Republic of Botswana

BOTSWANA WATER ACCOUNTING REPORT 2015

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WAVES

CENTRE FOR APPLIED RESEARCH

MMEWR
DEPARTMENT OF WATER AFFAIRS

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Abbreviations

BA	Business Area
BCM	Botswana Chambers of Mines
BEAC	Botswana Economic Advisory Council
BPC	Botswana Power Corporation
BURS	Botswana Unified Revenue Service
CAR	Centre for Applied Research
DDP	District Development Plan
DEA	Department of Environmental Affairs
DGS	Department of Geological Surveys
DoE	Department of Energy
DoM	Department of Mines
DWA	Department of Water Affairs
EA	Energy Accounting
EIA	Environmental Impact Assessment
IWRM	Integrated Water Resources Management
ISIC	International Standard Industrial Classification
L	Litre
LA	Local Authorities
MA	Mineral Accounting
MC	Management Centre
MCM	Million Cubic Metres
MDG	Millennium Development Goal
MFDP	Ministry of Finance and Development Planning
MMEWR	Ministry of Mineral, Energy and Water Resources
MoA	Ministry of Agriculture
NCA	Natural Capital Accounting
NDP	National Development Plan
NMPWWS	National Master Plan for WasteWater
NS(W)C	North South (Water) Carrier
NWMP	National Water Master Plan
O&M	Operation and Maintenance
PA	Per Annum
PC	Per Capita
SADC	Southern African Development Cooperation
SB	Statistics Botswana
SEEA	System of Environmental Economic Accounting
SDG	Sustainable Development Goal
SIDA	Swedish International Development Agency
SIWI	Stockholm International Waters Institute
SNA	System of National Accounts
UN	United Nations
VA	Value Added
WA	Water Accounting
WAB	Water Apportionment
WAU	Interim Water Accounting Unit
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WE	Water Efficiency
WRB	Water Resources Board
WSR	Water Sector Reform (programme)
WUC	Water Utilities Corporation

Executive summary

Botswana continues to make strides in implementing water accounting as a tool for integrated water resources management and sustainable development. This is the second report of the Botswana water accounts has been developed through the WAVES initiative which Government is party to. The accounts cover 2012/13 to 2013/14; the first report covered 2010/11 and 2011/12 (with a long term trend analysis).

The accounts 2010/11 – 2013/14 follow the international standard of the United Nation's System of Environmental Economic Accounting for Water (SEEA-water). The accounts currently cover (surface) water stocks, physical flows from the environment, within the economy and from the economy to the environment. Full monetary accounts cannot yet be developed due to insufficient data. However, some monetary aspects are covered, including water sector expenditures and costs, tariffs and subsidies as well as value added by economic sectors. Unlike the previous accounts, the updated accounts develop a new trend series for 2010/11 - 2013/14.

Stock accounts
Botswana has stocks of groundwater, surface water (reservoirs and rivers) and wastewater. The current accounts cover water stocks (chapter 4) in major reservoirs including the recently developed reservoirs (Dikgatlhong, Thune and Lotsane – all in eastern Botswana). Groundwater and wastewater stocks will be developed in the future. There has been an increase in the reservoir storage capacity from 349.2 Mm^3 to 880 Mm^3 as a result of the new dams. This will increase the safe yields to 143 Mm^3.

Physical flow accounts
The accounts cover both use and supply of water (Chapter 5). The use accounts show an annual water abstraction of 194.1 Mm^3 in 2012/13 and 194.5 Mm^3 in 2013/14. Abstraction by self-providers is significant and almost similar to abstraction by service providers. Groundwater abstraction contributes half of total water abstraction while abstraction from reservoirs and rivers is 42 and 8% respectively. The supply accounts show that service providers abstract water for distribution to various sectors and the bulk of this water is used by households. Groundwater is mostly abstracted by self-providers. Water consumption declined marginally from 178.3 to 169.8 Mm^3 between 2012/13 and 2013/14 and this may be due to water rationing in the south-eastern part of the country. Return flows are mostly unknown and therefore water use and consumption are similar for many sectors. However, this is different for the mining sector and service providers. The former provides WUC with water for distribution to its consumers. This was not captured in the previous accounts. Consumption is highest for the agricultural sector followed by the mining sector and domestic use (households). Greater attention for IWRM is therefore required for these sectors. Water losses are captured for service providers only. The 2012/13 losses are 10% lower than for the previous years and 2013/14. This sudden one year drop in losses is unrealistic and attributed to data short comings. Losses for self-providers are only documented for a few mines. Wastewater inflows and outflows from treatment works are currently not measured and therefore the accounts could not comprehensively describe the returns flows to the environment. A detailed analysis of the mining sector shows that diamond production accounts for three quarters of water use in the sector. About 0.8-1.m^3 is used to produce 1 carat while 0.125 m^3 is required for production of 1 tonne of copper-nickel matte.

Water supply and use by management centre
The draft Water Policy and the 2013 IWRM-WE Plan propose decentralised catchment area management. However, the water regions that could also be used for the water accounts, have not yet been identified the catchment area approach. Therefore, the WUC management centres (MCs) has been used at this stage as water management areas. Water abstraction for distribution is higher for MCs with old WUC serviced areas particularly Gaborone, Lobatse, Francistown and Selibe Phikwe

MCs. Abstraction is also significant for areas that have large mines and where agriculture is most concentrated. There is high reliance on the North South Carrier (NSC) and currently it seems to operate at maximum capacity. Water transferred through the NSC between 2012/13 and 2013/14 has increased and amounts to 23.6 and 36.1 Mm^3 respectively in the given period. Most of the water is transferred to Gaborone MC (54 and 73% in 2012/13 and 2013/14 respectively) followed by Selibe Phikwe MC. The second phase of the NSC is expected to increase the water supply to the southern part of the country. Although the supply will increase, the demand is expected to grow as well and thus IWRM implementation remains critical for the sustainability of the available water resources.

Monetary aspects of water accounts

The current analysis (chapter 7) focuses on costs and revenues of the water sector as well as tariffs, subsidies and value added per unit water consumed. Total annual operation and maintenance (O&M) expenditures increased rapidly from BWP0.8 billion in 2010-11 to stabilise at around BWP1.2 billion per annum from 2011-12 onwards. The O&M expenditures per m^3 have not decreased yet as was the intention of the water sector reforms. WUC performed well before the reforms but over past few years, the unit revenues have gone down. However, there seems to be an improvement since 2012/13 although the margin remains negative. Close monitoring of WUCs financial performance is necessary.

Trend analysis

The trend analysis (chapter 8) links the current SEEA-water modelled accounts and the earlier water accounts (not SEEA-Water styled) covering two decades. The main findings of the analysis are captured as follows:

- ✓ Water abstraction has increased by a third from less than 150 Mm^3 in 1990 to 195 Mm^3. Groundwater remains the most important source of water for abstraction but its share has been decreasing over time from more than 60% to above 50% in 2013/14;
- ✓ Abstraction from reservoirs has increased largely as a result of development of water infrastructures and connection of more villages to the NSC. Abstraction for self-providers has increased. An analysis of livestock water abstraction shows a declining trend due to a decline in livestock numbers while abstraction or the mining sector has more than doubled since 1990. The increase is observed particularly during the second half of the 1990s;
- ✓ Per capita water abstraction has increased from 300L/p/d top 253 L/p/d in 2013/14;
- ✓ The value added per m^3 has increased in time from BWP 230/ m^3 to BWP 364/ m^3. In terms of formal employment, the analysis shows an increase in the number of jobs created per m^3 consumed. Currently, 1 more formal job is created than in 2003 and this could be largely as a result of the expansion of the service sectors.

Policy indicators

A number of indicators are generated by the accounts (chapter 9). These are meant to inform macro-economic and development planning as well as water resource management and governance. The following are noted:

a. Water resources availability
   - ✓ Water storage capacity of reservoirs has increased from 422 to 462Mm^3;
   - ✓ Safe yields of reservoirs are well below per capita water use;
   - ✓ There is high reliance on external water resources;
   - ✓ There is a pressing need to develop similar indicators for groundwater resources, wastewater and water is perennial rivers.

b. Water use for human activities
   - ✓ Abstraction has remained stagnant over the four year period;
   - ✓ Abstraction for own use exceeds the abstraction for distribution;

- ✓ Agriculture is the largest water using sector followed by the mining sector and households.

c. Water costs, pricing and incentives for water conservation
   - ✓ Recurrent expenditures of WUC have sharply increased since the implementation of the water sector reforms, while the revenues dropped, leading to financial losses;
   - ✓ Average revenues/m^3 used was BWP 10.11 in 2012/13 and 12.24 in 2012/13;
   - ✓ For DWA, the average revenues/m^3 used was BWP 10.05 compared to recurrent expenditures of BWP11.06, leading to a shortfall of 10% (period 2002/3- 2010/11);
   - ✓ For WUC, the average revenues/ m^3 sold is BWP 10.14 compared to recurrent expenditures of BWP5.43 (period 2002/3 – 2010/11), leading to a considerable surplus of 87%;
   - ✓ Capital expenditures have increased from the BWP819 million in 2011/12 to BWP1, 236 million in 2013/14.

d. Water use efficiency
   - ✓ Value added per m^3 has increased in time: for all water consumed, value added increased from BWP476 to/m^3 in 2012/13 to BWP 549/ m^3 in 2013/14;
   - ✓ Per 1 000 m^3 consumes, overall 4.1 jobs are created while 2.5 jobs are created in the formal sector.

Institutionalisation of water accounting

DWA is now responsible for water resources planning, development and management (chapter 10). Water accounts are an important tool for water resources management and therefore a step towards fulfilling DWA's new mandate. DWA has established an interim Water Accounting Unit which will be formalised once the DWA structure is approved by DPSM. This Unit is responsible for updating of the accounts; development of policy briefs; dissemination of results to stakeholders and mainstreaming in development planning. Stakeholder participation remains important, particularly of self-providers, other government departments and water users. They need to regularly provide data for integration into the accounts for proper planning, development and management of the water resources. It is important that WUC will incorporate an economic classification in its client's base. This will increase the accuracy and consistency of the economic classification, and reduced the work load significantly. The use of technical working groups should be maintained to enhance the data collection process, accounts expansion and policy analysis of the results. A technical working group for analysis of the water accounts findings should also be established. The group will specifically regularly review the results of the accounts and their implications for development planning, IWRM and land use planning.

Recommendations

<u>Chapter 2:</u>

It is strongly recommended that WUC integrates the ISIC economic classification into its SAP customer information system.

It is recommended that WUC annually collects the required data for WA as per template in Appendix 3 as soon as possible.

It is recommended to systematically record water abstraction, use and consumption data from all mines through the annual Water Report that mines have to submit to the Water Apportionment Board (WAB).

DWA and MoA intend to undertake an irrigation survey in 2015 to assess water use in the irrigation sector therefore the results will be incorporated into future accounts.

It is recommended that SB develops a comprehensive national business registry as soon as possible based on client lists from WUC, BPC, etc. as well as lists from the Registrar of Companies and the Botswana Unified Revenue Service (BURS). Furthermore, it is recommended that SB incorporates key water data requirements in its regular surveys (e.g. agriculture and business survey etc.).

Chapter 3:

It is recommended that DWA and WUC develop and implement a comprehensive dam monitoring system that covers water stock and inflows and outflows of reservoirs. There is no evident reason why Ntimbale dam data are missing and monitoring and recording of Ntimbale dam should start as soon as possible. DWA should initiate research into improved modelling of inflows and evaporation.

WUC and DWA need to record wastewater and return flow data in future as this is an area that can assist in water demand management through options like recycling/reusing waste water.

Chapter 4:

Improved monitoring of the performance of small (agricultural) dams is needed before such dams can be incorporated into the stock accounts.

The new dams (Dikgatlhong, Lotsane and Thune) need to be integrated in the water distribution network as soon as possible to relieve pressure on the existing dams. Moreover, the capacity of the NSC needs to be expanded soonest to relieve pressure and dependency on the dams in south eastern Botswana with low safe yields.

Chapter 5:

Water losses need to be better monitored and reported in future in the annual reports for the WAB. The template for data requirements in these report is given in Appendix 3. It is further necessary that all mines that abstract water annually submit such reports and that DWA and WAB analyse these reports and use them for the WA updating.

Chapter 7:

Water tariffs need to increase cost recovery and O&M expenditures need to be controlled, preferably through a decrease as intended under the WSR programme.

It would be worthwhile to consider introducing a separate block tariff for large businesses that would encourage water conservation.

It can be argued that water consumption for production, income and employment generation should take priority over luxury domestic uses such as swimming pools and excessive watering of gardens (e.g. lawns). This could be achieved by a large rise in domestic use tariff for the upper band (e.g. over 40 m^3).

1 Introduction

1.1 Background to the report

This is the second Botswana Water Accounting report prepared by the Department of Water Affairs (DWA) together with the Centre for Applied Research (CAR). The first report was published early 2014 and reported on System of Environmental-Economic Accounting (SEEA)-styled water accounts for 2010-11 and 2012-12 as well as a trend analysis of water abstraction and use for the period 1990-2010 (DWA and CAR, 2014). The trend analysis used results of earlier water accounting efforts that have been carried out since the 1990s, preceding the SEEA Water Accounting framework that is used from 2010/11 onwards. This report provides new SEEA accounts for 2012-13 and 2013-14, and starts to develop a new trend series 2010-2013/14, which will be annually up-dated and expanded by the (interim) Water Accounting Unit (WAU) of DWA. In between both reports, policy briefs have been prepared on '*Irrigation and Water Resources in Botswana*' and '*Botswana's Mining Sector and Water Resources*'.

Botswana is one of eight countries in the world that has partnered with the World Bank to develop Natural Capital Accounting (NCA). The partnership programme is called WAVES, which stands for Wealth Accounting and Valuation of Ecosystem Services (www.wavespartnership.org), coordinated by the World Bank and funded by a trust fund. Other WAVES core countries are Madagascar and Rwanda in Africa, Colombia, Costa Rica and Guatemala in South America and Indonesia and the Philippines in Asia. NCA is a key instrument for the implementation of the Gaborone Declaration on Sustainable Development in Africa, which was signed by ten African countries and a number of large enterprises and international collaborating partners (www.ci.org).

Water accounting (WA) is done by the DWA as part of the implementation of *the 2013 Integrated Water Resource Management (IWRM) and Water Efficiency Plan* (DWA, 2013): activity SA1.5 under the Strategic Area '*Increasing Efficiency of Water Allocation*'. DWA views water accounting as an important tool to improve water allocation and efficiency among economic sectors and to engage sector ministries and the development planning process. Furthermore, it provides DWA and government at large with information about the trends in water abstraction, use and consumption as well trends in abstraction from different water sources (e.g. ground water, reservoirs and rivers). In other words, WA help to monitor and evaluate the impacts of water resource management policies, strategies and programmes. WA is also an important tool for informed development planning. The importance of this is abundantly clear as the effects of the near drying up of the Gaborone dam (March 2015) are felt by the private and public sectors as well as by households. It leads to extra costs of alternative water supplies and water service provision disruptions.

Water accounting is currently being implemented under the WAVES[1] partnership with the World Bank and will soon be fully institutionalised within the DWA (see chapter 10). Since the 2014 Water Accounting report was prepared, DWA has formed an interim Water Accounting Unit (WAU[2]). The results of the first WA report were shared with stakeholders at the 2014 and 2015 *Water Pitso* as well as with other African countries present at the 2013 international workshop on the implementation of the Gaborone Declaration on Sustainable Development in Africa; natural capital accounting was a core

[1] Wealth Accounting and Valuation of Ecosystem Services: www.wavespartnership.org.
[2] The unit will be made permanent as part of the on-going restructuring of MMEWR and DWA.

activity, to which signatory countries, including Botswana, have committed themselves. The implementation of SEEA by countries is also one of the proposed new Sustainable Development Goal (SDG) indicators.

