing information to support decision-making, in the following ways: (Bourke and Bain, 2009).

- *How to allocate water resources efficiently.* A SEEAW based water account shows the quantity of water used and who is using it. It also provides information about the economic value added generated by different industries. This allows decision makers to derive water efficiency and productivity indicators, and assists with developing policies for competing users.
- *How to improve water efficiency.* On the demand side, policy makers may introduce economic instruments to change the behaviour of the user. On the supply side, policy makers could encourage efficiency measures. A SEEAW based water account provides a dataset to analyse the impact of changes in regulations that might impact on water resources.
- *How to understand the impacts of water management on all users.* It is important to plan water resources development, allocation and management in an integrated manner. SEEAW, because of its links with the SNA provides the basic information system to evaluate tradeoffs of different policy options on all users.
- *How to get the most value for money from investment in infrastructure.* SEEAW based water accounts help to assess the economic implications of infrastructure maintenance, water services and potential cost-recovery, and also provide information about infrastructure and service charges.

- *Linking water availability and use.* The SEEAW provides information on the stocks of water resources as well as changes in stocks due to natural causes (e.g. inflows, outflows, precipitation) or human activities (e.g. abstraction and returns). In a SEEAW based water account, water abstraction and returns can be presented for different industries.
- *Provides a standardised information system which harmonises information from different sources.* Information on water is often generated, collected, and analysed by different agencies. The individual datasets might be collected for different purposes, use different definitions and classifications and show overlaps in data collection. A SEEAW based water account allows for disparate information to be integrated. (Bourke and Bain, 2009).

1.3 Statement of the Problem

Information on water is often generated, collected, analysed and disseminated by different government departments functioning in specific water-using sectors (e.g. irrigation, water supply, sanitation, etc.). The individual data sets are collected for different purposes and often use definitions and classifications which are not consistent resulting in overlaps in data collection. In a similar fashion, data collection may leave out important aspects of water resources, because not all information collected is of direct interest to a specific government department.

The PSUT brings together information from different sources in an integrated system with common concepts, definitions and classifications. This allows for the identification of inconsistencies in the data as well as data gaps.

1.4 Aim of the Study

The aim of this study is to compile a water accounting system to organize water information in a more efficient and consistent data collection for LWSC.

1.5 Objectives of the Study

The objectives of the study were:

- To determine the volume of water abstracted from the rivers/streams
- To determine the volume of water used by the organisation

- To determine volume of water supplied to industries and households by the organisation
- To determine the volume of waste water received from industries and *households*
- To determine volume of water discharged back into the rivers/streams by the organisation

1.6 Hypothesis

The hypotheses used during the study were:

- Physical supply and use tables are essential in integrating water information in a systematic framework for efficient and sustainable management of water resources.
- 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.

1.7 Rationale

The concept of water accounting which requires compilation of data using the PSUT, allows for the assessment and monitoring of the pressure on water quantities exerted by the economy. It also allows for the identification of the economic agents responsible for abstraction and discharge of water into the environment. Bringing the physical information of water in the economic accounting system introduces checks and balances in the hydrological data and produces a consistent data system from individual sets of water statistics often collected by different line ministries responsible for designing targeted policies (UN, 2006).

1.8 Definition of Terms used in the dissertation

i. **Abstraction for distribution** is water to be supplied, possibly after some treatment, to other economic units.

ii. **Abstraction for own use** is water abstracted to be used by the same economic unit which abstracts it.

iii. **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.

iv. **An industry** is a grouping of establishments engaged in the same or similar kinds of activities.

v. **Regulated discharge** refers to water discharged after use where that discharge does not match the natural flow regime of the receiving water body.

vi. **Reused water** is wastewater supplied to a user for further use with or without prior treatment, excludes recycling within industrial sites.

vii. **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.

viii. **The classification used** in national accounts and water accounts is the International Standard Industrial Classification (ISIC).

ix. **Use of water received from other economic units** within the economy refers to the amount of water that is delivered to an industry, households by another economic unit.

x. **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.

CHAPTER 2: LITERATURE REVIEW

This chapter deals with literature review on the history of water accounting, the SEEAW, system of national accounting, natural resource accounting in Africa, Asia, South America, state of environmental statistics and implementation of water accounting.

2.1 Environmental Accounting History

International work on environment statistics has a comparatively brief history, dating back only three decades. Because environment statistics is a relatively new field, there are frequent changes in methodologies, measurement techniques, and other procedures. Meanwhile, the rapid emergence of new concerns and environmental threats is expanding the field's boundaries. Statisticians must therefore deal with a constantly changing set of demands, while incorporating new and often more complex procedures into their normal routine. Countries that have just begun to develop their own programs of environment statistics will encounter both advantages and disadvantages relative to those that have gone ahead of them. The former can draw on the experience of their predecessors by adopting classifications, methodologies, and techniques that have already been tested elsewhere. However, the dynamic nature of environment statistics means that the start-up is a more complicated undertaking today than it was only a decade ago (Hecht, 2004).

Environmental accounting – the modification of the national income accounts to take into account the economic role of the environment – has grown in importance over the past ten years. However, many countries have not yet implemented such accounts, and there is considerable controversy about whether and how to do so. Environmental accounts are being implemented with an array of goals in mind. One of the most ambitious is that they will help steer the economy onto a sustainable path or provide macroeconomic indicators that reflect the role of the environment in the economy. A more modest goal is that the accounts and the data underlying them will make it easier to analyze sectoral and macroeconomic issues, so as to design policies that reflect a more comprehensive understanding of the relationship between the economy and the environment. A further aim for the accounts is that the process of building them will serve as a catalyst for organizing data in new ways, reconciling discrepancies in underlying data, and investing in new data collection (Hecht, 2004).

2.2 Early Accounting Country Projects

This section gives an account of early water accounting works carried out by different countries.

2.2.1. Norway

The first environmental accounts were constructed in several European countries working independently of each other. Norway was one of the first. Influenced by the publication of *Limits to Growth* (Meadows et. al., 1972) and a burgeoning environmental movement, Norwegian officials were concerned that their natural resources, on which their economy is relatively dependent compared with other European countries, would run out. They therefore developed accounts to track use of their forests, fisheries, energy, and land. In the 1980s, they developed accounts for air pollutant emissions, which were closely tied to the energy accounts. The energy accounts were integrated into models used for macroeconomic planning, taking into consideration the roles of resource-based sectors in economic growth (Hecht, 2007).

2.2.2. Netherlands

The Netherlands was also a leader in the development and adoption of environmental accounting. Dutch interest in this area originated with the work of Roefie Hueting, who developed and sought to implement a measure of sustainable national income that would take into account the degradation and depletion of environmental assets resulting from economic activity. Although his approach was not implemented at that time, his work led the national income accountants to develop the national accounts matrix including environmental accounts (NAMEA), which builds on portions of the national income accounts by adding physical data on pollutant emissions by sector. The NAMEA approach has been adopted by Eurostat, implemented in many other European countries, and integrated into the environmental accounting procedures developed under UN auspices (De Haan, 1999). The Hueting approach has since been tested in the Netherlands (Verbruggen, 2000).

2.2.3. France

France was a third early adopter of environmental accounting. In the 1980s, it began developing an approach termed the *Comptes du patrimoine*, or patrimony accounts. These involved an integrated system structured around three distinct but linked units of analysis. First, natural, cultural, and historical resources were to be measured in physical terms and their stocks and flows quantified. Second, places were to be organized into geographic accounts, giving physical data about assets organized by location and by ecological and land characteristics. Third, people and institutions were to be described in both physical and monetary terms in agent accounts, which were to be linked to data about how and where each agent used resources. Portions of this system were constructed, particularly those focused on forests and water, but its complexity made it difficult to implement fully (Hecht, 2000).

2.2.4. Indonesia

An accounting effort that had considerable influence on the field was a study of Indonesia undertaken by the World Resources Institute (Repetto et. al., 1989). The authors estimated what GDP might have had natural resources depreciated in the same way as manufactured ones. They then compared trends in conventional (GDP) with trends in their environmentally adjusted measure over a period of 15 years. The results show that Indonesian growth rates would have been considerably lower with the adjusted GDP than in the conventional accounts. Though widely criticized on technical grounds and rejected by the Indonesian government, this study has been very influential. It was written for a lay audience and distributed widely, and did much to stimulate interest in the field.

2.2.5. United States

Another early accounting project took a very different approach. In the late 1980s, the US Environmental Protection Agency (EPA) undertook the development of a set of pilot accounts for the Chesapeake Bay region of the eastern United States (Grambsch et. al., 1989). This work was led by an economist, Henry Peskin, who felt that the accounts should incorporate the full value of non-marketed goods and services, and that all changes in value of capital should be deducted from gross indicators to calculate net ones, rather than adjusting only for changes attributable to economic activity. Peskin also brought this approach to USAID-funded work in the

Philippines. These accounts, built by the Department of Natural Resources rather than the accounting agency, added in the value of non-marketed services of the environment, subtracted harm caused by pollution, and calculated an environmental Net Domestic Product (NDP) by subtracting the depletion of natural capital and adding in both the natural growth of forests and new discoveries of minerals [Environmental and Natural Resources Accounting Project (ENRAP), 1999].

2.3 The 1993 System of Integrated Environmental and Economic Accounts (SEEA)

Organized international efforts to share knowledge of environmental accounting and develop rules analogous to the SNA began in the 1980s. The United Nations Environment Program (UNEP) and the World Bank organized a series of workshops on the subject, which led to the publication of two collections of papers that became reference works in the field (Ahmad et al. 1989; Lutz, 1993). Work in the field received a boost from Agenda 21, the declaration of the 1992 World Conference on Environment and Development, which called on all countries to build environmental accounts (UN, 1992, Chapter 8). In 1994, the European Commission launched a program to develop environmental accounting methods and help its member countries implement them, which has provided a major impetus in the field [Commission of the European Communities (CEC), 1994].

The 1993, System of Integrated Economic and Environmental Accounts (UN, 1993) was the first effort to bring some order to the cacophony of voices. The United Nations Statistics Division took the lead in its development. Rather than choosing among the many approaches, it offered five versions, suggesting that countries might choose components that responded to their priorities. Versions I, II, III, and much of IV had already been the subject of much international discussion and limited consensus. Version V was a concession to economists advocating approaches that were considered more controversial and were not the subject of any consensus in the field. The versions are:

- Version I: Same data as the conventional SNA reformatted to highlight issues of environmental importance;
- Version II: Disaggregation of environment-related monetary flows and assets within the conventional SNA;

- Version III: Physical accounts that track the movement of materials between the environment and the economy, natural resource use, discharge of residuals. (The SEEA term for waste), and physical asset accounts that track resource stocks over the course of the year;
- Version IV: Costs of environmental protection and harm. IV.1 identifies changes in the value of natural assets as a result of depletion and degradation. IV.2 values the expenditures required to prevent additional environmental degradation over the course of the year. IV.3 identifies the marketed and no marketed costs borne by households or industry because of environmental externalities. The various parts of this version permit the calculation of several versions of environmentally adjusted domestic product (EDP) (Hecht, 2007); and
- Version V: Elements are considered more experimental, among them the value of unpaid household activities, the value of non-marketed environmental services such as watershed protection, and the integration of input–output with the environmental accounts (Hecht, 2007).

The World Bank, the United Nations, and other donors funded efforts to implement these methods in Mexico, South Africa, Papua New Guinea, Namibia, Botswana, the Philippines, and elsewhere in the world. The Philippines was an interesting case, because the UN and USAID funded two separate projects, using different methodologies. In some respects, notably how they calculate green net national product (NNP), the two approaches are in direct contradiction to each other. In part, this is because the USAID work included the value of non-marketed environmental services and harm whereas the UN work (and the SEEA) did not. In addition, the USAID work included all changes in asset value as depreciation, which is consistent with economic theory but not with the SNA. (Peskin and delos Angeles, 1998). The existence of two independent projects taking different approaches was a source of confusion at times, but it made the country a very interesting case for study (Hecht, 2000). Unlike the revision of the conventional SNA issued the same year, the 1993 SEEA did not have the official approval of the United Nations Statistical Commission. It was proposed as a basis for discussion and experimental implementation, and was not considered a part of the national income accounting framework recommended for all countries' use (Hecht, 2007).

2.5 Environmental and Natural Resource Accounting (ENRA) In Africa

In the African continent, the records reviewed show that only five countries (Angola, Botswana, Namibia, Tanzania and Zimbabwe) have considered or attempted ENRA efforts. This compares unfavourably with developing nations in Asia (8 countries) and Latin America (17 countries). African ENRA efforts, on the whole, have been quite modest (Juan, 2002).

2.5.1 Angola

In the case of **Angola**, the National Environmental Action Plan has included a focus on NRA, initially for petroleum (WWF, 1995), and there is no information on any further developments.

2.5.2 Botswana

Botswana, in contrast, in the late eighties, constructed a set of integrated environmental and economic accounts to assist in the preparation and implementation of a National Development Plan and a conservation strategy. Preliminary accounts were constructed for livestock, food crops, forestry (including fuelwood), minerals, and water. Initially, physical accounts were established, with the intent of eventually valuing some of the environmental variables. This information, however, is based on a report dating from 1989 (Perrings, cited by Lange & Duchin, 1993), and no later information on the Botswana environmental accounts could be found in the available literature.

2.5.3 Namibia

The case of **Namibia** has benefited from a longer-term vision. Namibia's work on resource accounting began in the mid-1990s with financial support from USAID and Swedish SIDA and continued through the late 1990s. Namibia's economy is largely dependent on natural resources, and with almost no industry. Consequently, environmental accounting has focused entirely on natural assets, with no attention to pollution issues. Work has concentrated on water, fisheries, minerals, and livestock, and a project is also underway on energy. The primary output has been policy studies, rather than publication of accounting data (Hecht, 2000).

2.5.4 Tanzania

The work in **Tanzania** was limited to a study conducted in 1989 by Henry Peskin. This study focused on fuel wood and included the imputation of a value for physical depletion of forest resources in Tanzania in 1980 due to fuel wood production. This was the first study to correct for exclusion of non timber values and one of the first to *correct NDP for net accumulation of forest capital (Vincent and Hartwick, 1997).*

2.5.5 Zimbabwe

Finally, the experience in **Zimbabwe** also consisted of a single study published in 1993. This was an academic study that focused on round wood (fuel wood and construction timber) in natural forests, gold, and agricultural soils (Vincent and Hartwick, 1997). The Zimbabwe study emphasized data problems suggesting that the implementation of SEEA to a wider range of developing countries would prove complex (Hamilton and Lutz, 1996)

2.6 Environmental and Natural Resource Accounting (ENRA) From Other Continents

Regarding lessons from other developing countries that would be of benefit to African countries interested in pursuing ENRA efforts, the experiences of China, Mexico and the Philippines are recommended for their thoroughness, their depth and their long-term vision leading to institutionalization of the ENRA processes (Juan, 2002).

2.6.1 China

In 1988, the Development Research Centre of the State Council coordinated a project, "Chinese Resource Accounting and its Integration into National Accounts." It focused initially on physical accounts, then monetary valuation, individual resource accounting, and then a comprehensive system. The integration of resource accounting into the national accounting system through legislation is explicitly stated as an ultimate objective. Monetary accounting has always been a major focus (WWF, 1995).

Carsten Stahmer, one of the authors of the UN handbook on SEEA, regards the Chinese work as a major contribution to the international community, for it has integrated Marxist economics, Chinese philosophy, and market economic principles in the determination of the value theory and pricing method for natural resources (WWF, 1995).

Eight working groups have been focusing on: land, minerals, water, forestry, grassland, ocean, biological resources and recycled resources. Physical and monetary accounts for the eight resources have already been compiled on a preliminary basis (WWF, 1995).

A study sponsored by the World Resources Institute (WRI) and the Ford Foundation (1993) focused on forest resources. The study added value of timber growth to GDP and added net accumulation of timber to NDP. It also calculated the asset value of forests for timber production, but did not link it to accounts (Vincent and Hartwick, 1997).

2.6.2 Mexico

A case pilot study was conducted in 1990 and 1991. The objective was to integrate and link environmental and economic information and to determine whether environmentally adjusted. The study started with the existing SNA. It identified information related to three environmental aspects to be accounted for: oil depletion; deforestation and land use; and environmental degradation (arising from land erosion, air and water pollution, groundwater use, and the generation of solid wastes by the household sector) (WWF, 1995).

The pilot study (published in 1993) was intended to test the key features of the SEEA. The focus was: forests (natural and plantations), soil erosion in forestland, petroleum, and environmental degradation (air and water pollution, solid waste, soil erosion, and groundwater depletion). The study concentrated on current accounts and did not calculate asset values. This is one of the few studies to treat deforestation as a process that not only reduced the stock of forestland but increased the stock of developed land (Vincent and Hartwick, 1997).