The preparation of water accounts under the WAVES programme started in September 2012 and was phased as follows:

- ✓ 2012 (August – November): preliminary account construction and analysis; presentation of the results to the Botswana Economic Advisory Council (BEAC);
- ✓ 2013: elaboration of the water accounts and development of a road map towards full institutionalisation of water accounts at DWA, support institutions (e.g. Statistics Botswana –SB-, Ministry of Agriculture –MoA- and Water Utilities Corporation –WUC-); and
- ✓ 2014 (March) – 2016 (February): full institutionalisation, up-dating and expansion of water accounts and ensuring integration of results in National Development Plan (NDP) 11.

The structure of this report is as follows:

- Chapter 1: SEEA framework and WAVES Botswana programme;
- Chapter 2: Water resource management in Botswana;
- Chapter 3: Methodology;
- Chapter 4: Stock accounts for reservoirs
- Chapter 5: Physical supply and use accounts 2012/13 and 2013/14
- Chapter 6: Regional water supply and use
- Chapter 7: Monetary aspects of water accounting;
- Chapter 8: Trend analysis 1990/91- 2013/14 and 2010/11 – 2013/14
- Chapter 9: Water resource policy indicators; and
- Chapter 10: Institutionalisation and capacity building.

1.2 SEEA framework

The SEEA-Water framework was described in detail in the last WA report (see DWA and CAR, 2014 and also UN, 2012 for more details). Below, the main features are summarised.

SEEA-Water Accounts (WA) provide a conceptual framework for organising hydrological and economic information in a sound and consistent manner (UN, 2012). As with the System of National Accounts (SNA), countries have committed themselves to develop SEEA-WA to permit comparisons between countries through a standardised structure and common definitions, concepts and classifications. The SEEA-Water provides aggregate indicators for environment and economic performance and a set of statistics that inform decision making for development planning and resource utilisation and management.

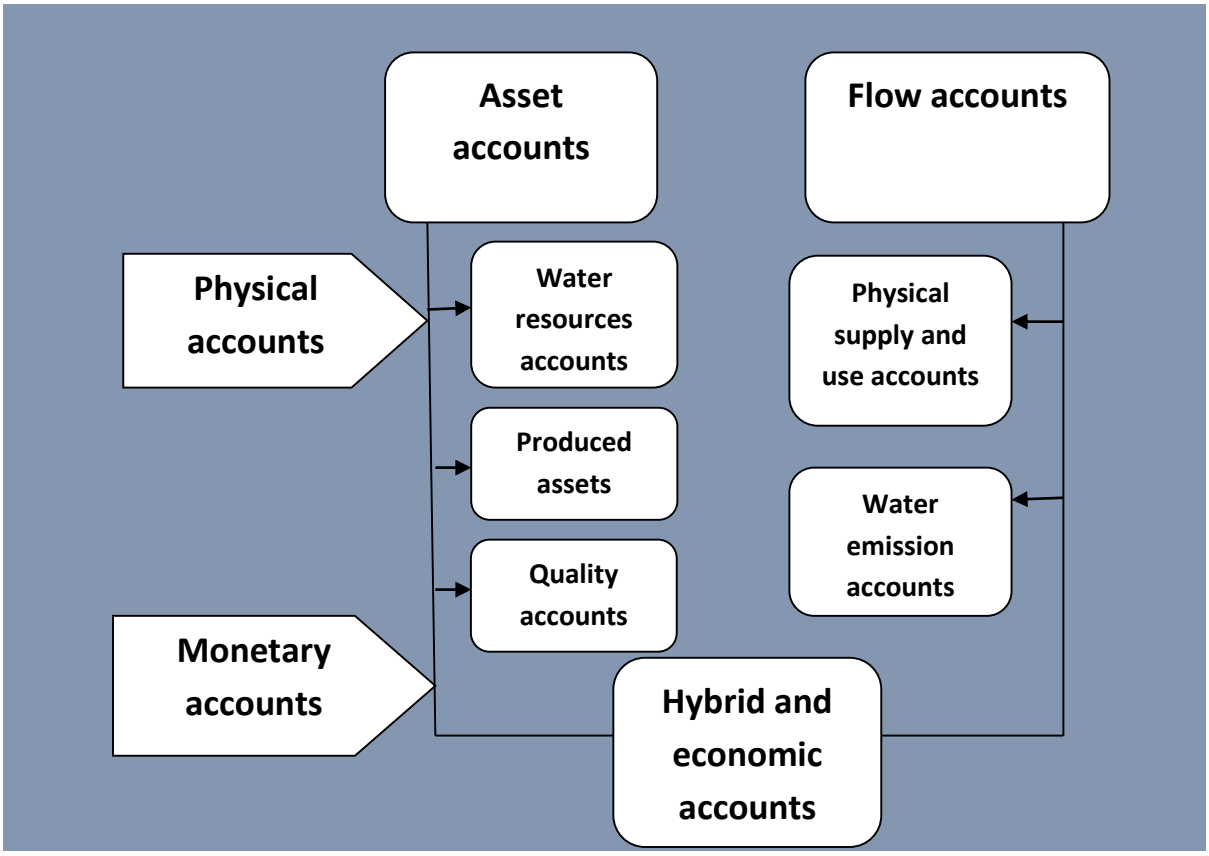
The framework consists of a set of standard SEEA-WA tables (UN, 2012). Both the System of National Accounts (SNA) and SEEA-Water use the International Standard Industrial Classification (ISIC) of economic sectors. Currently, Botswana's National Accounts (NA) use ISIC Rev 3, which has also been adopted in the water accounts. The SEEA WA system captures information on the water stocks, flows from the environment to the economy as well as flows within the economy in physical and monetary terms and water quality issues. Figure 1 illustrates the SEEA-Water framework.

Few countries have developed the full set of SEEA water accounts. Most countries develop the accounts that are most important for development planning and policies and for which data are available. In Botswana, priority has been given to the:

a. construction of physical stock accounts for dams/reservoirs (stock accounts); and
b. physical flow accounts from the environment to the economy, within the economy (supply accounts); and
c. flows back into the environment (use accounts).

Monetary aspects have focused on review of revenues and costs of water supply as well as value added produced by m^3. Plans exist to develop detailed monetary accounts, construct stock accounts for groundwater and supply and fully integrate wastewater in the supply and use accounts.

Figure 1: SEEA-Water framework



Source: United Nations, 2012.

In Botswana, the programme is coordinated through the Ministry of Finance and Development Planning (MFDP) and accounting units for water, energy and mineral accounts have been established in the DWA, Department of Energy (DoE) and the Department of Geological Surveys. Institutionally, the Botswana WAVES programme is led by the Steering Committee, with senior representatives of key Ministries and chaired by the Deputy Permanent Secretary MFDP.

Draft mineral accounts have been prepared and are currently being up-dated and finalised. Work on energy accounts is on-going and planning for ecosystem accounts has started. Initial electricity and coal accounts are expected by mid-2015. A detailed work plan for ecosystem accounting, including tourism accounts, still needs to be developed by the Ministry of Wildlife, Environment and Tourism (MEWT).

Table 1: Important SEEA terminology

Terms	SEEA description	Comment
Water abstraction	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 can be abstracted for distribution or for own use (once it is used it can be delivered to another user for treatment or re-use).	Rainfall that is not captured is not abstraction. For example, rain-fed crop production uses rainfall but this is not recorded in the WA; in contrast, irrigation water is usually abstracted and stored and therefore accounted for in the WA
Water use	Water intake of an economic unit. It is the sum of water: a. provided to that economic unit by a water service provider or another economic sector; and b. water abstraction from the environment by that economic unit.	
Water consumption	That part of water use which is not distributed to other economic units and does not return to the environment because during use it has been incorporated into products, or consumed by households or livestock.	When return flows are unknown consumption becomes similar to water use. Water consumption is not equal to water sales but consumption relates to the hydrological water cycle.
Return flows	Water that is returned into the environment or another economic unit by an economic unit. Returns can be classified according to the receiving body and to the type of water, such as treated water.	Return flows can potentially be used again within the economy.
Water losses	The volume of water lost during transport through leakages and evaporation between a point of abstraction and a point of use, and between points of use and re-use.	Water losses from water infrastructure become return flows into the environment.

Source: United Nations, 2012.

2 Water Resources Management in Botswana

This chapter provides a brief review of water resources management in Botswana. It highlights water resource issues and challenges as well as the resource policies and plans adopted by the country. The chapter explores the opportunities to augment water supply in order to cope with the increasing and competing water demands. Finally, it outlines plans to address water resources issues in a more organised and systematic fashion, which include the full institutionalisation of the water accounts within the DWA.

2.1 Water resource issues

As a semi-arid country, limited water resources remain a major challenge for socio-economic development and growth in Botswana (DWA, 2013). Growing water demand and limited resources, put pressure on the ecosystems, which require water for their survival, and on society, which is dependent on water resources for people's basic needs and livelihoods.

Botswana faces a wide range of interrelated water resource challenges, which include water scarcity, water quality, access to sanitation facilities, climate change, persistent poverty, high unemployment, especially among youth, and increasing and competing demands for water resources from economic sectors and households (DWA, 2013). If unaddressed, these challenges are likely to curtail future socio-economic development.

The estimated combined sustainable yield of Botswana's well fields and dams[3] is 165 Mm^3/annum. (DWA, 2013). This is less than the current abstraction of just under 200Mm^3/annum (DWA and CAR, 2014). Therefore, there is a need to explore options to reduce demand and to augment water supply from conventional (e.g. dams and well fields) and non-conventional sources (e.g. wastewater, rain and storm water harvesting). The 2006 Review of the Botswana National Water Master Plan (SMEC and EHES, 2006) argues that continued reliance on conventional water supply augmentation will make water unaffordable in future, mostly because of the required long distance water transfer schemes[4]. Further groundwater explorations are needed to determine the potential for developing additional well fields.

The above shows the need for more efficient water allocation and use, water conservation, rainwater harvesting, storm water capturing and use of shared water courses to cope with the increasing water demands (DWA and CAR, 2014). Furthermore, increased wastewater re-use i.e. using treated effluent, particularly for irrigation, can relieve pressure on fresh water (SMEC and EHES, 2006). Government has set itself the target of 96% reuse and recycling by 2030 in the National Master Plan for Wastewater and Sanitation (SMEC, 2003), but insufficient progress has been made to-date in the pursuit of this target.

2.2 Water resource policy environment

2.2.1 Water sector reforms (WSR)

DWA is responsible for Integrated Water Resources Management (IWRM) in Botswana. The 2006 Review of the National water Master Plan (NWMP) recommended various policy and institutional reforms in the water sector in Botswana (SMEC & EHES, 2006). Among others, the review

[3] The terms dams and reservoirs are used interchangeable in this report.

[4] While government may subsidise future water consumption, it is doubtful whether the required high subsidies can be sustained.

recommended the rationalisation of the water sector to improve service delivery. The rationalisation process started in 2009 and was completed in 2013 leaving the DWA with the mandate of assessing, planning, developing and maintaining water resources for domestic, agricultural, commercial, industrial and other uses in Botswana. The DWA currently works on aligning the departmental structure proposed by the Water Sector Reform (WSR) Programme with the approved MMEWR organisational structure (see Chapter 10, this report). The DWA anticipates that the new structure will be implemented during 2015.

Under the WSR programme, WUC became responsible for water supply services and wastewater treatment in settlements country-wide[5]. The last district (Ngamiland) was taken over in April 2013 from DWA and the District Council. WUC presently operates sixteen Management Centres (MCs). Table 2 lists the MCs and their linkages with the Business Areas (BA) under operation by WUC. Map 1 shows the location of each MC while Map 2 shows the Business Areas within the MCs.

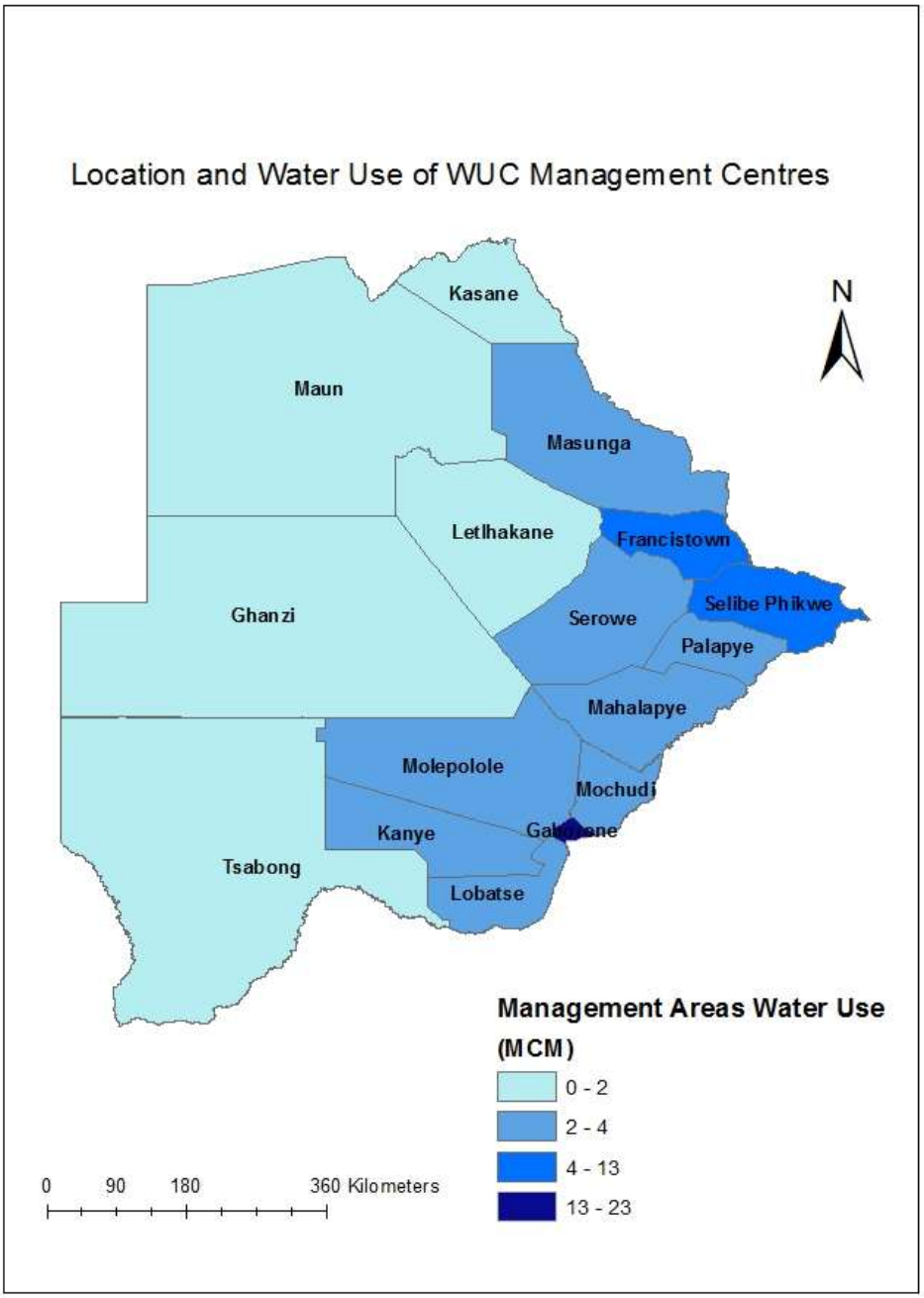
Table 2: WUC Business areas and Management centres and their linkages

Business Area (BA)	Management Centre (MC)	Part of
Head Office		
Mogoditshane		Gaborone MC
Masunga	Masunga	
Lobatse	Lobatse	
Mochudi	Mochudi	
Gaborone	Gaborone	
Palapye	Palapye	
Mathangwane		Francistown MC
Tonota		Francistown MC
Mahalapye	Mahalapye	
Mmadinare		Selibe Phikwe MC
Sese		Kanye MC
Kasane	Kasane	
Jwaneng		Kanye MC
Tlokweng		Gaborone MC
Sowa		Masunga MC
Francistown	Francistown	
Selibe Phikwe	Selibe Phikwe	
Tsabong	Tsabong	
Bobonong		Selibe Phikwe MC
Goodhope		Lobatse MC
Ramotswa		Lobatse MC
Molepolole	Molepolole	
Kanye	Kanye	
Serowe	Serowe	
Letlhakane	Letlhakane	
Ghanzi	Ghanzi	
Maun	Maun	