Mexico is implementing a System of Economic and Ecological Accounts (SCEEM). This has been a priority of the National Statistics, Geography and Informatics

Institute (INEGI), which is responsible for the Mexican National Accounts. The project has been well received by Congress, which gives it a chance as a public policy formulation tool (Claude, 1997).

The SCEEM is essentially a Mexican version of SEEA. The main innovation is the enlargement of the asset boundary, including oil depletion, degradation concerns (water and air pollution, soil erosion, groundwater use and the deposition of solid wastes), *land use concerns, and deforestation. The accounts provide two measures of* the Environmentally adjusted Domestic Product (EDP). "EDP1" is obtained by deducting the cost of resource depletion from NDP and "EDP2" by deducting environmental degradation (Hamilton and Lutz, 1996).

2.6.3 Philippines

WRI assessed the depreciation for forestry, soil erosion, and coastal fisheries for the 1978- 1987 period (WWF, 1995).

In 1991, DENR and USAID set up the ENRAP project. The first phase (known as "NRAP") focused on the forest sector and adjusted the GNP for the depreciation of forests (WWF, 1995).

The second phase, from January 1993 to March 1994 developed a more general accounting framework with the aim of supporting integrated environmental and economic policy formulation. The third phase started the institutionalization of the accounting process within government structures. Accounts were refined and updated to meet specific policy and management needs (WWF, 1995).

NRAP phase I focused on current accounts of forest resources and calculated the asset value of dipterocarp forests, but did not link it to asset accounts. Apparently the first study to compare alternative methods for estimating net accumulation of timber (Vincent and Hartwick, 1997).

The WRI study referred-to by WWF focused on timber in natural forests, agricultural soils and fisheries. The approach is essentially identical to that applied in the Indonesia WRI study (Vincent and Hartwick, 1997).

The Philippines offers rich experience for other countries considering environmental accounting, because two separate, parallel projects were underway there for much of the 1990s (Hecht, 2000).

In 1991, the Environmental and Natural Resources Accounting Project (ENRAP) began in the Department of Environmental and Natural Resources (DENR) with financial support from the United States Agency for International Development (USAID). The stated goals of ENRAP were to build data useful for analysis of public policy and to encourage policymakers to use those data. From the start, the project placed a major emphasis on publishing analytical studies that applied the accounting data to specific policy questions, so that policy makers could see how the work was relevant to decision-making. Over time, the project focused on more detailed issues, taking on some regional accounting, cost-benefit analyses, and primary data collection (Hecht, 2000).

In the mid-1990s, the National Statistical Coordination Board began implementing SEEA. They received financial support from the UN for the project, which has been referred-to as PSEEA. This project was developed to implement SEEA without ENRAP's focus on data use. They built resource accounts for forests, minerals, fish, and soil, and estimated the costs of preventing air and water pollution. At the start, they relied on ENRAP technical assistance in building the accounts. They have published asset accounts, and are working on improving their data on pollution costs (Hecht, 2000).

Unlike many countries, both projects (ENRAP and PSEEA) produced green GDP figures, although PSEEA has not published them (Hecht, 2000).

The existence of two separate projects using different methods, estimating different resource depletion figures, and calculating different values for green GDP has confused Philippine officials. An important aspect of the Philippine experience is that ENRAP was run by analysts (mainly economists), while statisticians ran PSEEA. Other countries may learn from this experience about the importance of involving both official statisticians and analysts in a collaborative effort from the start, instead of allowing an uncomfortable competition to develop (Hecht, 2000).

2.7 State of Environment Statistics in Developing Countries

Robust environmental and socioeconomic data provide the foundation for the analysis and interpretation of the state of the environment. In the absence of such data, any report on the state of the environment is reduced to a descriptive, anecdotal, and non-systematic observation, which is not an acceptable basis for rational decision making. The type of data required covers a wide spectrum. Data on natural resource stocks and environmental conditions are essential. Similarly, statistics on human activities impacting on the environment, the environmental changes are equally important in assessing the ecosystem interactions (Rump, 1996).

Environmental and socioeconomic data tend to be collected independently by diverse agencies, using different methods and classifications, and for quite specific purposes. Data on the environment are usually derived from monitoring programs and the interpretation of remotely sensed images. Socioeconomic data are collected from statistically designed surveys and from administrative records. From a state of the-environment perspective, particularly at national, regional, and global levels, the spatial resolution and temporal dimensions of much of the data are often limited. Much of the available data relate to individual environmental or human activity components rather than to a synergistic, ecosystem perspective. For example, databases for commercial forest areas tend to emphasize the production mandate of the forestry management agency, not adequately reflecting the diverse values of forest ecozones, which include their role in terms of habitat and biodiversity, water conservation, and traditional and alternative land uses (Rump, 1996).

Although high-quality data are vital for credible information, a systematic approach to their generation is largely lacking. The acquisition, processing, and storage of environmental data is time-consuming and expensive, and is not a priority for most governments. Consequently, baseline and trend data related to the ways the ecosystem functions and its components interact are insufficient. The data we do have tend to be scattered and difficult to obtain, while proprietary and security factors can inhibit dissemination and open access. Environmental and socioeconomic data do not generally exist in usable and integrated formats for reporting. There is a common deficiency of infrastructure and standards to facilitate the easy exchange and correlation of data from different jurisdictions and disciplines (Rump, 1996).

2.8 Implementing Water Accounts

Several dozen countries have implemented portions of the SEEA since the first version was published in 1993. Perhaps a dozen, most of them Commission of the European Communities-Eurostat (OECD) countries, are routinely implementing most of the SEEA. In choosing portions of the accounts to construct, countries are typically driven by operational rather than conceptual issues; their environmental problems, data availability, funding availability, and which components seem most manageable in terms of the practical issues involved in building accounts (Hecht, 2007).

Less work has been undertaken in the developing world, because conventional national accounts are often weak and funds available for accounting usually go to basic economic information. Most work in the developing countries has been funded by foreign aid donors. Because such assistance is rarely provided over a long period of time, developing countries are less likely to have ongoing time series environmental accounting systems than are wealthier countries (Hecht, 2007). This situation is slightly different in developing countries, where foreign assistance may focus both on producing the accounts and on using those for policy purposes and direct connections can be made between data supply and use (Hecht, 2007).

2.9 Summary

The collection and compilation of environment statistics constitute a recent phenomenon in most of the developing countries. The present system of data collection in all these countries is weak, unorganized, and poorly funded. Most of the countries do not collect core environment statistics; what they have is environment-related statistics. Where some core environment data exist, their quality, comparability, and accessibility normally fall short of the standard required for decision making. There is a wide variance among countries with respect to the extent of their expertise and knowledge. There are also variations in their interpretations of terminologies, classifications and standards, estimation methods, the training they provide to their personnel, and the resources they allocate for data collection (Rump, 1996).

Despite some data gaps, there have been some efforts by international organizations to compile and publish global/regional environmental data. Since there is a general dearth of environmental data in all the developing countries, it is always likely that international data will show gaps. No amount of international efforts can therefore succeed in compiling regional or global statistics unless the countries' capabilities to produce environment statistics are improved (Rump, 1996).

CHAPTER 3: RESEARCH METHODOLOGY

This chapter gives a description of the sources of data collection, sampling procedures as well as methods of data analysis used. Problems encountered during data collection are also described.

3.1 Research Method

This study involved obtaining primary data by carrying out a survey at LWSC using self administered questionnaires. LWSC was selected because it is mandated to distribute water and provide wastewater services in Lusaka City.

Supplementary secondary data was collected from governmental and non governmental statistics, research studies and reports.

3.2 Sample Size and Sampling Procedure

Key persons from LWSC were interviewed from Water Supply and Sewerage Departments using self administered questionnaire (Appendix A).

3.3 Data Analysis

The data was analysed quantitatively using simplified PSUT. Information collected from self administered questionnaires (Appendix A) was used to enter the water use and supply tables respectively quantitatively analysed using PSUT formulas.

3.3.1 PSUT Description

In coming up with the PSUT description, Table 3.1 which shows the standard physical use and supply tables for water were used. The breakdown of the economic activities, classified according to International Standard Industrial Classification (ISIC) Revision 4, by columns distinguishes industries and households. Industries are disaggregated as follows:

i. ISIC 1-3 which includes agriculture, forestry and fishing;
ii. ISIC 5-33, 41-43 which includes mining and quarrying, manufacturing and construction;
iii. ISIC 35 - Electricity, gas, steam and air conditioning supply;
iv. ISIC 36 - Water collection, treatment and supply;

v. ISIC 37 - Sewerage; and

vi. ISIC 38, 39, 45-99, which corresponds to the service industries (Table 3.1)

By rows, three types of flows namely abstraction (in-flow) of water from the environment to the economy, flows within the economy and returns (or out-flows) of water from the economy to the environment are distinguished (Table 3.1).

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 and groundwater) as in the asset classification. Most of the water is abstracted for distribution by ISIC 36, water collection, treatment and supply (Table 3.1).

The **total water use** (row 3 in Table 3.1) of an industry is computed as the sum of the amount of water directly abstracted (row 1 in Table 3.1) and the amount of water received from other economic units (row 2 in Table 3.1). 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. All calculations were done using Excel Software (Microsoft, 2007).

The **total water supply** (row 6 Table 3.1) is computed as the sum of the amount of water supplied to other economic units (row 4 Table 3.1) and the amount of water returned to the environment (row 5 Table 3.1).

The difference between the water use (row 3 in Table 3.1) and the water supply (row 6 in Table 3.1) is referred to as water consumption. It can be computed for each economic unit and for the whole economy. Water consumption by industry i = Total use of water by industry i – Total supply of water by industry i.

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. 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) (Table 3.1). 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. Returns to the environment are described to be under water resources which are disaggregated as surface water, groundwater and soil water (Table 3.1).

Table 3.1: Standard Physical Supply and Use Table (PSUT) for water

Physical Use Table		Industries (by ISIC categories)							Households	Total
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total		
From the environment	**ROW 1. Total abstraction** (=1.a+1.b=1.i) 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									
Within the economy	**ROW 2. Use of water received from other economic units**									
ROW 3. Total use of water (=1 + 2)										

Physical Supply Table		Industries (by ISIC categories)							Households	Total
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total		
Within the economy	**ROW 4. Supply of water to other economic units** of which: 4.a. Reused water 4.b. Wastewater to sewerage									
To the environment	**ROW 5. Total returns** (=5.a) 5.a. To water resources 5.a.1. Surface water 5.a.2. Groundwater									
ROW 6.Total supply of water (=4+5)										
ROW 7. Consumption (=3-6)										

CHAPTER 4: INTERPRETATION AND DISCUSSION OF RESULTS

In this chapter the results collected using self administered questionnaires are interpreted and discussed.

4.1 INTERPRETATION OF RESULTS

Figure 4.1 first shows that water is self abstracted from the environment either by LWSC or the industries. From the abstracted water by LWSC, some of it is treated and then redistributed through mains to water users representing industries and households. Reuse water, though shown in Figure 4.1, it is currently not being supplied to industries or households (Figure 4.1). However, reuse water is seen as a future potential for supplying water to industries or households especially in production of electricity which requires large volumes of water instead of using high quality water. After industries or households use the water it is supplied as sewerage to waste water industry (LWSC). Water is finally discharged back into the environment either as regulated or unregulated by LWSC or industries. Figure 4.1 is thus a diagrammatic representation of how information between the economy and environment is integrated.

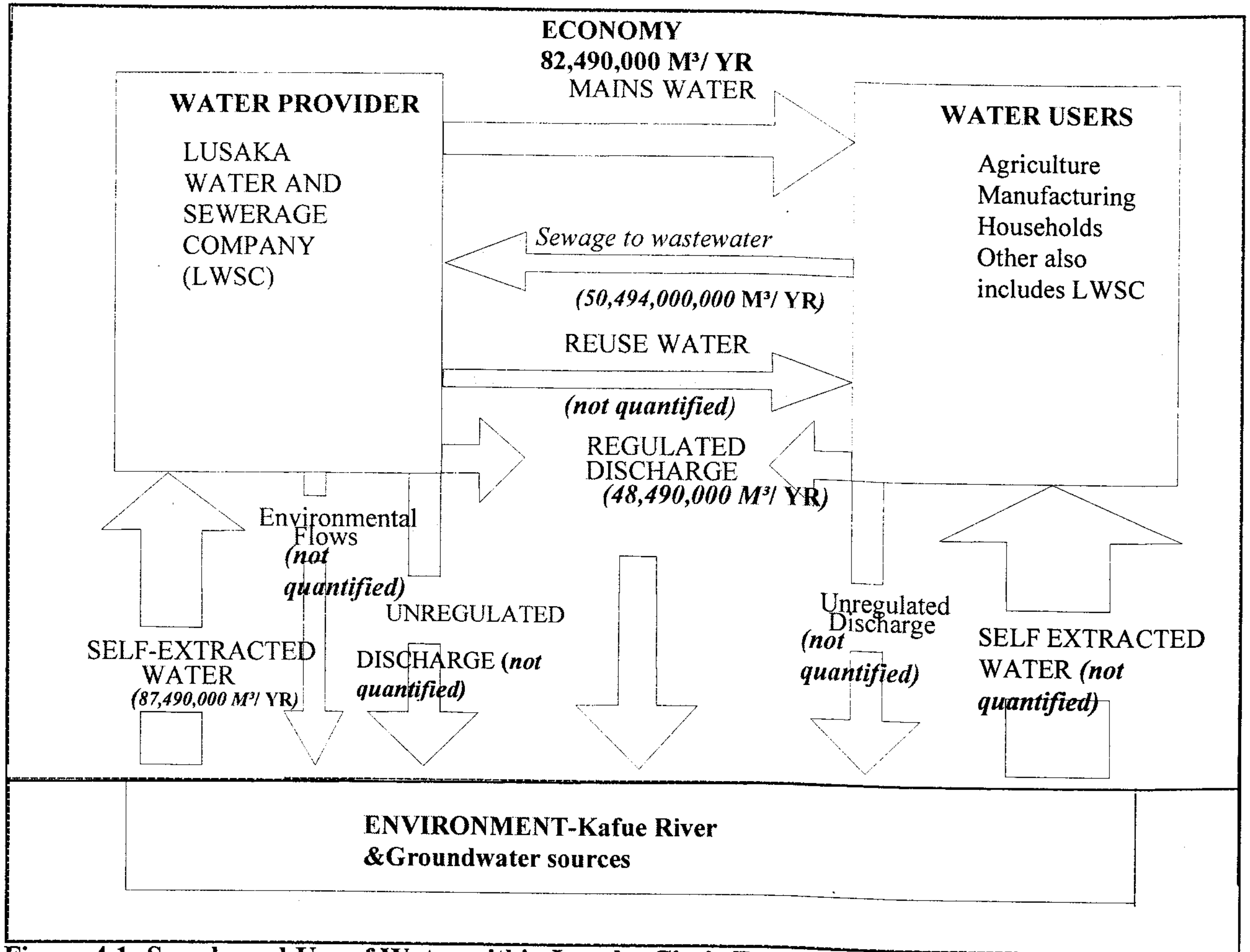

Figure 4.1: Supply and Use of Water within Lusaka City's Economy, Zambia

An illustration of how Table 3.1 and Figure 4.1 works is given by data supplied by LWSC through the survey done in this study. For one to be able to use Table 3.1 and Figure 4.1, you need the following data:

i. Volumes of water abstracted
ii. Volumes of water supplied (delivered through infrastructure and licensed to self-extract). Total water supply (row 6 Table 4.1) is computed as the sum of the amount of water supplied to other economic units (row 4 Table 4.1) and the amount of water returned to the environment (row 5 Table 4.1)
iii. Volumes of waste water discharged by water suppliers
iv. Volumes of reuse water supplied
v. Losses in water supply systems (which represents water consumption in Table 3.1). This is calculated as the difference between the water use (row 3 in Table 3.1) and the water supply (row 6 in Table 3.1)
vi. Volumes of water used by individuals, industry, etc The **total water use** (row 3 in Table 4.1) of an industry is computed as the sum of the amount of water directly abstracted (row 1 in Table 4.1) and the amount of water received from other economic units (row 2 in Table 4.1)
vii. Sources of water used by individuals, industry, etc
viii. Volumes of reuse water used by individuals, industry, etc
ix. Volume of water discharged by individuals, industry, etc

These are the data which are entered in Figure 4.1 . The data can be used for projecting future water demand which is essential for water management. For example, future water and sanitation requirements depend on many factors, including population growth, the volume and composition of economic growth, and technological change. How the requirements are met depends on available technologies, including innovative ones like water demand management and reuse of water, and water policies such as pricing and other incentives for water conservation. Scenario modeling designed to incorporate some of these factors, especially for influencing water demand and unconventional water supply, are useful tools for water managers. They require sophisticated economic models, often built around water accounts integrated with Input-output (IO) table.