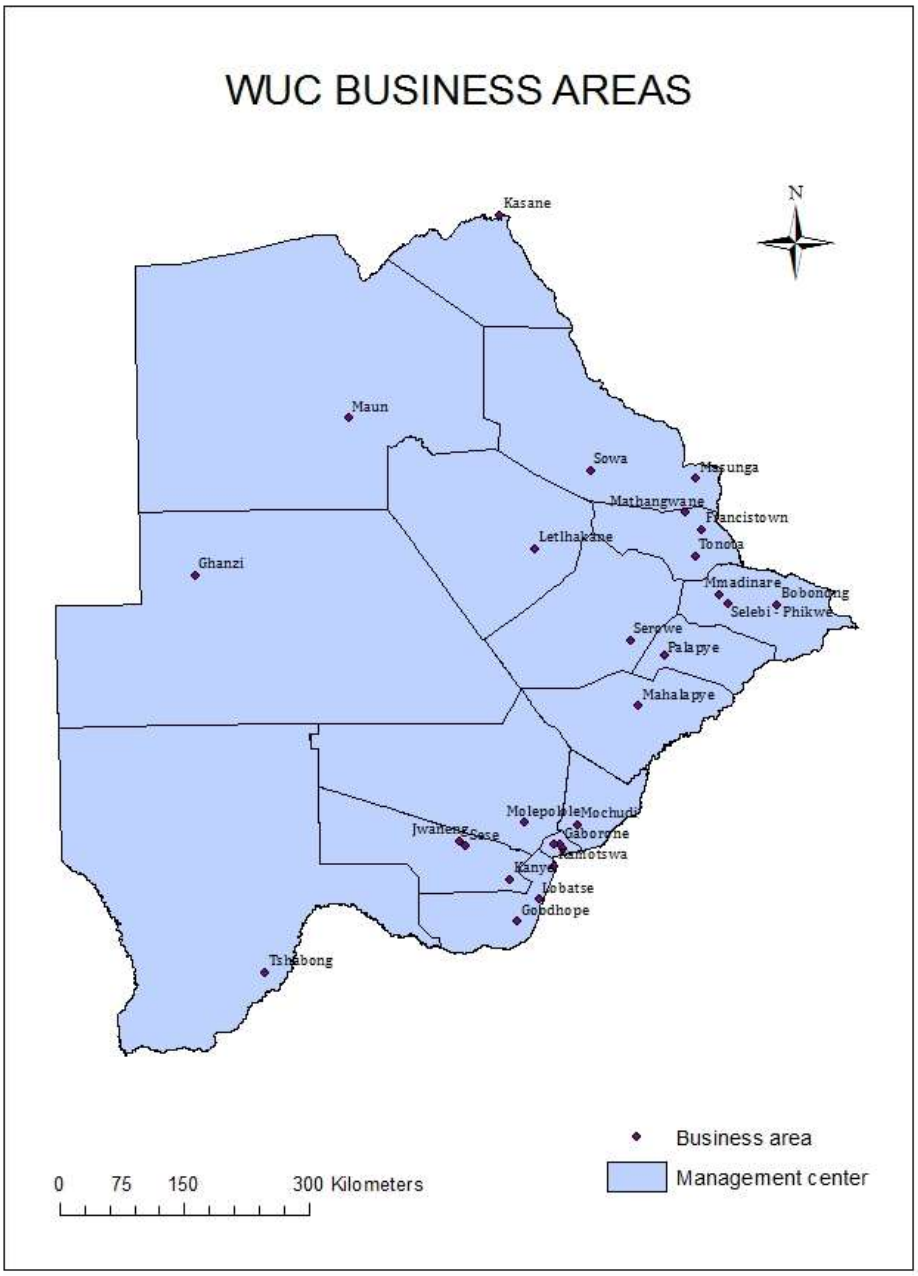
Source: adapted from WUC information.

[5] Previously, DWA supplied large villages and District Councils were responsible for water supply of rural villages and settlements.

Map 1: Location of WUC Management Centres with spatial variability of water use



Map 2: Location of WUC Business Areas



WUC currently experiences major challenges in water supply delivery country-wide and in coping with drought conditions in south-eastern Botswana, including the virtual drying up of the Gaborone dam (March 2015). Prior to the take-over exercise WUC was successful in recovering operational costs. However since 2009, a little while after the first take-over of villages from DWA, operating costs have rapidly risen and exceeded the revenues (DWA and CAR, 2014). More recent financial data indicates the same, albeit smaller, shortfall (Chapter 7, this report).

The main results of the WSR programme to-date are summarised in Table 3.

Table 3: Main outputs of Botswana's WSR process

Category	Output	Progress
Water system reform	All water supply systems have been taken over by WUC	The takeover exercise was completed in 2013
Wastewater reform	Wastewater systems, treatment works operated and managed by WUC	All wastewater treatment works are operated by WUC
Legal and institutional frameworks	National Water Policy, Water Tariff Policy, Water Resources Board, Water and Energy Regulator, DWA assuming overall water planning, development and management	The National Water Policy was approved by Cabinet in 2012 and turned down by Parliament in 2014 DWA restructuring process expected to be implemented in March 2015
Communication and participation	Communication strategy Consultation of stakeholders on the process and mainly Water Policy	Strategy is available and consultation reports have been prepared.

Source: based on DWA information.

2.2.2 Botswana IWRM and Water Efficiency plan

The vision of the Botswana IWRM and Water Efficiency (WE) Plan is to ensure that all people and the environment have adequate access to sufficient water and economic production and growth is not curtailed by water shortages (DWA, 2013). The overall goal of the plan is to improve people's livelihoods and welfare as well as contribute to sustained economic growth, economic diversification, social justice and poverty eradication through efficient, equitable and sustainable water resources development and management. The main objectives are to integrate the activities of the plan into existing planning frameworks as well as budgets and to encourage private sector and community participation in implementing the plan (DWA, 2013).

The Plan was developed to deal with the present and future challenges of water resources management such as population growth, urbanization and climate change. It was a commitment made by Government at the 2002 World Summit on Sustainable Development held in Johannesburg. The IWRM-WE Plan acts provides the framework and action plan that support water use and management in various sectors leading to greater economic and environmental efficiencies (DWA, 2013). It has ten strategic areas, each with specific objectives and activities to be undertaken (Table 4).

Table 4: Strategic areas and objectives of the IWRM & WE Plan

	Strategic Areas	Specific objectives
1	**Increasing efficiency of water allocation**	Maximize benefits of water allocations; Ensure adequate water allocations to strategic sectors; maximise use of non-potable water for sectors not in need of potable water
2	**Water Supply and Demand Management**	Full re-use & recycling of treated effluent; Reduce WUC water losses; Raise awareness about water saving practices and appliances; Promote water eff. technologies; Develop new sustainable conv. & non-conv. supply opportunities.
3	**IWRM mainstreaming in development and land use planning**	integration of IWRM into economic growth, trade and diversification policies, in the NDP/DDP cycle and in land use planning; Integration of IWRM in EIA process; Development of a water-saving technology sector.
4	**Establishment of an IWRM-WDM enabling environment**	Establish a comprehensive policy environment supportive of IWRM, including a policy, Act and set of standards, and shared water courses.
5	**Development of catchment area man. Approach**	Review possible catchment area management models and develop an appropriate model for Botswana.
6	**Management of Shared Water resources**	Compliance with SADC Protocol on Shared Water Courses Obtain fair, sustainable and equitable access to water resources and sharing of benefits Promote cooperative planning and development of shared water
7	**Institutional capacity building in IWRM**	Institutionalisation of IWRM in lead water sector institutions; Establish planning and implementation capacity in lead water sector institutions; Incorporation of IWRM in training programmes in Botswana; Intensify the use of regional capacity building opportunities
8	**Stakeholder participation in IWRM**	Ensure stakeholders participation in IWRM; Enhance IWRM knowledge and understanding; Improve access to and share information on IWRM;
9	**Maintaining water quality and pollution control**	Maintain water quality to meet water standards Maintain water quality to meet the standards for discharges into environment
10	**Ecological water requirements**	Maintain the natural quantity and quality of water resources; Ensure adequate water for the environment.

Source: DWA, 2013.

The implementation of the plan is fully aligned to the WSR programme (section 2.2.1) and the draft Water Policy (section 2.2.3). The DWA will drive and coordinate implementation of the plan.

2.2.3 Draft National Water Policy

The 2012 Draft National Water Policy prescribes the mandate of the DWA as that of being responsible for assessing, planning, developing and maintaining water resources for domestic, agricultural, commercial, and industrial and other uses in Botswana. Some of the proposed developmental issues in the new Water Policy include raw water abstraction strategy and development of catchment

management committees. The latter are aimed at easier control of the abstraction of raw water, a scarce resource everywhere in the country and decentralisation of the management of water to the catchment in question respectively.

The main objective of the draft policy is to provide a national framework that will facilitate access to water of good water quality and adequate quantity to support livelihoods and provide the foundations for economic growth, diversification and poverty eradication. The draft policy envisages the establishment of a Water Resources Board (WRB) responsible for equitable and sustainable allocation of water resources and development of water related policies as well as efficient implementation of the IWRM plan (NWP, 2012). The draft policy was approved by cabinet in 2013 but still awaits approval by Parliament.

Within the policy document, the three guiding and overarching principles that are emphasized throughout the policy implementation are equity, efficiency and sustainability; these are shared with the national development planning principles. The challenge for implementation of the policy is to strike a satisfactory balance among the three principles.

2.3 DWA plans for the future

The expected results of the DWA reforms in IWRM include the following responsibilities and activities (Enosyst Consulting, 2013):

a. Ensure efficient use of water resources through promotion of water demand management measures and practices;
b. Assessing and rationalising the use of water resources for sustainable development, including analysis of extreme events and climate change;
c. Analysis of water data (surface water, groundwater, wastewater) and derive information for strategic planning;
d. Protection and conservation of water resources;
e. Develop and implement adaptation strategies for climate change impacts on water resources; and
f. Exploration and increased use of alternative water sources (wastewater reuse, bio solids and other alternative sources of water).

For DWA to fully discharge its mandate, a regulatory body to focus on water will be constituted with the main responsibility of regulating the functions of WUC such as tariff adjustments and smooth service delivery[6]. This is recommended in the 2006 Review of the NWMP and as part of the subsequent WSR.

In 2012, the DWA and the Stockholm International Water Institute (SIWI) entered into a 2-year contract to provide capacity building in areas of IWRM, Wastewater and Sanitation, International Water Law etc. The 2-year program was jointly funded by the Swedish International Development Cooperation Agency (SIDA) and the Botswana Government through the Ministry of Minerals, Energy and Water Resources. The partnership has been extended with a further two years (2015-2016) in order to support and solidify the structures and leadership of the DWA and to assist DWA in effective and efficient water resources planning and management (SIWI/DWA partnership, 2014). The partnership covers four key areas to improve IWRM in Botswana:

a. Support to the DWA organisational review project;
b. Institutional framework for optimised wastewater and sanitation resource management;

[6] The regulator will also cover energy and therefore regulate the role of BPC.

c. Raw water abstraction strategy; and
d. Catchment Management Committees.

The four key areas above are intended to provide structures and a basis for effective delivery of water resources management in the country. These improvements build up from the National Water Policy and the IWRM-WE plan.

3 Methodology

This chapter gives details of the adopted methods for the construction of the 2012/13 and 2013/14 water accounts: stock accounts for reservoirs and physical supply and use accounts. It provides information on the data requirements, availability of data, data challenges as well as assumptions that had to be made to overcome the absence of (or differences between) data provided by WUC, Ministry of Agriculture, DWA and Statistics Botswana. Given the water resource management issues that the country faces, it is undesirable to wait until all required data of good quality are available. The challenge is to use the best available data and make the best possible assumptions to fill data gaps. From a data quality perspective, it is important to fully account for the data used and assumptions made, as done in this chapter. In time, data availability and quality is expected to improve and collection made easier through the use of data supply templates (Appendix 2) and surveys (e.g. for irrigation).

3.1 Data needs and availability

The water accounts require data from various stakeholders in the water sector, in particular from the service providers (WUC and DWA), Ministry of Agriculture (livestock and irrigation) and self-providers (e.g. mines and farmers) as well as other important stakeholders such as Statistics Botswana (SB) and the Department of Mines. Data availability for each data provider is briefly reviewed below.

WUC

WUC is a major (and since April 2013 the sole) water service provider in the water sector. The following data were requested from WUC for the accounts:

a. Water abstraction and use by source for the country and by management centre (MC);
b. Water abstraction and use by economic sector;
c. Water abstraction and use by MC;
d. Water losses country-wide and by MC; and
e. Costs and revenues by MC.

WUC provided water abstraction and use data by MC for the given period[7]. Water abstraction by source is only available for 2013/14. Data were not available for water abstraction by sector except for the self-providers (discussed later). Water sales by contract or client were also provided for 2012/13 and 2013/14. However, the water sales (volume and value) were not disaggregated by ISIC 3 sector classification. WUC uses ten client categories (each with different tariffs), comprising domestic, business and industries, some mines and government (see Table 5).

As for the previous years (2010/11 and 2011/12), the link between water use and economic sector was done manually using the UN's ISIC classification. Team knowledge, internet searches, telephone directories and follow up phone assisted in the sector allocation process. The clients that could not be allocated to a particular sector were distributed to the different economic sectors based on that sector's weighted water use (25% of the total WUC clients' contracts but contributing only 4% of the total water use).

[7] For Maun MC, only water abstraction data was provided for 2013/14.

Table 5: WUC's customer categories

Number	Category
2A	Div 02 - Normal Water, BC WUCA - Domestic Custom.
2B	Div 02 - Normal Water, BC WUCB - B&I Custom.
2C	Div 02 - Normal Water, BC WUCC - The Government
2D	Div 02 - Normal Water, BC WUCD - City Councils
3B	Div 03 - Raw Water, BC WUCB - B&I Customers
3F	Div 03 - Raw Water, BC WUCF - BCL
3K	Div 03 - Raw Water, BC WUCK - Tati Nickel
4D	Div 04 - Standpipe Water, BC WUCD - City Councils
5E	Div 05 - TrtB Water, BC WUCE – District Councils & DWA
6E	Div 06 - UnTB Water, BC WUCE – District Councils & DWA

Note: B&I = business and industry.

WUC expenditures and revenues' data were incomplete and different figures were made available. It was therefore agreed with WUC to use the cost and revenue data from the WUC annual reports. Some cost and revenue data were available by MC while others are only available for the company as a whole. This includes data on operations and maintenance (O&M) costs, capital costs and emergency expenditures. With respect to incomplete data and variations in data for the same years from different sources, clarity was sought from WUC as to which figures to use[8]. It was agreed to utilise –where possible- the figures of the WUC annual reports.

The empirical data required from WUC to construct stock accounts include the actual daily water levels for dams recorded in meters above sea level. This is to determine opening and closing volumes for each dam using the elevation-capacity tables. Water gains are represented by inflows and incoming transfers whilst water outflows are depicted by evaporation and abstractions, including outgoing transfers. Neither WUC nor DWA measure inflows into the dams and evaporation. These two variables are therefore computed using available empirical data. Computation of evaporation was judged to be more accurate. Therefore, computed evaporation values were used in a water balance method approach for open water reservoir to compute inflows into the dam (SMEC and EHES, 2006) and the inflow was calculated as the variable balancing the equation.