Simple time trends of total water use and pollution reveal changing pressure on water resources and indicators of separating economic growth from increased use of resources can be done using the data. For example, in Botswana, per capita water use and water productivity (measured by GDP per cubic meter of water used) both declined from 1993 to 1998, so that the volume of total water use increased only 5% (Figure 4.2) even though GDP grew more than 25%. For a water scarce country, this is a positive trend.

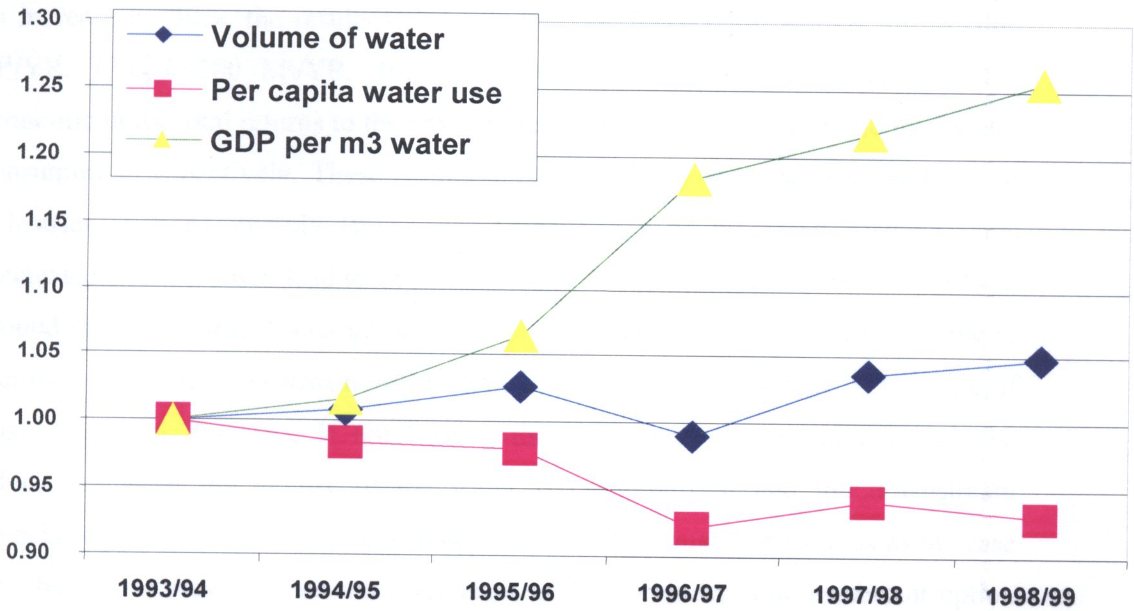

Figure 4.2: Index of Water Use, Population and GDP in Botswana, 1993 To 1998 (1993 = 1.00).
Source: Based on Lange et al., 2003
Note: These indicators can be derived from the physical supply and use table described in Table 4.1

In the 2009 LWSC survey, total water abstraction from the environment was 87,490,000 M³/YR, while within the economy the use of water received from other economic units was 80,000,000 M³/YR and the total water use to Lusaka City by water from LWSC was 134,940,000 M³/YR (Table 4.1). On the other hand, households use most of the water abstracted which is 60,000,000 M³/YR while all ISIC such as Zambia Breweries, Trade Kings are second with 20,000,000 M³/YR (Table 4.1). These results indicate that any future increase in households connected to LWSC will require the company to increase its abstraction to more than

95,436,359.80 M^3/YR in order to meet this resultant increase in use. However, any increase in abstraction either from the surface or groundwater requires that environmental flows are maintained. If no consideration is made as is the current practice, aquatic biota will adversely be affected. Supply of water to other economic units within the economy which represented waste water to sewerage was 50,494,000 M^3/YR, while total returns to the environment was 48,450,000 M^3/YR. The total supply of water was 98,994,000 M^3/YR while the total consumption for the whole Lusaka City's economy was 35,996,000 M^3/YR (Table 4.1). Nevertheless, if there is an increase by 30%, the results will be as follows, 65,642,200 M^3/YR, 62,985,000 M^3/YR, 128,692,200 M^3/YR, 46,794,800 M^3/YR for supply of water to other economic units, total returns to the environment, total supply of water and total water consumption respectively. These results indicate that any increase in production of industries such as Zambia Breweries, Trade Kings or increased housing units connected to LWSC will lead to an increase in discharge to the environment (surface, ground or soil). If this discharge is regulated and treated, this situation is positive in that those who are downstream will benefit by abstracting this water. Futhermore, if this increase in discharge is not treated, then the environment can adversely be affected because the quality of the water is compromised and the downstream especially where there is direct consumption either by humans or animals as the case may be. Reuse water though indicates zero entry is considered an important option for securing water supply into the future (Table 4.1). There are a variety of water sources that may be supplied as reuse water, including waste water (from sewerage systems), drainage water, and storm water. 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.

Table 4.1: Standard Physical Supply and Use Table (PSUT) for Water

Use Table		Industries (by ISIC categories) Water Supply 36	Sewerage 37	all ISIC (except 36&37)	Physical units M³/YR Total	Households	Row Total
1. from the environment	**ROW 1. total abtraction (=1.a+1.b=1.i)**	87,490,000			87,490,000		87,490,000
	1.a Abtraction for own use	5,000,000			5,000,000		5,000,000
	1.b Abtraction for distribution	82,490,000			82,490,000		82,490,000
	1.i From water resources:						
	1.i.1 Surface water	35,040,000			35,040,000		35,040,000
	1.i.2 Groundwater	47,450,000			47,450,000		47,450,000
2. within the economy	**ROW 2. Use of water received from other economic units**			20,000,000	20,000,000	60,000,000	80,000,000
ROW 3. Total use of water (=1+2)		87,490,000		20,000,000	107,490,000	60,000,000	134,940,000

Supply Table		Industries (by ISIC categories) Water Supply 36	Sewerage 37	all ISIC (except 36&37)	Total	Households	Row Total
4. within the economy	**ROW 4. Supply of water to other economic units of which:**						
	4.a Reused water 4.b Wastewater to sewerage	1,000,000		5,000,000	6,000,000	44,494,000	50,494,000
5. to the environment	**ROW 5. Total returns (=5.a)**	950,000	1,000,000	4,500,000	6,450,000	42,000,000	48,450,000
	5.a. To water resources						
	5.a.1. Surface water	950,000	1,000,000	4,500,000	6,450,000	42,000,000	48,450,000
	5.a.2. Groundwater resources						
ROW 6. Total supply of water (=4+5)		1,950,000	1,000,000	9,500,000	12,450,000	86,494,000	98,944,000
ROW 7. Consumption (=3-6)		85,540,000	- 1,000,000	10,500,000	95,040,000	- 26,494,000	35,996,000

Using the data obtained from the LWSC survey example Table 4.1, households use approximately 69% of the total water supplied by LWSC, this is followed by all ISIC industries with approximately 23% and the lowest being LWSC at 8% (Figure 4.3). These results indicate that households use most water distributed by LWSC and therefore any increase in housing units will require LWSC to respond by increasing their redistributed water accordingly. Consequently, if not monitored properly it can lead to over abstraction of surface or groundwater. Groundwater can be adversely affected in that it is currently free to abstract and LWSC abstracts 50% of their water from groundwater. This type of analysis helps to identify the households or industries that place the most pressure on water resources (ground, surface or soil).

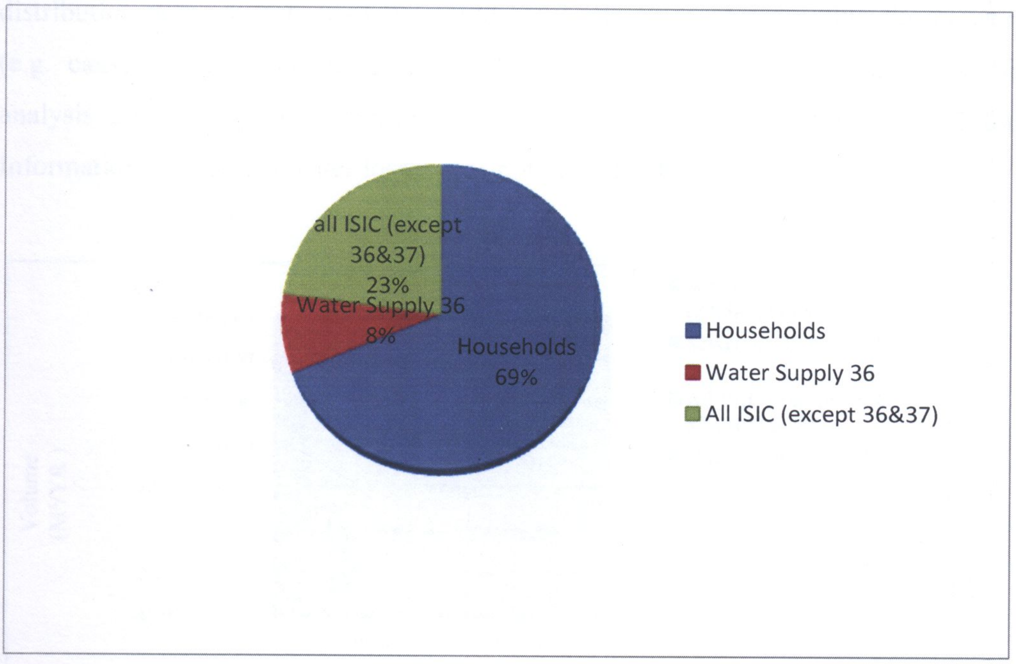

Figure 4.3: Use of LWSC Distributed Water to Industries/Households in 2009

LWSC has the highest consumption slightly above 80,000,000 M³/YR followed by all ISIC with about 10,000,000 according to the survey obtained from LWSC while sewerage and households had negative consumption (Figure 4.4). These results indicate that most water loses are incurred during distribution of water to industries. Consumption for households as negative showing that water was used completely and non was returned. The concept of water consumption gives an indication of the amount of water that is lost by the economy during use in the sense that it has entered the economy but has not returned either to water resources. This happens because during use, part of the water is incorporated into products, evaporated, transpired by plants or simply consumed by households or livestock. 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 (UN, 2006).

There are cases where illegal tapping or removal of water from the distribution network become 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 analysis are required to determine the extent of this phenomenon (UN, 2006). Information on types of water losses was not provided by LWSC.

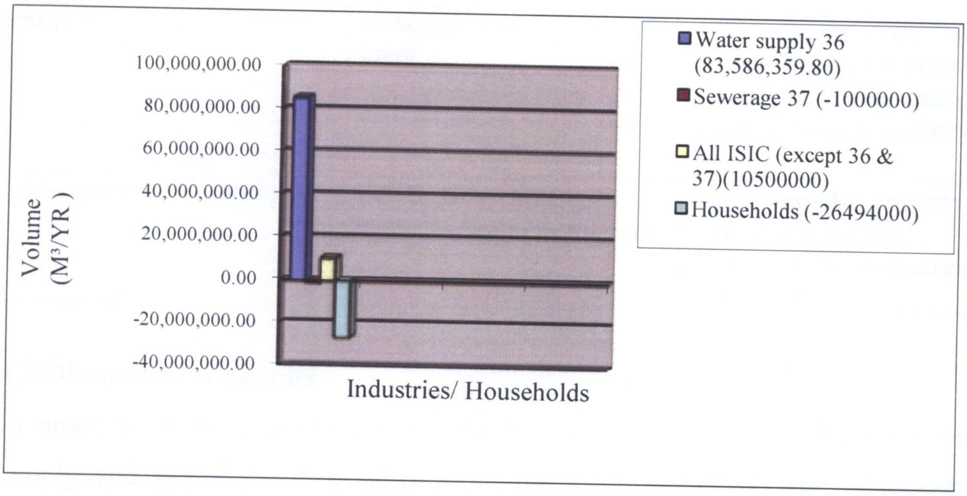

Figure 4.4: Consumption of Water by Industries, Households and LWSC

A great deal of information is required to compile a comprehensive picture of water supply and use for LWSC (Table 4.2). The nature of monitoring water resources and their interactions with the economy is complex and there are currently many sources addressing these information requirements to some extent. Nevertheless, there are still many significant data gaps. Key data gaps include actual water use by user type and the location where water is supplied and used (to enable the production of high quality data). There is also a lack of integration of physical, economic and social data relating to water use. Table 4.2 outlines the data gaps in water statistics that were identified after analysis of data collected during the survey. It refers to specific data, and outlines the benefit of collecting this data.

Table 4.2: Current Data Gaps in Water Statistics and Benefits of Collection

Gap	Data Provider	Benefit of collection
Volume of water supplied (including reuse water)	LWSC (Water suppliers)	Regular (annual) compilation of national and state figures on total volumes supplied by the water supply industry
Details of customers (including reuse customers)	LWSC (Water suppliers)	To show the levels of use (and importance) of water in various industries Industry value added by water users Balancing of water accounts
Volumes of water used	Water users (eg. Industries, including LWSC)	To assist with balancing water accounts
Source of water	LWSC including other Water users	To show the importance of water to each industry Economic value added by water to each industry
Discharges of waste water	LWSC , Government agencies/water regulators	Help monitor impacts on receiving waters To assist with balancing water accounts

4.2 Discussion of Results

In order to understand the system one has to derive indicators from the physical supply and use tables. These include, for example, water use, abstraction and consumption by industry per capita water use. Indicators on water abstraction, use and consumption by industry allow for comparisons between different types of water use. Abundant information exists on the water resources in different institutions. Water statistics is most commonly compiled within countries' environment statistics programmes both in developed and developing regions. In developing regions, Air, Land, Forest and Biodiversity statistics are additional areas among the most commonly covered by the programmes. Areas of expansion include, in order of importance, Air, Water, Land, Biodiversity, Forest, and Energy.

Water accounts, Energy and emission accounts are among the modules most commonly compiled as well as priority areas for further expansion in developing regions.

Countries identified that the lack of human and financial resources as the most common impeding factors for the development of both environment statistics and environmental-economic accounting programmes. Mostly data is organised in different definitions, is often inaccecible (e.g in a paper file), sometimes obsolete (old) or has short and incomplete time series. Furthermore, legal framework for data collection and availability is not ideal in most countries. Moreover, in the compilation of these statistics, the availability and quality of data were considered key impeding factors.

A great deal of information is required to compile a comprehensive picture of water supply and use. The nature of monitoring water resources and their interactions with the economy is complex and consequently, Department of Water Affairs should be the lead department in currying out water accounts. The following are the data requirements for water supply and use:

- Volumes of water supplied (delivered through infrastructure and licensed to self-extract);
- Volumes of water waste water discharged by water suppliers;
- Volumes of reuse water supplied;
- Losses in water supply systems;
- Volumes, source and reuse of water used by individuals, industry and crop type;
- Volumes of water traded;
- Volumes of water discharged by individuals, industry and crop type;
- Efficiency of water use practices;
- Changes in water use practices over time by differnet industry sectors;
- Cost to supply water;
- Charges for water use;
- Value of production from water use (ideally net and not gross value) value of water and water rights (including water trading);

- Value of water storage and delivery infrastructure, environmental flows and water quality;
- Emissions;
- Area irrigated by crop type, irrigation techniques and scheduling tools, water stocks, farm dams, responses of farmers to drought;
- Water recycling by industry; and
- Domestic rainwater tanks and water drainage.

LWSC have the required information even though some data gaps in terms of Volume of water supplied (including reuse water), details of customers, source of water used, volumes of water used and discharges of waste water were observed when compiling PSUT. Volumes of water supplied assists in regular (annual) compilation of national and state figures on total volumes supplied by the water supply industry. Details of customers of LWSC supply water assists in showing the levels of use and importance of water in various industries, industry value added by water users and balancing of water accounts. Volumes of water used assists in balancing of water accounts. Groundwater sources of abstraction show the importance of water and the economic value added to LWSC. Discharges of waste water to the environment helps in monitoring impacts on receiving waters and also in balancing of water accounts. LWSC did not avail this data and yet by virtue of being a water provider they obviously collect and certainly have information on the identified data gaps. Nevertheless, this situation can be improved by LWSC re-arranging current water data to match the format of the standard tables (PSUT) and to ensure they are consistent with the definitions and classifications of SEEAW. Consequently, integration of water information in terms of volumes of water abstraction for own use or distribution which is surface and groundwater, supply of water to industries or households, waste water services provided to industries or households and water discharged back to the environment can be achieved.

Collaboration with other agencies will be key in building capacity of carrying out water accounts by LWSC especially DWA which should be the lead department in the production of the accounts. DWA should carry out preliminary work, including learning the details of the SEEAW and investigating the available data. Hence, data gaps and deficiencies may be identified and, if important enough, these can be addressed. Once the preliminary work is done by DWA, it will be easier for LWSC and other agencies to be trained in compiling water accounts.