WUC provided the daily water levels for all major dams (Gaborone, Letsibogo, Bokaa, Nnywane, Thune, Shashe and Lotsane) for the period 2013/14 except for Thune dam, it records starts from January 2014. The daily water levels provided had some gaps of 2 to 5 days. These gaps were filled by assuming that in the case of no rainfall during that particular day, water level follows a linear regression trend and decreases at a steady rate. This was to ensure that no errors are introduced. Water abstractions were also provided which were then converted into daily water abstraction rates. Evaporation was calculated as a function of area corresponding to the actual water volume in the dam. A water balance formula was applied to calculate daily inflows into the dam.

Natural inflows have also been independently estimated. Seepage and overflows are not recorded and have been used to balance the opening and closing stock, taking into accounts inflows and outflows. Inflows were calculated by using the following procedure: observed water level at the dam

[8] WUC does not close excel files and therefore changes may occur in the same files accessed at different dates. It is recommended that key WUC files for each year are frozen after a few months so that no differences will occur in future.

was obtained and area capacity curve was used to compute water volume by linear interpolation, the obtained volumes were corrected to obtain the true volumes. Spillage was then determined from subtracting volume from true volume. Using the water level, 'area' was computed by linear interpolation, the resulting area was used to compute evaporation which was obtained by averaging the current and previous areas and multiply it by evaporation constant and million factor ((current evaporation + previous evaporation)/2 * 1 000 000 * 0.006301). Lastly inflow was derived using if-statement for when the current water level is greater than previous or the current water level is greater than the maximum water level, then current true volume minus the previous multiplied by the million factor plus evaporation plus abstraction multiplied by the million factor.

Two recently constructed dams are not yet operational (Dikgatlhong and Thune) and therefore abstraction is zero. Changes in their water volumes are solely due to inflows and evaporation. It is recommended that a comprehensive dam monitoring system be developed that covers water stock and inflows and outflows of reservoirs. There is no evident reason why Ntimbale dam data are missing and monitoring and recording of Ntimbale dam should start as soon as possible. DWA should initiate research into improved modelling of inflows and evaporation. Given the large capital investment in dams and water transfer scheme, their performance measurement should be a priority.

In the WA, genuine water losses are returns to the environment, as they represent leakages into the ground. WUC has carried out a three months pilot to better understand water losses and non-revenue water based on internationally accepted IWA terminology. The results are summarise in Box 1. For the physical WA, water flows within the economy are authorised consumption (billed and unbilled) and apparent losses. Genuine water losses are return into the environment from the water service providing sector. For the monetary accounts, only billed water consumption by economic sectors is recorded in the monetary accounts.

Box 1: Authorised water use, water losses and non-revenue water

WUC has investigated water losses and non-revenue water for the period January – March 2014. The internationally accepted International Water Association (IWA) terminology and assessment procedure was used (IWA, 2000). WUC provided the data to the DWA interim water accounting unit and CAR.

The following was found:

- ✓ *Authorised water use (i.e. clients with a WUC contract) amounted to 71.8% of the system input volume (i.e. amount of water abstracted for distribution);*
- ✓ *Of the authorised sales, 92.1% was billed; 7.9% was used but not billed.*
- ✓ *Water losses amount to 28.2% of water abstracted. This include real losses (23.6%) and apparent losses (4.6%); Real losses cover leakages in distribution network and storage facilities. Apparent losses refer to unauthorised consumption and metering inaccuracies.*
- ✓ *Non-revenue water (i.e. water losses and unbilled authorised consumption) amounted to 33.9%. Revenue water is therefore 66.1% of abstraction.*

Implications for physical flow accounts:

a. The use accounts should include the authorised water use and the apparent losses (76.4%);
b. Real losses must be treated as return flows into the environment (23.6% in pilot period).

Implications for the monetary accounts:

i. Use accounts record the revenue generating water only (66.1% in the pilot period).

Source: adapted from WUC data.

It is recommended that WUC be required to annually collect the required data for WA as per template in Appendix 3 as soon as possible.

DWA

In 2012/13, Maun was the only village that was serviced by DWA; the Maun water supply was taken over by WUC in April 2013. Unfortunately, DWA did not have abstraction and use data for Maun for 2012/13. This gap was addressed by applying an estimated daily per capita water abstraction using available production estimates from the previous years. Both overall capital and O&M costs for DWA were provided for 2012-2014 period.

Self-providers

The main self-providers currently covered in the accounts are the mining, livestock and irrigation sectors[9].

With respect to the mining sector, a data template for mines water data was developed and sent out by DWA to all mining companies. Only five mining companies provided comprehensive data, while others provided some data and some mines did not respond at all. The provided data included water abstraction for own use and distribution (Jwaneng mine provides water to WUC for Jwaneng Town) as well as a few monetary data. The annual water reports to the Water Apportionment Board (WAB) offered another data source. Mines and WUC have differing data on water provided to mines. To be consistent, WUC sales data was used for all mines that receive (some) water from WUC.

The Botswana Chambers of Mines (BCM) and the Department of Mines (DoM) assisted in contacting mines and providing some data. While the DoM has the authority to request for water usage data from all mines, the data are not systematically recorded and kept and therefore could not be used. *It is recommended to systematically record water abstraction, use and consumption data from all mines through the annual Water Report that mines have to submit to the Water Apportionment Board (WAB).* A template for the required data is given in Appendix 3.

Ministry of Agriculture

For the livestock sector, water use is not metered and therefore has to be estimated. Water use was estimated using the best practice method of multiplying livestock numbers from the Agricultural Statistics (cattle, goats, sheep and donkeys) with standard daily water requirements per type of livestock. Livestock numbers for 2013/14 were not yet available. The most recent livestock figures refer to 2012. It has been assumed that livestock numbers remained constant in 2013.

With regards to the irrigation sector, data required include water abstraction and use, water sources and water return flows. The irrigation sector is currently small and poorly documented[10]. Farm level and sectoral irrigation data is fragmented and incomplete, and could not be used for the WA. Water use for irrigation has therefore been kept constant at 18 Mm^3 as per the 2006 NWMP (SMEC and EHES, 2006*).* DWA and MoA intend to undertake an irrigation survey in 2015 to assess water use in the irrigation sector therefore the results will be incorporated into future accounts.

Statistics Botswana

Statistics Botswana provided their interim business registry classified by economic sector as per the ISIC classifications that is used for the national accounts. In addition, they made recent National

[9] Other self-providers are not yet included as no data or estimates are available. Therefore surveys are needed to collect such data (e.g. sector surveys or additional questions in regular SB surveys).

[10] For example, irrigation is not covered in the annual Agricultural Statistics. As a results of inputs from the WA WAVES project, irrigation has at least some coverage in the 2015 Agricultural Survey, but it does not required all data needed for the WA. Therefore, an irrigation survey will be done by DWA and MoA to fill this data gap.

Account and employment figures available. The business registry was compared with WUC's list of clients that had been manually processed and assigned economic sector codes. This was carried out to check as to whether the companies that are common to the two lists have the same economic sector codes and also to identify the contracts/companies that could not be assigned codes in the WUC list because they were unknown. The exercise was time consuming but useful as it assisted in the sector allocation of previously unknown sector clients. The results are shown in Box 2. There was limited overlap between both business lists. This suggests that the SB-business registry needs to be significantly up-dated and expanded. Both business lists will benefit the economic classification of BPC customers for the energy accounts. This issue continues to pose a major limitation for natural accounting activities (water, energy and ecosystems) and requests have been submitted to SB through the WAVES Botswana Steering Committee to expedite the completion of the business register.

Box 2: Comparison of SB interim business registry and WUC business client list

SB uses their business registry for the national accounts as per the UN's International Standard Industrial Classification of economic activities whereas WUC has not yet adopted a detailed economic sector classification. WUC's client list was therefore processed and assigned economic sector codes (based on ISIC) as part of the water accounts exercise and the final list was then compared with the SB list.

The purpose of the exercise was to check as to whether the companies that are common to the two lists have the same economic sector codes and also to identify the contracts/companies that could not be assigned codes in the WUC list because they were unknown.

Results:

- ✓ The cleaned up SB registry had 12 399 entries. The WUC client list had 13 840 entries.
- ✓ The SB registry and the WUC client list greatly differed in that only a few entries were common to both lists. Only 2 166 businesses appeared on both lists (15.7% of the WUC client list)
- ✓ 537 and 462 WUC list entries in 2012/13 and 2013/14 respectively listed as unknown were assigned new codes based on the SB list (around 10% of the clients that could not be assigned a sector). This reduced the unknown to 3.8% of the total water use from the initial 4.2% whereas for 2013/14, these account for 3.6% from 4%.

It is recommended that SB develops a comprehensive national business registry as soon as possible based on client lists from WUC, BPC, etc. as well as lists from the Registrar of Companies and the Botswana Unified Revenue Service (BURS). Furthermore, it is recommended that SB incorporates key water data requirements in its regular surveys (e.g. agriculture and business survey etc.).

3.2 Assumptions for account construction

The assumptions made for the study are captured in this section.

For the flow accounts (supply and use tables), the following assumptions were made based on best international practice:

1. In estimating water abstraction for Maun MC in 2012/13, an average inter-censal (2001 – 2011) growth rate of 1.9% was applied across all villages to estimate settlement population;
2. For Maun village, an estimated annual per capita water abstraction of 28.8m^3 (based on abstraction for the previous year) was used to estimate water abstraction for 2012/13. For the settlements, abstraction was based on the average annual per capita water abstraction of 26.3 m^3;
3. An average water loss of 26% was applied to estimate water use for Maun MC. Of the total water use, it was assumed that 75% was for domestic purposes while the rest was distributed across other sectors;

4. The total WUC sales used are based on the billing information. For 2012/13, total WUC sales of 89.8 Mm^3 was adjusted to 82.7 Mm^3 because there was an anomaly in the sales for Gaborone business area in June 2012 (around 6.2 Mm^3) for category 2B. An average of May and July sales was therefore used to adjust the June figure (428 720 m^3);
5. The total sales for businesses and government as per the WUC client data for both years differed from the sales derived from the billing information provided. Therefore, to account for the difference, correction factors of 1.41 and 1.04 for 2012/13 and 2013/14 respectively were applied to sectoral sales such that the total for both data sets are equivalent;
6. For irrigation and livestock farming, it is unclear whether the available figures refer to abstraction or use. This needs further investigation. For the time being, it is assumed that abstraction equals use (hence zero losses);
7. For livestock water abstraction and use by MC, agricultural districts were super imposed on WUC MCs by assigning proportions of the cattle population in each area based on the total cattle population for 2012; and
8. In terms of water abstraction by source, WUC only provided data for groundwater and this was deducted from total abstraction for each MC and therefore the balance was allocated to surface water in areas that rely on more than one water source.

4 Stock accounts

4.1 Introduction

This chapter discusses on-going work on the water stock accounts in Botswana. Botswana has stock of groundwater, reservoir water and in a few areas perennial river water resources. The country has a small number of large dams, mostly used for supply of urban areas and some large villages, as well as a large number of small dams mostly used for livestock production and irrigation. Most small dams have been constructed by the Ministry of Agriculture; the large dams have been constructed by the DWA and are operated by WUC.

Currently, DWA is developing for major reservoirs operated by WUC only. *Improved monitoring of the performance of small (agricultural) dams is needed before such dams can be incorporated into the stock accounts*. Water resource data for the small agricultural dams are currently not available.

DWA intends to develop stock accounts for groundwater in future. This is important as groundwater accounts for over half of the country's water consumption and there are widespread concerns about groundwater depletion. Ground water resources are vulnerable to over-exploitation, and evidence exists that some of the existing well fields are over-utilised (CSO, 2009). Therefore, DWA views the construction of groundwater stock accounts as the next priority to contribute to their sustainable use.

Previous work indicates that waste water resources are significant but under-utilised (CAR, 2006). The opening and closing stocks of wastewater are likely to be the same as the wastewater is stored in maturation ponds (and presumably full at the start and end of the year. Supply and use accounts for wastewater are much more important.

Botswana only has two perennial transboundary rivers, i.e. Okavango and Chobe, which supply water to adjacent villages; the river water is important for maintenance of the ecosystems. Given the limited use in the economy the river stock accounts are currently not a priority.

4.2 Review of data requirements and availability

For reservoirs, data exist for the opening and closing stocks, abstractions, transfers into and from the reservoirs, and evaporation data in the form of average long-term monthly evaporation. However inflows into the reservoirs are not measured. No data are available for Ntimbale dam[11].

For groundwater, there is limited data in the form of abstractions, but it is impossible to determine opening and closing stocks. For wastewater accounts there are no measurements for outflows from water treatment works.

The stock accounts exercise for 2010/11 and 2011/12 concentrated on stock accounts for five major WUC water supply reservoirs, namely Bokaa, Gaborone, Letsibogo, Nnywane and Shashe dams. During the year 2013/14, three new dams were completed, namely Dikgatlhong, Thune and Lotsane. Abstraction from Dikgatlhong and Thune dam was zero[12]. Opening and closing stocks for both dams are known but evaporation and inflows are unknown.

[11] Even though Ntimbale dam started operating in 2005 but no data are available.

[12] These dams were not connected to the main water transfer system (NSWC) in 2013/14.

The dams can be characterized according to their size and yield (NWMP, 2006). Map 3 shows the location of the dams, which are mostly located in eastern Botswana in the Limpopo catchment, together with their respective carrying capacity. The three new dams more than doubled the existing reservoir storage capacity to almost 880 Mm^3 (existing capacity is 349.2 Mm^3). This will have a large impact on the reservoir stock account. While safe yields will increase to 143.4 Mm^3 the ratio of safe yields to storage capacity will decline to 16.3%. It is worth noting that among the three dams added to the stock accounts, water is presently abstracted from only one dam (Lotsane with a carrying capacity of 40 Mm^3). The capacity and safe yields are shown in Table 6.

Table 6: Capacity and safe yields for WUC dams

Dam	Full Supply Capacity (Mm^3)	Safe Yields (Mm^3)
Gaborone	140.5	9.4*
Bokaa	18.5	4.9
Nnywane	2.3	.6
Shashe	87.9	25.3*
Letsibogo	100	24
Ntimbale	26.4	3.6
"old" dams (above)	**349.2**	**65.8**
Dikgatlhong	400	62
Lotsane	40	6.6
Thuni	90	10
New dams	**530.0**	**78.6**
Total	**879.2**	**143.4**

*Based on pre-siltation volumes

Source: DWA & CAR, 2014. Safe yields: DWA data.

Data required for the reservoir stock accounts include the following:

a. Opening and closing volumes
b. Natural Inflows & incoming transfers;
c. Abstraction and outgoing transfers;
d. Evaporation; and
e. Seepage and overflow.

Reliable data exist for a. and c. for the period 2000/01 – 2013/14 as well as for water imports from South Africa. The inflows and evaporation are not measured and recorded and had to be estimated. Data for e. are used to ensure that the opening stock plus additions minus subtractions equal the closing balance. Earlier work on the estimates for inflows and evaporation is currently being re-assessed (reported in DWA and CAR, 2014) to ensure that best estimates are used in the stock accounts. Unfortunately, this work could not be completed before completion of the report. Therefore, the remainder of this chapter focuses on long term trends in stocks and abstraction only.