Environmental accounts, although rooted in resource accounting, go beyond the measure of natural resources in purely physical terms. Environmental accounts aggregate national data by linking the environment with the economy, providing an analytical framework, which allows the analysis of both. Ideally the accounts would be focused on answering important policy questions, not simply driven by a desire to build databases.

In the absence of such information, policy decisions are taken without a clear understanding of consequences on all users of environmental goods and services. The opposite enables decision makers to effectively assess past and current policies, and where necessary adjust them. Information can also enhance public confidence in the policies and management of water resources.

Recently, environmental issues have been receiving more and more attention. A number of measures have been taken by both developed and developing countries to reduce the environmental costs of development. In the field of statistics, however, many things still need to be done. This is very challenging, realizing that many developing countries still do not have good vital statistics, let alone environment statistics.

Despite data availability problems and problems related to the method of estimation, each country needs to start taking appropriate measures to deal with environmental issues and to compile environmental statistics. Availability of environmental statistics is a necessary condition for compiling environmentally adjusted GDP, which should be considered the ultimate goal. Without some form of environmentally adjusted GDP, sustainable growth is only an illusion.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

This chapter gives the conclusions and recommendations on the best way to alleviate the data gaps identified during the study.

5.1 Conclusion

Water accounting is becoming a common accounting system practiced by many countries including Australia, Jordan, South Africa, Botswana, China, Norway, Netherlands, France, Indonesia, United States, Angola, Namibia, Tanzania, Zimbabwe, China, Mexico and Philippines.

In undertaking water accounts, PSUT is a minimum requirement that agencies are encouraged to compile. However, a more detailed breakdown of PSUT can still be compiled both on the industry side as well as well on the type of water and industries can be further disaggregated is often necessary for more detailed analyses. The level of detail will depend on the LWSC priorities and data availability.

The preparation of the water accounting framework for LWSC should be seen as the starting point for the development of environment statistics in Zambia. The collection of water accounts statistics should be made a regular data collecting activity, which includes data such as volumes of water abstracted, volumes of water supplied, details of customers (including reuse customers), volumes of water used, losses in water supply system, source of water and discharges of waste water. The water accounts data base and the process of building them will serve as a catalyst for organizing data in new ways, reconciling discrepancies in underlying data, and investing in new data collection.

For instance, total water consumption for Lusaka City was calculated as follows: Row 3 total 134,940,000 M^3/YR (total water use)-Row 4 total 98,944,000 M^3/YR (total water supply) = 35,996,000 M^3/YR (Table 4.1).

This dissertation has provided a brief overview of the benefits of using an environmental–economic framework for water accounting. Their importance cannot be over emphased and include:

- Environmental accounts aggregate national data, provide an analytical framework and focuses on answering important policy questions;
- In the absence of such information, policy decisions are made are taken without the clear understanding of consequences. The opposite enables decision makers to asses past and current policies and also adjust them;
- Recently, environmental issues have raised attention of both developed and developing countries. Consequently, measures have been put into place to reduce environmental costs of development; and
- Despite data availability problems and problems related to the method of estimation, each country needs to start taking appropriate measures to deal with environmental issues and to compile environmental statistics.

The development and maintenance of a water account framework for LWSC will require significant resources as well as the cooperation and goodwill of many agencies and individuals.

5.2 Recommendations

The following are the recommendations:

a) LWSC needs to adopt the ISIC reporting format for easier compilation of water accounts;

b) LWSC needs to build capacity to obtain reliable, continuous and harmonious primary water data; including establishing and operating water monitoring facilities, applying standard monitoring procedures and programmes;

c) LWSC needs to collect the necessary information via surveys, administrative records or other means to obtain the required information for the development of water accounts according to the SEEAW international standard;

d) LWSC needs to build on existing water knowledge and recognise that a range of different information systems are already in place and that LWSC need to understand that their data is valuable and that others could use it for their purposes;

e) LWSC needs to enhance coordination through an institutionalized mechanism among various national agencies generating primary data for water and environment accounting, by means of a specific action programme;

f) DWA needs to undertake a comprehensive knowledge mapping effort to assess water and environment monitoring systems and related economic data collections in order to generate primary data on achievements, gaps, constraints, challenges, opportunities, lessons learned, best practices and coordination instruments;

g) For water accounts to be achieved, LWSC needs to collaborate with other departments such as Water Affairs Department which should be the lead department in carrying water accounts, Central Statistical Office, economic/planning, agriculture department, and research institutions. Consequently, proper legal and administrative processes should be developed and used for the sharing and integration of data and that the duplication of activity is reduced between different agencies, within agencies as it paves the way for internal cooperation and there are no "turf wars" between or within agencies;

h) Water Affairs Department (DWA) should take the lead in the coordination and production of the accounts. The lead agency does the preliminary work, including learning the details of the SEEAW and investigating the available data.

References

Microsoft Office Excel (2007). Microft cooperation.

Ahmad, Yusuf, Salah El Serafy, and Ernst Lutz (eds.). 1989. "Environmental Accounting for Sustainable Development." *Proceedings of a UNEP-World Bank Symposium*. Washington, DC: World Bank.

Bourke, D.M., and D. Bain. 2009. *Water accounting-International standards and ABS experience*, 18th World IMACS / MODSIM Congress, Cairns, Australia.

CEC (Commission of the European Communities). 1994. *"Directions for the EU on Environmental Indicators and Green National Accounting: The Integration of Environmental and Economic Information Systems." COM* (94) 670. Brussels: CEC.

CEC (Commission of the European Communities-Eurostat), International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, and World Bank. 1993. System of National Accounts 1993. Brussels/Luxembourg, NewYork, Paris, Washington DC: CEC, IMF, OECD, UN, World Bank.

Claude, M. 1997. *Informe Final – Estado y Evolución de las Cuentas del Medio Ambiente en América Latina.* Fundación Futuro Latinoamericano.

De Haan, Mark. 1999. "On the International Harmonisation of Environmental Accounting: Comparing the National Accounting Matrix Including Environmental Accounts of Sweden, Germany, the UK, Japan and the Netherlands." *Structural Change and Economic Dynamics* **10**: 151–160.

ENRAP. 1999. *SHELF (Searchable Hyperlinked Electronic Library of Files*). CD produced by the ENRAP project and distributed by the Philippines Department of Environment and Natural Resources.

Grambsch, Anne E., R. Gregory Michaels, and Henry M. Peskin, 1993. "Taking Stock of Nature: Environmental Accounting for the Chesapeake Bay." In Ahmad et al. 1989.

GRZ, December 2009.*National Water Policy.* Ministry of Energy and Water Development.

Hamilton, K., and E. Lutz. 1996. *Green National Accounts: Policy Uses and Empirical Experience.* The World Bank, Environment Department Paper No. 039.

Hecht, Joy. 2000. *Lessons Learned from Environmental Accounting: Findings from Nine Case Studies*. Washington, DC: IUCN–World Conservation Union. Available on the web at http://www. joyhecht.net/professional.html.

Hecht, Joy. 2004. *Environmental Statistics and Accounting in Egypt: Challenges and Opportunities*. USAID DATA Project, Ministry of Planning Egyptian Arabic Republic.

Hecht, Joy. 2007. *National Environmental Accounting: A Practical Introduction.*

Juan. S. 2002. *A Discussion Paper on Environmetal and Natural Resources Accounting and Potential Applications in African Countrie.* IRG.

Lange, G.M., and F. Duchin. 1993. Integrated Environmental-Economic Accounting, Natural Resource Accounts, and Natural Resources Management in Africa. Paper prepared for the Bureau for Africa/USAID.

Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William H. Behrens. 1972. *The Limits to Growth.* New York: University Books.

Repetto, Robert, William Magrath, Michael Wells, Christine Beer, and Fabrizio Rossini. 1989. *Wasting Assets: Natural Resources in the National Income Accounts.* Washington, DC: World Resources Institute.

Rump, P., 1996. *State of the Environmental Reporting: Source Book of Methods and Approaches.* UNEP/DEIA/TR.96-1, Division of Environmental Information and Assessment, United Nations Environment Programme, Nairobi.

Charles Mackay (2003). *UN World Water Development Report: Water of people, Water for Life*. Paris, New York and Oxford, UNESCO and Berghahn Books.

United Nations and the World Water Assessment Programme (2006). *UN World Water Development Report 2: Water a shared responsibility.* Paris, New York and Oxford, UNESCO and Berghahn Books.