Map 3: Geographical location of major dams in Botswana

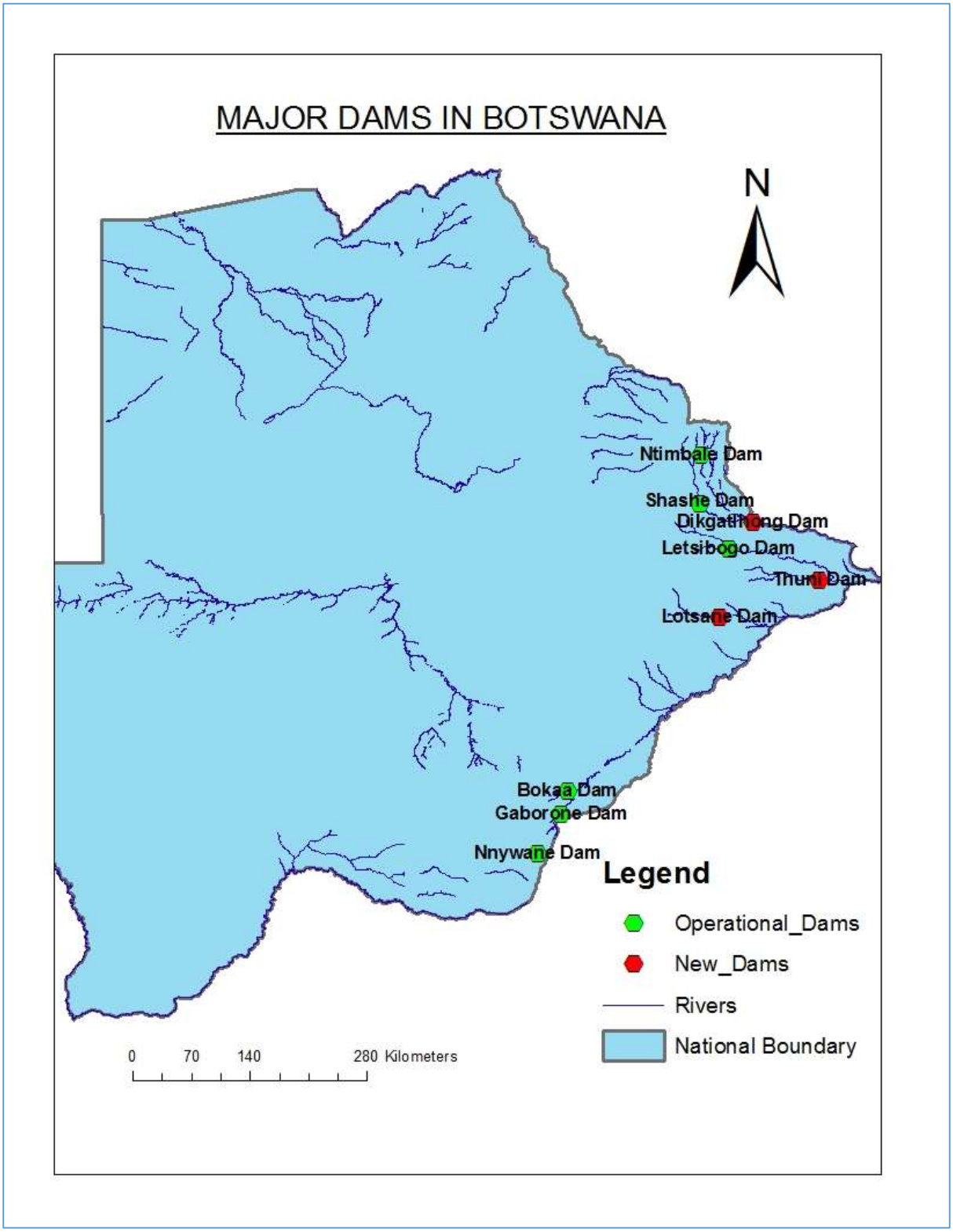
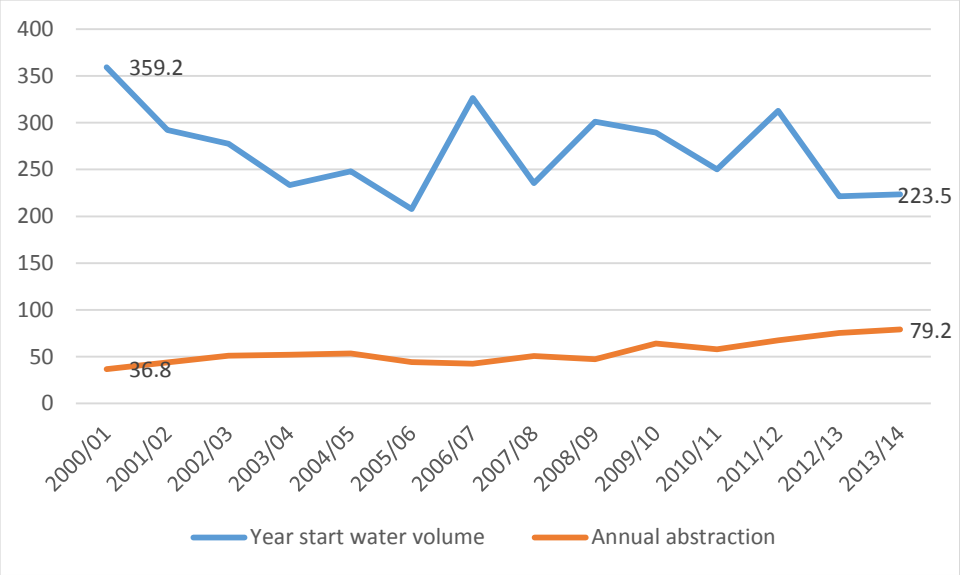


Figure 2 shows the volume of water stored in major dams at the beginning of the year and annual water abstraction from the dams. The opening volume shows a decreasing trend while abstraction is increasing, putting more pressure on the dams. Water imports from South Africa offer little relief. During the period 2000/01 – 2013/14 an average of 5.2 Mm^3 was imported with a maximum of 7.2 Mm^3 and a minimum of 2.7 Mm^3. Therefore the new dams (Dikgatlhong, Lotsane and Thune) need to be integrated in the water distribution network as soon as possible to relieve pressure on the existing dams. Moreover, the capacity of the NSWC needs to be expanded soonest to relieve pressure and dependency on the dams in south eastern Botswana with low safe yields.

Figure 2: Water stored in and abstracted from dams (Mm^3)



Note: excludes Dikgatlhong, Lotsane, Ntimbale and Thune dams.

The annual abstraction of dams is compared with their opening volume in Table 7. The relative abstraction is very high for the small dams (Nnywane and Bokaa) and much lower for the large dams (between 15 – 30%). Shashe is the most stable dam with small differences between the average and min-max percentage. The other dams have a large difference between the lowest and highest percentage of abstraction. Interestingly the small dams have a maximum annual abstraction that exceeds the opening volume, meaning that they rely on annual inflow for water abstraction. The highest percentage for Gaborone dam refers to 2013/14 when the dam was drying up and abstraction continued because of the high water demands in south eastern Botswana.

Table 7: Annual water abstraction from dams as % of opening volume

	Average	Maximum	Minimum
Gaborone dam	28.4%	73.6%	6.9%
Bokaa dam	47.1%	130.2%	11.6%
Nnywane dam	57.2%	129.0%	16.8%
Shashe dam	15.8%	20.3%	11.9%
Letsibogo dam	19.7%	55.9%	3.4%
All dams	21.1%	35.4%	10.2%

5 Up-dated physical supply and use accounts 2010-11 to 2013-14

The SEEA water framework was created to link hydrological and economic information and this enables integrated analysis. The past flow accounts report (2010-2012; DWA and CAR, 2014) also utilised the SEEA water framework. The physical supply and use tables enable analysis of interactions between water and the economy. The tables use internationally accepted definitions and classifications. The supply table captures water abstraction for distribution to other economic sectors (by water service providers) as well abstraction for own use (so-called self- providers). The use table describes the flows of water within the economy and return flows back into the environment.

Botswana has a number of self-providers who abstract for own use, including most mines, livestock and irrigation farmers as well as the Botswana Power Corporation (BPC)[13]. Some self-providers also receive water from WUC.

This chapter reports on the years 2012/13 and 2013/14. With this report, SEEA physical supply and use tables are now available for four years (2010/11- 2013/14). The use and supply tables for the earlier years are shown in Appendix 1 (see also DWA & CAR, 2014).

5.1 Physical water use and supply accounts

Detailed tables for the physical supply and use tables for 2012-2014 are attached in the appendices with summarised versions tabulated in Tables 13 and 14. In order to appreciate the results, a brief explanation of the tables is provided below. The comparable tables for 2010/11 and 2011/12 are shown in Appendix 1.

The top part of each table is the *SEEA physical use account*, which documents water abstraction for own use and for distribution, water abstraction by sources and water received from other economic sectors as well as water received from imports. *Total water use* is the amount of water abstracted and the amount of water received from other economic sectors.

The bottom part of each table is the *SEEA physical supply table*, which refers to the supply of water within the economy and the returns to the environment. The *total water supply* is the supply within the economy plus the return flows to the environment. Water consumption is the use (from the use table) minus the supply (from the supply table).

Abstraction

Tables 8 and 9 display an annual water abstraction of 194.1 Mm^3 in 2012/13 with a slight increase to 194.5 Mm^3 in 2013/14. There are no exports of water, but around 3% of the total water supply is imported from Molatedi Dam in South Africa. The abstraction for own use is close to the abstraction for distribution:

- ✓ For 2012/13 the figures are 91.5 Mm^3 and 102.6 Mm^3 representing abstraction for own use and abstraction for distribution respectively;
- ✓ In 2013/14, the figures are 94.9 Mm^3 and 99.6 Mm^3 for own use and distribution.

[13] Water abstraction, distribution and use from BPC and Morupule Coal Mine (MCM) could not be analysed in detail as details about the water flows between the companies could not be adequately documented. In this report, WUC supply data to BPC and MCM were used along with figures of own abstraction by both companies. Further investigation of the water balances of Morupule B and MCM needs to be done for the next WA 2014/15.

The categorisation of the water abstracted per water source shows a similar trend for 2012/13 and 2013/14. Groundwater accounts for approximately 50%, reservoir water approximately 42% and the rest (8%) comes from river water (Chobe and Okavango Rivers). Self-providers mainly use ground water, whilst water in urban areas and many large villages is mostly sourced from surface water.

Water use

Overall water use decreased to 269.3 Mm^3 in 2013/14 (from 280.9 Mm^3 in 2012/13). The water provision sector is the largest water user followed by the agricultural sector, mining and households. The water provision sector (mostly WUC) abstracts mostly water for distribution; in contrast, both agriculture and mining use mostly water that has been abstracted for own use. The analysis of use of water from other economic sectors (mostly from WUC) shows that households are the major users of distributed water, followed at a distance by government and the mining sector. The water use by government and mining is significantly larger in 2012/13 than in 2013/14 (and the earlier years of 2010/11 and 2011/12. The reasons are not fully understood and need to be further investigated. It could be due to inaccuracies in WUC data for 2012/13 or to the completing of the transfer of water provision duties to WUC[14]. The service industry uses more water than manufacturing, which reflects the small size of the country's manufacturing sector. (54.5% for 2013/14 and 43.7 % in 2012/13). In 2010/11 and 2011/12 the share of households was 51.0 % and 55.9 % respectively.

Water consumption

Water consumption marginally declined in 2013/14 to 169.8 Mm^3. This is likely to be due to water restrictions in south-eastern Botswana. The agricultural sector is the largest water consumer followed by mining and households. It should be noted that the return flows from distributed water are unknown and hence water use and consumption tend to be equal for most sectors with two exceptions. First, the water provision sector is the largest water user but a small consumer, as it distributes most of the abstracted water. Second, the mining sector provides some water to WUC, hence the use is higher than the consumption. This flow from the mining sector to the water provision sector has not been captured in earlier accounts due to lack of data.

Water losses

Genuine water losses can currently only be analysed for the service provider WUC, and have been calculated as the percentage difference between water supplied by WUC and water abstraction plus imports. The loss figure for 2012/13 appears low (14.2 %) compared to 2013/14 (23.3 %) and that of previous years (25 % for 2010/11 and 2011/12). The reasons for the low loss figure in 2012/13 are unknown but it is suspected to relate to data weaknesses as the loss figures for the other 3 years are similar. It is unlikely that loss figures dropped by 10 % in one year and rose again 10% in the next year.

Table 10 shows that the 2012/13 losses are 10% lower than for the other years in the period 2010/11 – 2013/14. A closer look at the table shows the distribution increased significantly in 2012/13 (mostly to mines and government), which implied lower losses and return to the environment. Earlier data quality concerns have been expressed about the water use and losses for 2012/13.

[14] As a result, DWA no longer purchases water from WUC and the high water use of government in 2012/13 may be due to delayed billing of DWA by WUC.

Table 8: SEEA physical supply and use table 2012/13 (in Mm^3)

Physical use table	Agriculture	Mining and Quarrying	Manufacturing	Electricity	Water service providers	Construction	Trade	Hotel & restaurants	Transport	Finance and business	Social & personal services	Government	Int. Organisations	Total agr & ind	households	rest world	Total
Abstraction for own use	66.0	25.3			0.2									**91.5**			91.5
Abstraction for distribution		1.6			93.4									**94.9**		7.7	102.6
1. Total abstraction	66.0	26.9			93.5									**186.4**	-	7.7	194.1
Reservoir water	10.8	0.3			**64.7**									**75.8**		7.7	83.5
Ground water	42.6	26.6			**26.8**									**96.0**			96.0
River water	12.6	-			**2.0**									**14.6**			14.6
Abstraction from water resources	66.0	26.9			**93.5**									**186.4**		7.7	194.1
2. Use of water from other economic sectors	0.2	15.5	3.4	0.2	1.6	0.4	1.6	0.8	0.3	2.4	6.4	16.1	0.2	**48.9**	37.9		86.8
Total use of water (1+2)	**66.2**	**42.4**	**3.4**	**0.2**	**95.1**	**0.4**	**1.6**	**0.8**	**0.3**	**2.4**	**6.4**	**16.1**	**0.2**	**235.3**	**37.9**	**7.7**	**280.9**

Physical supply table	Agriculture	Mining and Quarrying	Manufacturing	Electricity	Water service providers	Construction	Trade	Hotel & restaurants	Transport	Finance and business	Social & personal services	Government	Int. Organisations	Total agr & ind	households	rest world	Total
4. Supply of water to other economic units		1.6		0.0	77.5									**79.1**		7.7	86.8
5. Total returns					15.8									**15.8**			15.8
6.Total supply of water (=4+5)	-	1.6	-	0.0	93.4	-	-	-	-	-	-	-	-	**94.9**		7.7	102.6
7. Consumption	**66.2**	**40.9**	**3.4**	**0.2**	**1.7**	**0.4**	**1.6**	**0.8**	**0.3**	**2.4**	**6.4**	**16.1**	**0.2**	**140.4**	**37.9**	**-0.0**	**178.3**

Table 9: Physical Supply and Use Table 2013/14 (in Mm^3)

Physical use table	Agriculture	Mining and Quarrying	Manufacturing	Electricity	Water service providers	Construction	Trade	Hotel & restaurants	Transport	Finance and business	Social & personal services	Government	Int. Organisations	Total agr & ind	households	rest world	Total
Abstraction for own use	66.0	28.8			0.1									**94.9**			94.9
Abstraction for distribution		1.9			91.1									**93.1**		6.5	99.6
1. Total abstraction	66.0	30.8			91.2									**188.0**	-	6.5	194.5
Reservoir water	10.8	0.2			**63.1**									**74.1**		6.5	80.6
Ground water	42.6	30.6			**26.4**									**99.6**			99.6
River water	12.6				**1.7**									**14.3**			14.3
Abstraction from water resources	66.0	30.8	-	-	91.2	-	-	-	-	-	-	-	-	**188.0**	-	6.5	194.5
2. Use of water from other economic sectors	0.2	9.2	2.3	0.1	1.9	0.3	1.1	0.6	0.2	1.6	5.2	11.3	0.1	**34.1**	40.8		74.9
Total use of water (1+2)	**66.2**	**40.0**	**2.3**	**0.1**	**93.1**	**0.3**	**1.1**	**0.6**	**0.2**	**1.6**	**5.2**	**11.3**	**0.1**	**222.1**	**40.8**	**6.5**	**269.4**
Physical supply table	**Agriculture**	**Mining and Quarrying**	**Manufacturing**	**Electricity**	**Water service providers**	**Construction**	**Trade**	**Hotel & restaurants**	**Transport**	**Finance and business**	**Social & personal services**	**Government**	**Int. Organisations**	**Total agr & ind**	**households**	**rest world**	**Total**
4. Supply of water to other economic units		1.9		0.0	66.4									**68.4**		6.5	74.9
5. Total returns					24.7												-
6.Total supply of water (=4+5)	-	1.9	-	0.0	91.1	-	-	-	-	-	-	-	-	**93.1**	-	6.5	99.6
7. Consumption	**66.2**	**38.0**	**2.3**	**0.1**	**2.0**	**0.3**	**1.1**	**0.6**	**0.2**	**1.6**	**5.2**	**11.3**	**0.1**	**129.0**	**40.8**	**-**	**169.8**

Table 10: Water losses for the service providers in the period (2010-2014)

	Unit	2010/11	2011/12	2012/13	2013/14
Domestic abstraction	Mm^3	90.4	83.7	93.5	91.2
Imports	Mm^3	7.3	7.2	7.7	6.5
Distribution	Mm^3	65.7	60.9	77.5	66.4
Water losses	%	25.3	25.1	14.2	23.3

The losses are captured for the service providers but in the case of self-providers, only some of the mines reported loss figures. Losses in the livestock sector and irrigation are unknown. For the current accounts, self-providers are taken to use all their abstracted water. This therefore gives a picture of minimal return flows into the environment. Losses and return flows require work in future *accounts. There is need to get better data for abstraction, use and consumption from self-providers.*

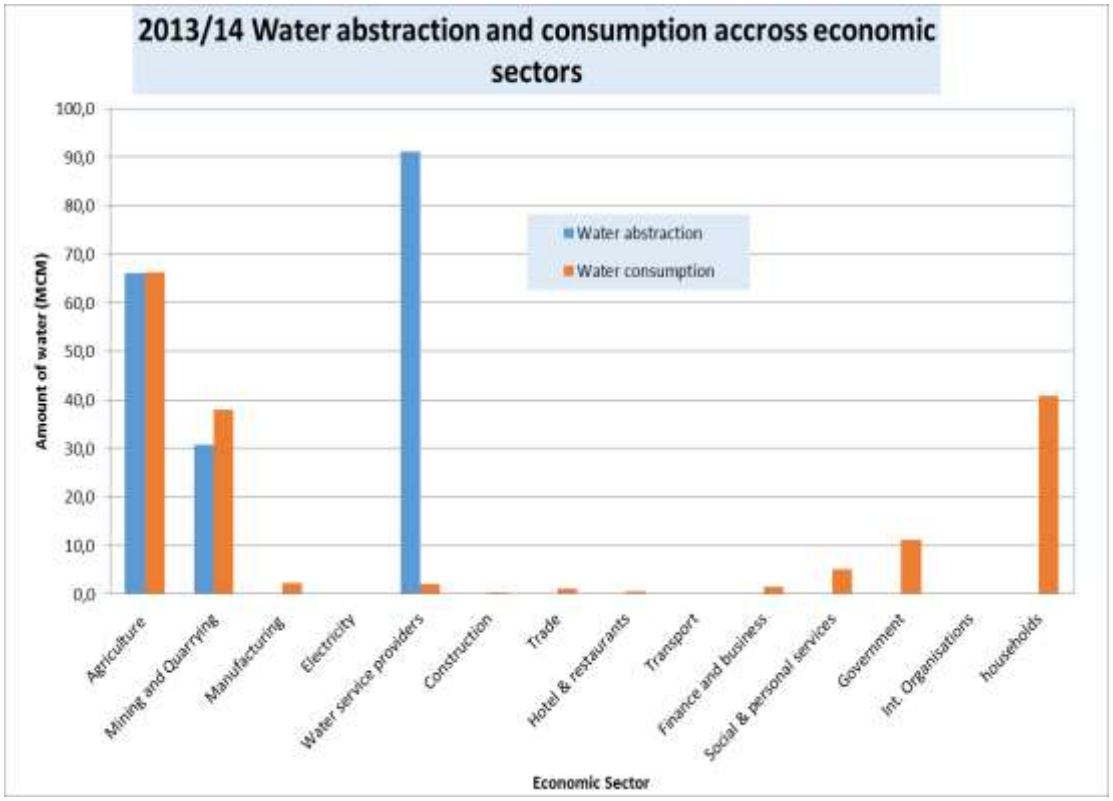
Return flows into sewerage and from treatment plant to other economic sectors or the environment

Households, businesses and government generate return flows to the sewerage sector in cities, towns and some of the large villages. These return flows are currently not captured in the supply and use accounts due to lack of data. There is currently no metering of inflows and outflows from waste water treatment facilities. Data scarcity makes it a challenge to include wastewater[15] even though some of it is re-used in economic sectors e.g. irrigation. There is an urgent need to collect sewerage inflow and outflow data or alternatively to carry out a pilot monitoring study of the in-and outflows of on treatment plant which can then be used to estimate overall wastewater flows. WUC and DWA need to record wastewater and return flow data in future as this is an area that can assist in water demand management through options like recycling/reusing waste water. The DWA already has plans in place and this include an ongoing partnership with SIWI on projects that include institutional framework for optimised waste water and sanitation resource management.

The water abstraction and consumption by economic sectors is shown in Figure 3. The most striking feature is that –unlike for most other economic sectors- the abstraction of the water service sector is much higher than the consumption (see above). Data gaps do not enable a comprehensive description of return flows and environmental returns (other than water losses). Inflows and outflows from treatment facilities are currently not measured.

[15] Standard return rates (e.g. 80% of household water consumption is returned to the sewerage system have shown to be too high, and have therefore not been used. Sewerage flows will be incorporated once WUC starts to measure inflows and outflows at some of its wastewater treatment works.

Figure 3: **Annual water abstraction and consumption by economic sector (2013/14; Mm^3)**



5.2 The mining sector: water supply and use assessment

The mining sector remains the main driver of economic development despite the country's efforts to diverse the economy. Therefore, a closer look of the supply and use of water resources in the mining sector is warranted.

Diamond mining dominates the mining sector while coal, copper, nickel, soda ash and gold are also extracted, but on a smaller and less profitable scale. Water abstraction and use in the sector is significant and is expected to increase in future. The 2013 Botswana IWRM & WE Plan[16] (DWA, 2013, p. 92) states that "*Further growth in the mining sector is likely and this may require significant water resources*". WRC (2012) estimated that water demands of the mining sector will grow to around 100.4 Mm^3 in 2027, before demand may decrease due to closure of some of the existing mines. Competition for water resources will increase in future given the growing resource demands of other sectors (e.g. irrigation and domestic use). It is therefore imperative to prioritise water efficiency in mining operations.

Compared to the previous accounts (201/11 and 2011/12), more comprehensive and disaggregated water abstraction and use data for the sector was obtained. For example, some water abstraction by Debswana in Jwaneng is distributed to WUC, and this flow is included in the WA for the first time. The results are presented in this section.

[16] Department of Water Affairs (2013). Botswana Integrated Water Resources Management and Water Efficiency Plan. Ministry of Minerals, Energy and Water Resources, Government of Botswana.

Below water sources of the various mines are briefly detailed.

Most mines abstract all their water requirements themselves (typically groundwater). A few mines depend on WUC for their water supply while some augment their own water supply with water delivered by WUC. The resource situation of the main mines is shown in Table 11.

Table 11: Sources of water of the main mines

Source of water supply	Name of mine	Water source
Mines with own water abstraction & supply only	Jwaneng diamond mine	Groundwater and pit water
	Orapa, Letlhakane & Damtshaa diamond mines (OLD)	Groundwater, pit water and some storm water
	Mowana copper mine	Groundwater
	Matsitama copper mine	Groundwater
	Boseto copper silver mine	Groundwater
	Karowe diamond mine[a]	Groundwater
Mines with water supply by WUC only	Phoenix copper/ nickel mine	Dam water
	Mupane gold mine	Dam water
	Tati Nickel	Dam water
Mines with water supply from own abstraction & WUC	Botash: soda ash & salt	Own: Ground water; WUC groundwater
	BCL copper nickel mine	Own: Fissure water; WUC: dam water
	Morupule coal mine	Own: groundwater & storm water; WUC: North South Water Carrier

[a] This mine received water from WUC when the desalination plant did not work adequately.

Table 12 shows water flows for the mining sector between 2010/11 and 2013/14. Water abstraction and consumption is determined by the diamond and copper nickel subsectors. Most of the mines abstract their own water but some mines (Botash, BCL, Tati Nickel, Mupane gold and Morupule) receive water from other sectors such as WUC and Botswana Power Corporation[17] (BPC). The diamond sector accounts for the largest share of mining water abstraction (81.2% in 2013/14). The copper nickel sector accounts for most of the balance (16.6%). The picture differs for water consumption. BCL accounts for a much higher share of consumption (31.11%) as (unlike the diamond sector) it receives significant amounts of water from WUC.

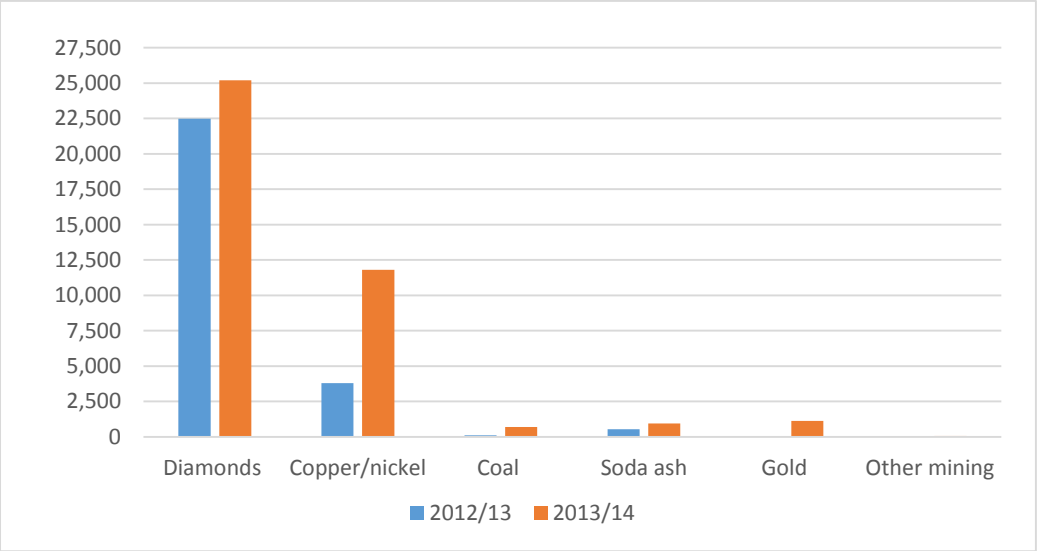
Water abstraction for the mining sector has increased by about 18% between 2010/11 and 2013/14. Annual abstraction and consumption varies related to mineral extraction. Abstraction for 2012/13 and 2013/14 amounts to 26.9 Mm^3 and 30.8 Mm^3 respectively or around 15% of the country's annual abstraction (Figure 4). Water is abstracted almost entirely from groundwater resources for mining operations; groundwater includes water from well fields, fissure water and pit dewatering.

[17] Details about the water flows between BPC and Morupule coal mine could not be obtained. Data from own abstraction and WUC were used, which do not reflect water flows between BPC (energy sector) and Morupule coal mine (mining sector). Such flows would alter consumption of BPC and MCM. This issue needs further investigation.

Table 12: Water abstraction and consumption for the mining sector (2010/11 to 2013/14; Mm^3)

	Diamonds	Copper/nickel	Coal	Soda ash	Gold	Other	Total mining	Botswana
Water abstraction								
2010/11	21.7	3.4	0.1	-	-	-	**25.2**	**197.2**
2011/12	23.3	5.5	0.1	0.2	-	-	**29.1**	**194.4**
2012/13	22.5	3.8	0.1	0.5	-	-	**26.9**	**194.0**
2013/14	25.0	5.1	0.1	0.6	-	-	**30.8**	**194.4**
Water consumption	-	-	-	-	-	-	**-**	**-**
2010/11	21.9	8.3	0.1	0.3	1.6	0.1	**32.4**	**276.7**
2011/12	23.7	7.8	0.1	0.8	2.1	0.1	**34.6**	**267.9**
2012/13	21.3	14.6	1.9	1.0	1.9	0.1	**40.8**	**174.1**
2013/14	23.3	11.9	0.7	1.0	1.1	0.1	**38.0**	**166.1**

Figure 4: Water abstraction by the mining sector (2012/13 to 2013/14; 000m^3)



As mentioned, some mines receive water from WUC and BPC. WUC mostly supplies the copper/nickel sub sector while BPC distributes some of its water for coal mining. Of the total water distributed, the water received by the mining sector ranges between 13 to 20 %, most of which is used for copper/nickel mining (Table 13). There seems to be a significant decrease in the water distributed for copper/nickel and coal mining in the years 2012/13 and 2013/14. In 2012/13, copper/nickel sub-sector received 10.9 and 6.7 Mm^3 in 2013/14, while the coal subsector accounted for 1.8 and 0.6 Mm^3 in the same period. It is unclear what led to this decline. For copper-nickel, own abstraction declined which could be compensated by increased water supplies from WUC. The decrease may also be due to poor data quality, and therefore this needs to be carefully considered during the next updating of the Water Accounts.

In terms of total water used, the sector accounts for 15% of overall water used in the country. More than 60% of this is attributed to diamond mining. The picture is similar for water consumption (Figure

5). Overall water consumption for mining decreased moderately from 40.8 to 38 Mm^3 between 2012/13 and 2013/14.

Figure 5: Water consumption for the mining sector (2012/13 to 2013/14; 000m^3)

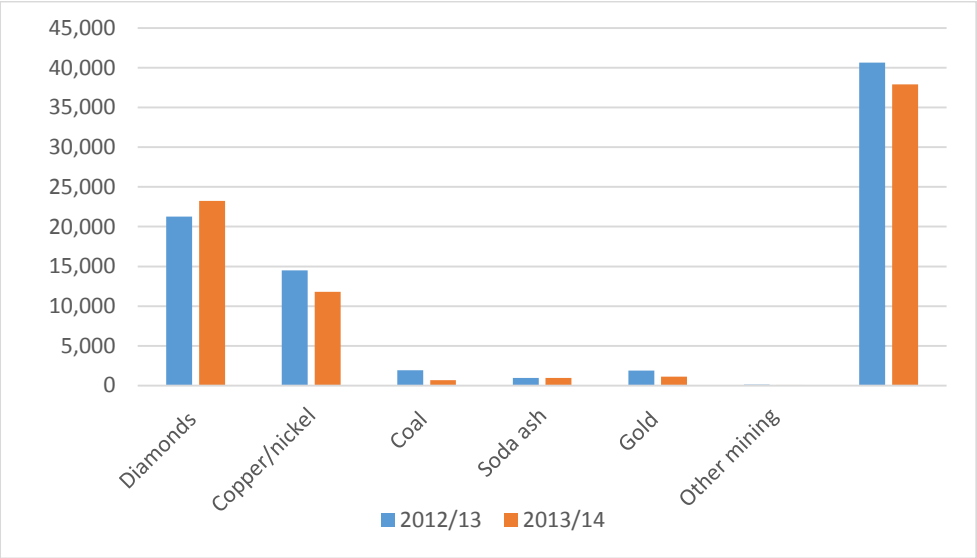


Table 13: Total water received by the mining sector from other economic sectors (2010/11 to 2013/14; Mm^3)

	Diamonds	Copper/nickel	Coal	Soda ash	Gold	Other	Total mining	Overall
2010/11	0.2	4.9	0.0	0.3	1.6	0.1	**7.3**	**68.1**
2011/12	0.4	2.3	0.0	0.5	2.1	0.1	**5.5**	**73.0**
2012/13	0.3	10.9	1.8	0.4	1.9	0.1	**15.5**	**86.8**
2013/14	0.2	6.7	0.6	0.4	1.1	0.1	**9.2**	**74.9**

No data were available for genuine water losses and therefore these return flows to the environment could not be incorporated into the WA. Water losses need to be better monitored and reported in future in the annual reports for the WAB. The template for data requirements in these report is given in Appendix 3. It is further necessary that all mines that abstract water annually submit such reports and that DWA and WAB analyse these reports and use them for the WA updating.