United Nations Statistics Division. June 2006. *Integrated Environmental and Economic Accounting for Water Resources*, Final Draft. New York, USA.

Verbruggen, Harmen (ed.). 2000. *Final Report on Calculations of a Sustainable Nationals Income According to Hueting's Methodology.* Amsterdam: IVM, Vrije Universiteit (Institute for Environmental Studies, Free University).

Vincent, J.R., and J.M. Hartwick. 1997. *Accounting for the Benefits of Forest Resources Concepts and Experience.* Revised draft, commissioned by the FAO Forestry Department, dated July 10, 1997.

World Wildlife Fund. 1995. *Real Value for Nature: An Overview of Global Efforts to Achieve True Measures of Economic Progress.* WWF International, Gland, Switzerland.

Appendixes

Appendix A

THE UNIVERSITY OF ZAMBIA
IWRM CENTRE
SCHOOL OF MINES
QUESTIONNAIRE

TITLE: WATER ACCOUNTING FRAMEWORK – A CASE STUDY OF LUSAKA WATER AND SEWERAGE

Purpose of Collection
This survey will collect information on the amount of water extracted, supplied and discharged by Lusaka Water and Sewerage Company (LWSC) during 2009. The information will be used to compile a water account for (LWSC) which shows the physical flows of water from the environment through the economy. This information is very useful for planners and policy makers in all levels of government and the private sector.

Collection Authority
Your co-operation is kindly sought in completing this form by the due date if possible. The information is in fulfilment of the requirements for an award in Postgraduate Diploma in Integrated Water Resource Management (IWRM) from the University of Zambia.

Confidentiality
Your completed form remains confidential as it will just be used for academic purpose only.

Due Date
Please kindly complete this form and I will personally collect in a week's time from date of receiving the questionnaire.

Help Available
If you have problems in completing this form, or feel that you may have difficulties meeting the due date, please contact numbers below:

Mobile Number: 0977-344993/0967-344993, Name: Makayi Ben

Definitions
• Water supplier – a business or organisation that provides a reticulated water supply, irrigation water, reuse/recycled water and/or bulk water supply service. Water suppliers may be government or private and often operate water storage, purification and supply services. They may also provide sewerage or drainage services.
• Reuse water – drainage, waste or storm water that has been used again without first being discharged to the environment. It may have been treated to some extent. Reuse water is also known as recycled water and effluent reuse.
• Waste water – any water that has been used once and cannot be used again without treatment, for example untreated effluent, sewage water and trade waste.
Instructions: Kindly fill in your information in spaces and a tick [√] in the boxes provided

Section A – Water sources

1. Did this organisation supply water in 2009?
No ☐ Go to Section D
Yes √

2. If yes, how much water did this organisation supply within this period?

Volume
(M^3/YR)
98,944,000

3. Did this organisation self-extract water from the environment in 2009?

Including
• Water extracted from rivers, dams

and boreholes for the purpose of supply
• Water for own use

Excluding
•Reuse water (Report in Section

No ☐ Go to Section B
Yes √

4. What was the volume of water extracted from each source in 2009?
(a) Inland surface water
Excluding
• Groundwater

Name of dams, river or stream	Location	Volume (M^3/YR)
Kafue river	Kafue	35,040,000

(b) Groundwater
Excluding
• Inland surface water
Name of basins or aquifers Locations of extraction
• Inland surface water
Name of basins or aquifers Locations of extraction

	Volume (M^3/YR)
(c) Total volume extracted [sum of (a) and (b)]	47,450,000

Section B – Water Use and Supply

5. What volume of water was used by this organisation in 2009?

	Volume (M^3/YR)
(a) Parks and gardens owned by this organisation (including sporting fields)	
(b) Office use, drinking water facilities and other amenities … … … … … …	....
(c) Mains flushing … … … … … … … … … … … … … … … … … …	....
(d) Other …	....
(e) Total [sum of (a) to (d)] … … … … … … … … … … … … … … …	5,000,000

6. Did this organisation supply water directly to any customers in 2009?

No ☐ Go to Section C

Yes √

7. What was the volume of water supplied to these customers in 2009?

	Volume (M³/YR)
(a) Parks and gardens (including sports fields, golf courses, race courses).................	
(b) Domestic or residential	60,000,000
(c) Agriculture (including plant nurseries and turf farms)	......
(d) Aquaculture or fishing...	
(e) Mining	
(f) Electricity generation	....
(g) Commercial (including offices, shops, accommodation)	....
(h) Industrial (including Zambia Breweries, Trade Kings,....)	20,000,000
(i) Institutional (including hospitals, jails, schools, fire fighting)	......
(j) Other (including water carriers or tankers)	....
(k) Total [sum of (a) to (k)]	80,000,000

8. What was the size of the residential population this organisation supplied with water in 2009?

Persons/Households
(Number)
63,000 households

Section C – Environmental flows

9. Did this organisation release water for environmental flows in 2009?

No √ Go to Section D Question 12

Yes ☐

10. What was the volume of water released for environmental flows in 2009?

Volume
(M³/YR)
Not applicable

11. Please describe the method for allocating the environmental flows?

Not applicable

....

Section D – Reuse Water

12. Did this organisation supply or use reuse water in 2009?

No √ Go to Section E

Yes ☐

13. Did this organisation collect waste or storm water, which was used or supplied as reuse in 2009?

No ☐ Go to Question 15
Yes ☐

14. What was the volume of waste or storm water collected in 2009?

	Volume (M^3/YR)
(a) Waste water	......
(b) Storm water	....
(c) Total	......

15. Did this organisation treat any of the waste or storm water, which was used or supplied as reuse in 2009?

No ☐ Go to Question 22
Yes ☐

16. What was the volume of waste and storm water treated in 2009?
Volume
(M^3/YR)
....

17. Did this organisation use reuse water in 2009?

No ☐ Go to Question 19
Yes ☐

18. What was the volume of reuse water used by this organisation in 2009?

	Volume (M^3/YR)
(a) Parks and gardens (including sports fields)..............................	....
(b) Nurseries and pasture...	....
(c) Other (including forestry)...	....
(d) Total [sum of (a), (b) and (c)]..	....

19. Did this organisation supply reuse water to any customers in 2009?
No ☐ Go to Section E
Yes ☐

20. What was the volume of reuse water supplied to these customers in 2009?

Volume
(M^3/YR)

(a) Parks and gardens (including sports fields, golf courses, race courses) ....
(b) Domestic or residential ....
(c) Agriculture (including plant nurseries and turf farms) ....
(d) Forestry ....
(e) Aquaculture or fishing..........
(f) Mining ....
(g) Electricity generation ....
(h) Commercial (including offices, shops, accommodation) ....
(i) Industrial (including pulp mills and other manufacturing) ....
(j) Institutional (including hospitals, jails, schools, fire fighting) ....
(k) Other (including water carriers or tankers) ....
(l) Total [sum of (a) to (k)] ....

Section E – Sewerage Services

21. Did this organisation provide sewerage services in 2009?

No ☐ Go to Section F
Yes √

22. What was the size of the population that was provided with sewerage services in 2009?
Persons
(Number)
....

23. Did this organisation discharge waste water in 2009?
No ☐ Go to Section F
Yes √

24. What volume of waste water was discharged by treatment level in 2009?

Volume
(M^3/YR)

(a) No treatment (include spillage resulting from malfunction or flows exceeding capacity)..........
(b) Volume discharged after primary treatment ....
(c) Volume discharged after secondary treatment ....
(d) Volume discharged after tertiary treatment ....
(e) Total volume discharged [sum of (a) to (d)] 50,494,000

25. What volume of waste water was discharged by location in 2009?

		Volume (M^3/YR)
(a) Surface water bodies Name of dams, rivers etc	Locations	
....	....	....
....	....	....
(b) Groundwater Name of basins or aquifers	Locations	
....	....	....
(c) Stream Name of estuary or River	Locations	
....	....	....
(d) Total volume discharged [sum of (a), (b) and (c)]......		....

Section F – Water Losses

26. Did this organisation lose any water from its supply system in 2009?

No ☐
Yes ☐

27. What was the volume of water lost between in 2009?

Volume (M^3/YR)

(a) Apparent losses (e.g. inaccuracies associated with meter reading, theft, etc.) ....

(b) Real losses (e.g. seepage, leakage, evaporation, bursts, overflows etc.) ....

(c) Other... .

(d) Total [sum of (a), (b) and (c)]... ... ...

Thank you very much for completing this Questionnaire