A look at the long-term trend in water use in the mining sector shows the following:

- ✓ The mining sector is responsible for 10 to 15% of the country's water use;
- ✓ Diamond production accounts for three quarters of water use in the mining sector;
- ✓ 0.8 - 1 m^3 of water is used to produce 1 carat; more water is needed per carat in recent years; and
- ✓ 0.125 m^3 of water is used to produce 1 ton of copper-nickel matte; more water is needed per ton of matter in recent years.

6 Regional water supply and use

This chapter provides spatially disaggregated data on water supply and consumption. In line with the IWRM principles Government aims to decentralise water management. According to the 2013 IWRM-WE plan, the boundaries of these regions need to be defined through consultations with stakeholders and further assessment of the distribution of ground and surface water sources. This process is expected to start in 2015, and be completed in 2016. Future water accounts should adopt the regions adopted for decentralised water management.

In the interim, the WA have used the WUC Management Centres (MCs) as its regions. This chapter discusses water abstraction, consumption and distribution of water among MCs as well as the sources of water in each region.

6.1 Introduction

Botswana's water resources are unevenly distributed: high water demand centres, in particular south-eastern Botswana, have limited water resources, whilst water 'rich' areas have limited demand (Chobe and Ngamiland Districts). Therefore, water resource management requires a decentralised approach as well as linkages between the regions (e.g. through water transfer schemes). The IWRM-WE plan (DWA, 2013) as well as the draft Water Policy advocate the catchment management approach for managing the country's water resources. One of the advantages of decentralised management is that it allows for greater participation and understanding of local institutions and water users and may result in targeted and realistic resource management solutions. Furthermore, the competing interests of different actors are better addressed in such a setup and trade-offs between competing water uses are more explicit.

WUC operates 16 MCs and abstraction data was acquired for all of them. However there was no information on the water abstraction by source of water except for groundwater abstraction (available only for 2013/14) for each MC. Groundwater estimates were deducted from total abstraction for each MC and therefore the balance was allocated to surface water in areas that rely on more than one water source. Data on WUC water abstraction and use was available for 2012/13 and 2013/14 as well as data on the costs and revenues. However, an analysis of the costs and revenues is provided in Chapter 7.

In 2012/13, Maun MC was the only region that was still serviced by DWA (Maun village) and the District Council (other settlements) but WUC took over these responsibilities in April 2013. Water abstraction and use data for the region was unavailable for this period and therefore this gap was addressed by applying an estimated daily per capita water abstraction using available production estimates from the previous years.

Water abstraction for mines and livestock were allocated to MCs based on the location of the mines and livestock population in each region. It was not possible to allocate irrigation water abstraction by MC because of lack of data. The aggregate estimate used for the sector is based on the NWMP 2006.

6.2 North South Carrier and water imports

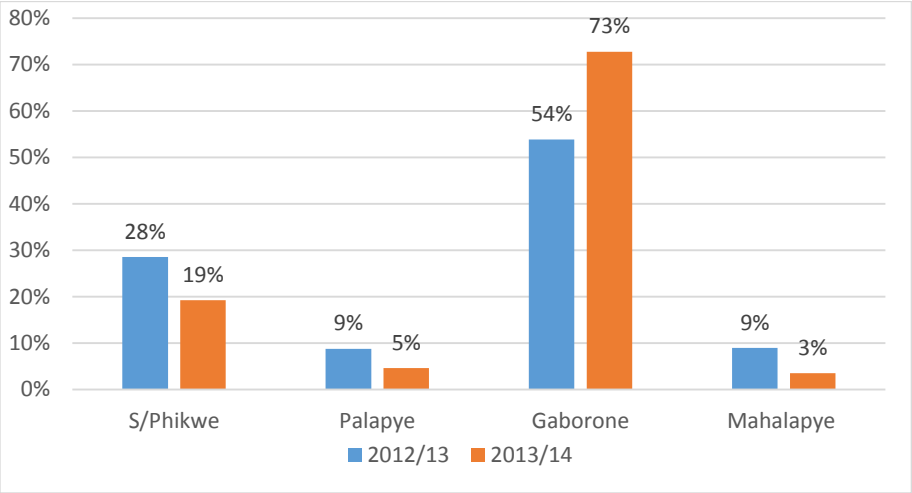
The northern and north-eastern parts of Botswana have relatively more abundant water resources than the southern and western areas. Therefore, water is transferred to various MCs from Selibe-Phikwe MC through the North South Carrier (NSC) to the mid and south-east. The NSC draws water from Letsibogo dam on the Motloutse River and transfers water to Mmamashia water treatment works in Gaborone as well as to the Palapye and Mahalapye treatment works. The water supply from

the NSC goes beyond the three MCs as they also support other few MCs (Lobatse, Mochudi and Serowe). With the recent WUC water supply takeover, a number of villages will be connected to the NSC hence the supply will expand beyond the current MCs.

The current NSC has a maximum capacity of 35 Mm^3 per annum while the optimum capacity is 25 Mm^3 per annum (WUC and DWA, pers.comm). There has been a significant increase of water transferred through the NSC between 2012/13 and 2013/14. This amounted to 23.6 and 36.1 Mm^3 respectively in the given period. Most of the water is transferred to Gaborone MC (54 and 73% in 2012/13 and 2013/14 respectively) followed by Selibe Phikwe MC (Figure 6). The increase in water transfers, particularly to Gaborone MC was necessary because of the drying up of the Gaborone Dam. The analysis shows that the NSC was operating at full capacity during the 2013/14 and the picture may not change for 2014/15 as the pressure is mounting to supply the southern part of the country with more water as Gaborone dam continues to dry up. Construction work on the capacity expansion of the NSC (NSC II) has started and this will allow more water to be transferred from the newly constructed Dikgatlhong Dam. The scheme will have an optimum capacity of 45 Mm^3 while the maximum will be about 50 Mm^3. Despite the expansion of NSC I, sustainable utilisation and management of water will still remain necessary to preserve the resource for future use.

Botswana also imports a modest amount of raw water from Molatedi Dam in South Africa. The dam supplies Gaborone and Mochudi MCs. The maximum entitlement of Botswana is 7.6 Mm^3/ year but the amount is reduced when dam levels are low. In 2012/13, Mochudi MC received 0.26 Mm^3 while supply to Gaborone MC was 7.4 Mm^3. For 2013/14, the total water supply from the dam to Botswana was recorded at 6.5 Mm^3. These imports have been captured in the SEEA water supply and use tables presented in Chapter 5.

Figure 6: Proportion of water transferred from the NSC to MCs (2012/13-2013/14)



6.3 Water abstraction and distribution by MC

Water is abstracted for distribution mainly by service providers, while self-providers abstract for their own use. Total water abstraction was almost similar for 2012/13 and 2013/14 (194 and 194.5 Mm^3; including self-providers). Self-providers and service providers each account for around half of the abstraction. Unsurprisingly, abstraction is highest for Gaborone MC in both years accounting for just over 30% of total water abstraction (Table 14) followed by Kanye, Francistown and Letlhakane MCs. Water abstraction is high in Kanye and Letlhakane areas largely due to the existence of Debswana diamond mines in those areas. The analysis of the mining water balances shows that diamond mining

contributes more than 85% of the total water abstraction by the mining sector hence the high figures for the two MCs. Without the self-providers, water abstraction is high for areas with urban centres mainly Gaborone, Francistown, Lobatse and Selibe Phikwe MCs where the demand is concentrated. Although overall water abstraction is high for the livestock sub-sector, it is evenly spread among the MCs so the local impact is minimal. Irrigation water abstraction has not been disaggregated for each MC and the estimate used is provided in the 2006 BNWMP. It is anticipated that such a distinction will be possible in future and that the results of the planned irrigation survey around the country will address the issue.

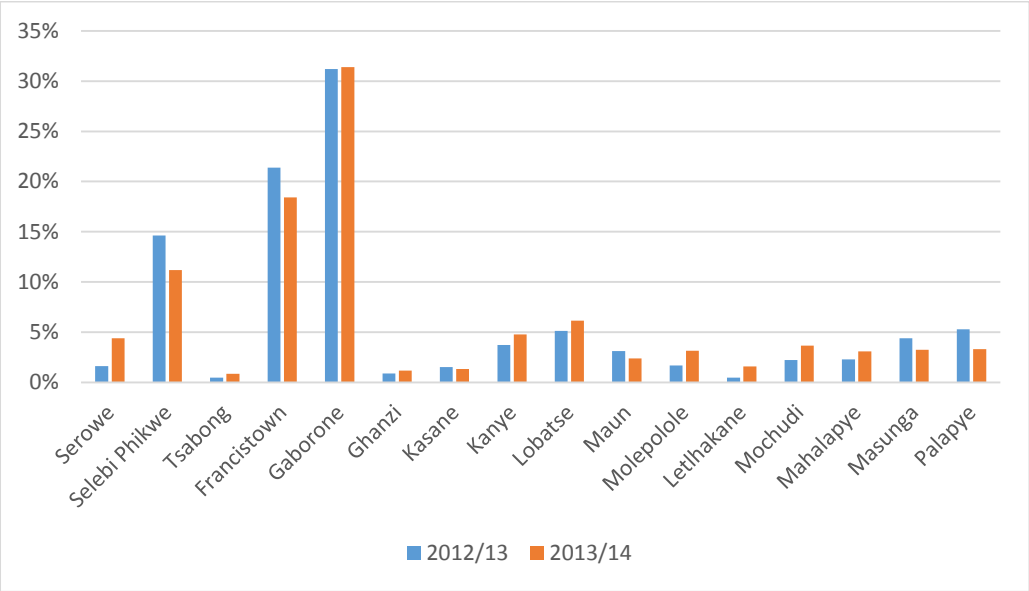
Table 14: Water abstraction by MC (2012/13 and 2013/14; Mm^3)

	2012/13					2013/14				
	Service provi	Self providers				Service provic	Self providers			
MC		Livestock	Irrigation	Mines	Total		Livestock	Irrigation	Mines	Total
Masunga	6.0	4.1		0.5	10.6	5.3	4.1		0.6	9.9
Lobatse	9.3	2.4		-	11.7	6.7	2.4		-	9.1
Mochudi	3.5	2.6		-	6.1	3.3	2.6		-	5.9
Gaborone	30.1	0.4		-	30.5	30.5	0.4		-	30.8
Palapye	2.4	3.1		0.1	5.7	2.7	3.1		0.1	6.0
Mahalapye	4.7	3.6		-	8.2	4.4	3.6		-	8.0
Kasane	1.5	0.1		-	1.6	1.4	0.1		-	1.5
Francistow	14.2	1.6		-	15.8	14.3	1.6		-	15.9
Selibe Phik	8.3	2.5		1.8	12.7	8.5	2.5		3.2	14.3
Tsabong	0.3	2.3		-	2.6	1.4	2.3		-	3.7
Molepolole	4.2	5.9		-	10.1	4.4	5.9		-	10.3
Kanye	6.7	4.3		12.6	23.6	6.5	4.3		14.4	25.2
Serowe	3.2	2.6		-	5.9	3.1	2.6		-	5.7
Letlhakane	1.4	4.5		9.9	15.7	1.3	4.5		10.5	16.3
Ghanzi	1.5	4.0		-	5.6	1.4	4.0		-	5.4
Maun	3.6	3.3		1.9	8.8	2.3	3.3		2.0	7.6
Total	**101.1**	**47.2**	**18.8**	**26.9**	**194.0**	**97.6**	**47.2**	**18.8**	**30.8**	**194.4**

Sources: WUC, mines and Agricultural census data and NWMP.

Figure 7 illustrates the proportion of distribution of water by service providers across MCs. This is captured in the billing data as the water sold to various customers in each region. Unsurprisingly, Gaborone MC receives the highest share of the distributed water as it is the largest demand centre. It accounts for more than 30% followed by Francistown and Selibe Phikwe MCs. There seems to be modest fluctuations in the overall water received by the various MCs except for Gaborone where the difference is minimal between the two years. The overall water sold has declined by 15% between 2012/13 and 2013/14. This may be due to the billing inconsistencies as a result of the WSR. This however needs further investigating. Despite the observed decline, water demand management remains critical and should be further employed in the high demand centres so as to reduce pressure on the available water resource.

Figure 7: Water distributed among MCs (2012/13 to 2013/14; as % of total)



Note: This excludes water distributed by self-providers (1.9 Mm^3 in 2013/14)

6.4 Water abstraction by source

There are three main types or sources of water in Botswana: groundwater, reservoirs and river water. Currently, roughly similar amounts are abstracted from ground and surface water sources. Traditionally, there was higher reliance on groundwater resources. However, the share of reservoirs has increased with the construction of several reservoirs in the north- eastern part of the country since the 1990s.

Abstraction from river water is very low and confined to settlements along the Chobe and Okavango Rivers. Overall, the accounts show that groundwater contributes about half of the total water abstraction in 2012/13 and 2013/14. Reservoirs follow at 42 and 43% while abstraction from rivers ranges between 7 and 8% (Figure 8).

An analysis of water abstraction at the MC level for 2013/14 (Table 15) indicates that about 70% of water abstracted for distribution by WUC comes from reservoirs while 23 % is abstracted from groundwater resources. The groundwater resources are abstracted all over the country, but it is the sole source of potable water for Kanye, Ghanzi, Tsabong and Molepolole MCs. Groundwater remains important in other MCs with more than one source of water, such as Maun, Malahapye, Palapye and Serowe MCs. Reservoirs are commonly used in MCs with urban centres as well as those connected to the NSC. Interestingly, currently most of Mochudi and Lobatse MCs is supplied from reservoirs. However, with the current rehabilitation of Ramotswa and Masama well fields, an increase in boreholes water production is expected and this will augment the supply of surface water in these areas. As indicated earlier, self-providers rely mostly on groundwater. For the livestock sub-sector, the abstraction of groundwater is widespread around the country whereas river-water abstraction is more prominent in the areas close to rivers such as Okavango and Chobe. 47% of the water abstracted for mining takes place in the Kanye MC followed by Letlhakane MC with 34%. These MCs host the country's largest diamond mines.

Figure 8: Water abstraction by source (as % of total)

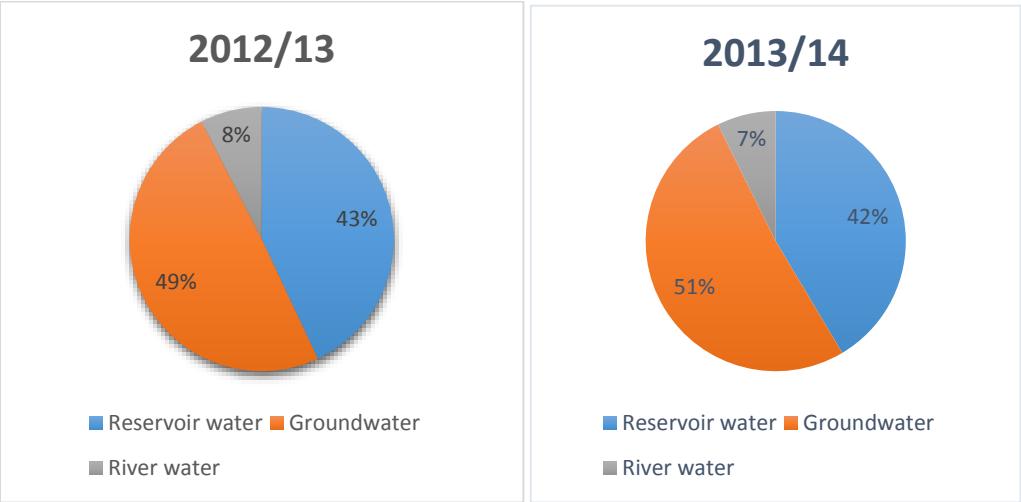


Table 15: Overall water abstraction by source by MC (Mm^3; 2013/14)

	WUC			Livestock			Irrigation	Mines		
Managemen	GW	SW	RW	GW	SW	RW		GW	SW	Total
Serowe	1.7	1.4	-	2.0	0.5	0.1		-	-	5.7
Selebi Phikw	1.5	7.1	-	1.9	0.5	0.1		3.2	-	14.3
Tsabong	1.4	-	-	1.7	0.5	-		-	-	3.6
Francistown	-	14.3	-	1.2	0.3	0.1		-	-	15.9
Gaborone	-	30.5	-	0.3	0.1	0.0		-	-	30.8
Ghanzi	1.4	-	-	3.0	0.8	-		-	-	5.2
Kasane	0.1	-	1.3	0.1	0.0	0.5		-	-	2.0
kanye	6.5	-	-	3.2	0.9	-		14.4	-	25.0
Lobatse	0.0	6.7	-	1.8	0.5	0.1		-	-	9.1
Maun	1.9	-	0.5	2.5	0.7	0.5		1.9	0.1	7.9
Molepolole	4.4	-	-	4.4	1.2	-		-	-	10.0
Letlhakane	1.3	-	-	3.3	0.9	0.2		10.4	0.1	16.3
Mochudi	-	3.3	-	1.9	0.5	0.1		-	-	5.9
Mahalapye	3.2	1.2	-	2.7	0.7	0.2		-	-	8.0
Masunga	3.4	1.9	-	3.1	0.8	0.2		0.6	-	9.9
Palapye	1.5	1.2	-	2.4	0.6	0.2		0.1	-	6.0
Grand total M	**28.3**	**67.6**	**1.8**	**35.4**	**9.4**	**2.4**	**18.8**	**30.6**	**0.2**	**194.4**

Note: GW=groundwater; SW= surface water/reservoir water; and RW = river water.

Groundwater is limited in quantity and quality and more work should be carried out to assess the sustainable amounts of the resource that can be used (DWA, 2013). Abstraction from rivers will remain limited largely because most of the rivers are shared with neighbouring countries and therefore their use is subject to agreements with the other countries. The use of wastewater was not assessed in this phase of the WA updating. There is still insufficient data as inflows and outflows are not measured. This will however be considered in future water accounts.

6.5 Concluding remarks

Water abstraction for distribution is higher for MCs with old WUC serviced areas particularly Gaborone, Lobatse, Francistown and Selibe Phikwe MCs. It would also be expected that abstraction be significant for areas that have large mines and where agriculture is most concentrated. There is high reliance on the NSC and currently it seems to operate at maximum capacity as indicated in this

section earlier. The second phase of the NSC is expected to increase the water supply to various MCs especially those in the southern part of the country. Although NSC will increase supply, the demand is expected to grow as well and thus IWRM implementation remains critical for the sustainability of the available water resources.

Water abstraction data is now available by village in some areas. The major challenge is that some boreholes are still not monitored and therefore quite often estimates have to be made. WUC is procuring projects country wide to install meters in the boreholes. These would help in monitoring of the volumes of water that the facility puts out and allow for accountability of the system while it would also aid in detection of leaks and breaks in the distribution system. Irrigation water abstraction could not be distinguished by region due to unavailability of data. As was the case for 2010/11 and 2012/13, the current accounts also use similar estimates. However this estimate is outdated and therefore comprehensive research countrywide is highly critical. DWA intends to carry out a survey of the irrigation sector and the results will assist to inform the water accounts and overall policy on water use or irrigation. However, such an effort will require that the major institutions (DWA and MoA) work together so that sufficient and detailed information is acquired from the survey.

7 Monetary aspects of water accounts

This chapter deals with monetary aspects of the water accounts. It is not yet possible to construct full SEEA-styled monetary accounts due to data constraints. This will be done in the future. Current monetary efforts to-date, have focused on the water sector expenditures and costs, tariffs and value added created by water units. Full monetary accounts require additional data that are currently not available (see 7.1).

7.1 Introduction

The SEEA-water handbook (UN, 2012) covers physical and monetary accounts; the latter show the economics of water in terms of costs of water supply, investments in water infrastructure, income generated from the sale of water, production costs as well as the fees and charges for water-related services. The monetary accounts are presented in the form of hybrid and economic accounts (Figure 1, chapter 1). The hybrid accounts capture the supply and use of water (monetary and physical) at the national level: total output, total intermediate consumption, gross value added, fixed capital formation and stocks of fixed assets for water supply. The *hybrid supply table* records the value of production indicating the origin of products and the producers (economic sectors). It captures output at basic prices by industry, imports and taxes and subsidies on products. The *hybrid use table* captures the destination of water related products. Therefore, it provides information on the intermediate consumption of water-related products) of each industry, final consumption, capital formation as well as exports. The table also captures information on total water use by industry for a particular period. The combination of both tables will also provide information on the gross value added, gross fixed capital formation for water supply and sanitation as well as the value of closing stocks of fixed assets for both water supply and sanitation. The products of interest in these accounts are natural water and sewerage services. Natural water is related to water exchanged between economic units.

The hybrid accounts can be complemented by economic accounts that capture water related activities carried out for own use, and government expenditures for collective water related services such as policy formulations, institutional set ups, enforcement of law, licencing and regulation among others.

Partial monetary accounts have been developed for Botswana, dealing with the following aspects:

- Cost of water supply (recurrent and capital), mostly for water service providers (section 7.2). Data for self-providers were patchy; data from WUC better but still have gaps: a. no reliable annual data on emergency expenditures during period 2010-2014; and b. no data on recurrent expenditures by management centre for 2012-13;
- Revenue data for water sales to different categories of water users (also section 7.2);
- Cost recovery and subsidies in two tiers (also section 7.2):
- Water use efficiency expressed in value added/ m^3 by sector and jobs/m^3 by sector (section 7.3);

7.2 Costs of water supply and water revenues

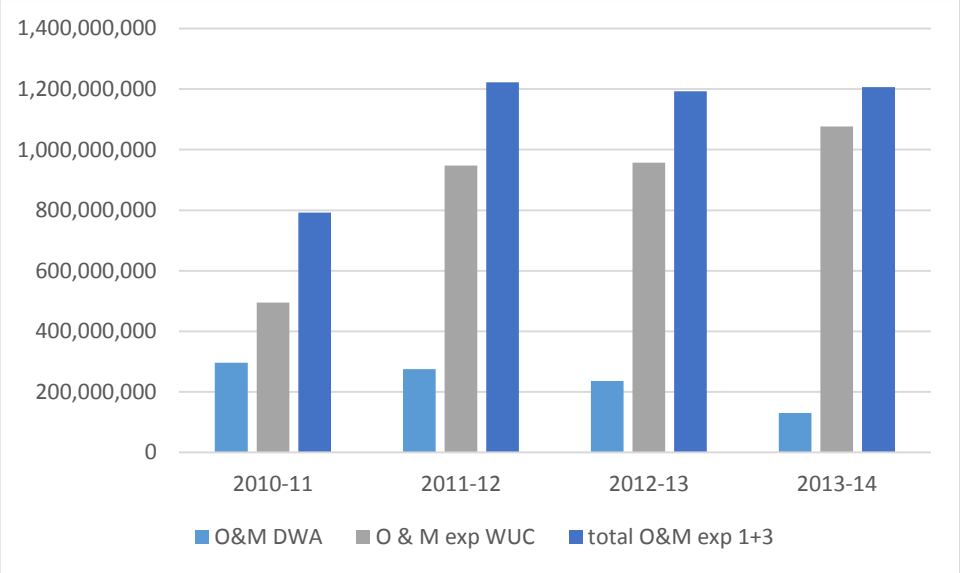
As stated earlier, the transfer of all water supply services WUC was completed in April 2013. Therefore, for 2013-14, WUC became the sole water service provider; in 2012-13 DWA and the Ngamiland District Council provided water to Maun and other settlements in Ngamiland respectively. WUC was responsible for water supply in all other cities, town and villages. In terms of cost and revenue data, District Councils never kept proper record of annual water revenues and expenditures; DWA and WUC kept records.

For the IWRM & Water Efficiency Plan, an analysis of expenditures and revenues was done for the period 1990- 2009 for DWA and WUC (DWA, 2013). The following conclusions emerged from this analysis:

a. The average annual recurrent (i.e. O&M) expenditures of WUC[18] amounted to BWP5.47/m^3 as compared to average annual revenues of BWP9.78/m^3, generating a positive gross margin of BWP4.31/m^3;
b. Annual recurrent expenditures of DWA were more than double that of WUC at BWP11.09/m^3 sold compared to average annual revenues of BWP10.02/m^3 sold, similar to the revenues of WUC. The higher O&M costs led to a negative gross margin for DWA of BWP1.07/m^3 sold. On the positive side, DWA cost recovery improved from 2005 onwards.
c. Capital costs of WUC amounted to BWP7.4 billion or BWP368.2 million per annum. The bulk of the capital costs related to the construction of the North-South Carrier (NSC). Detailed figures for capital expenditures of DWA were not available for the 2013 IWRM-WE Plan.

The diminishing role of DWA as a water service provider during the period 2010-2014 led to a decline of O&M expenditures of DWA and an increase of WUC's O&M expenditures (Figure 9). Total annual O&M expenditures increased rapidly from BWP0.8 billion in 201-11 to stabilise at around BWP1.2 billion per annum from 2011-12 onwards.

Figure 9: Operation & maintenance expenditures in the public water sector (current prices; BWP)



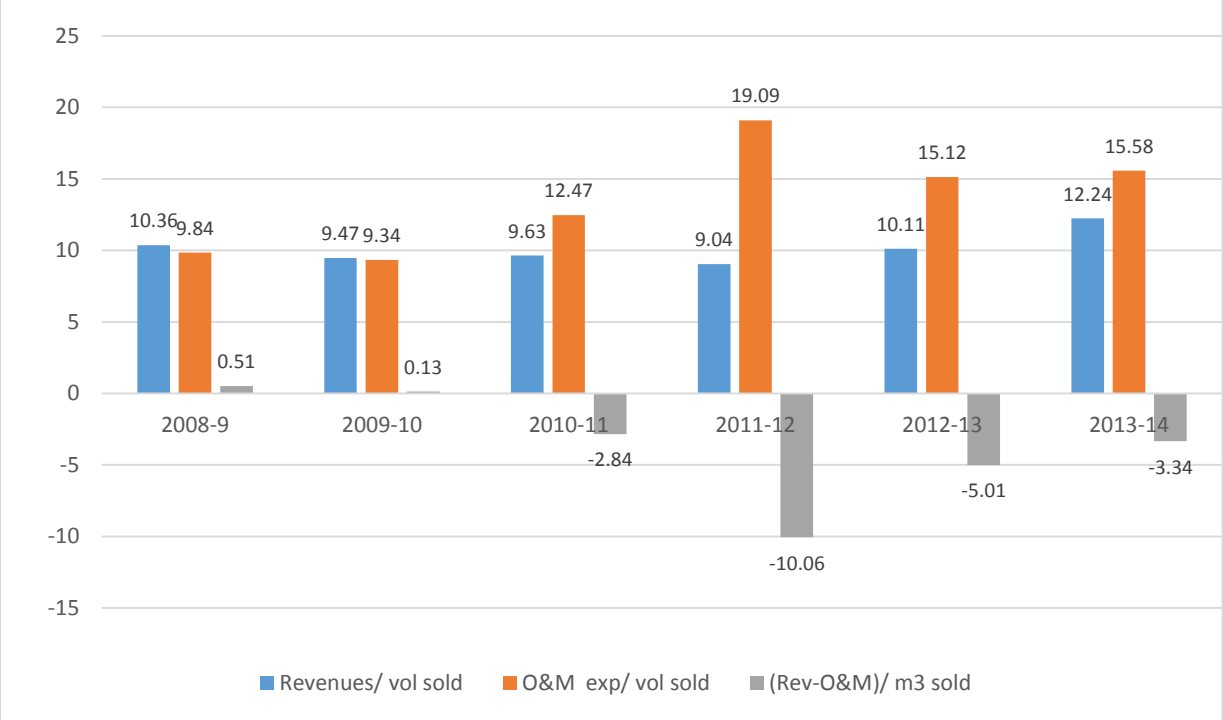
The expenditure increase may have a number of causes. Firstly, WUC took over water provision from the District Councils and the water expenditures of District Councils were not considered in earlier years due to absence of data. Secondly, WUC also assumed responsibility for wastewater treatment, the expenditures of which were not included in previous WUC and DWA expenditures. Thirdly, the take-over of all villages has necessitated an increased in O&M expenditures because of deficient water supply infrastructure and unfamiliarity with village water supply systems. Finally, water supply to remote rural villages may be inherently more expensive than water provision to urban centre.

A comparison was made of the unit revenues and O&M expenditures of WUC for the period 2008-9 to 2013-14. The results are shown in Figure 10. The unit O&M expenditures have increased to close to BWP15/ m^3 in 2013-14 while revenues lagged behind and only increased in 2013-14. As a result,

[18] By law, WUC has to recover all its costs.

the gross margin (revenues – O&M costs) rapidly deteriorated but has improved since 2012-13 (while remaining negative).

Figure 10: Unit water revenues, O&M expenditures and gross margin (current BWP)



Possible causes of the rising supply costs have been given above. The reasons for stagnation of unit revenues are likely to include:

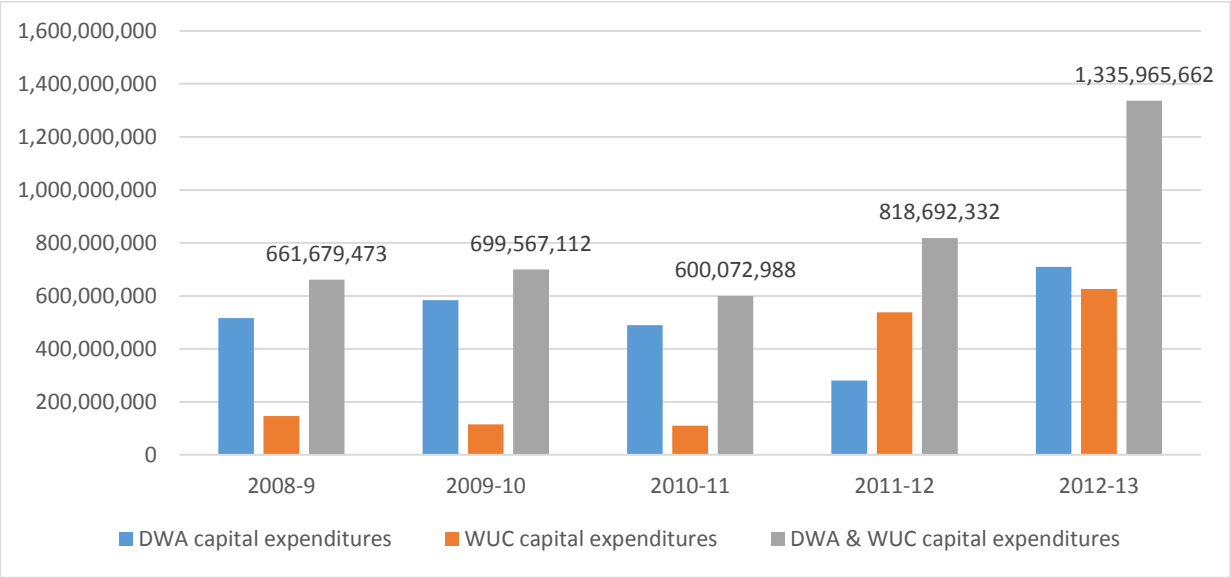
a. Billing delays especially in villages, which were recently taken over by WUC;
b. Non-payment of bills;
c. Lower revenues from government as DWA no longer purchased water for large villages at a premium tariff for distribution to businesses and households at a lower tariff;
d. No regular review of tariffs[19]; the water tariffs were only once increased during the period 2010-14 (i.e. in June 2013). A further tariff increase, which includes a wastewater treatment charge became effective 1st of April 2015.

It is encouraging to observe that the negative gross margin of WUC is getting smaller due to higher unit revenues and control of O&M unit costs. However, WUC is still far away from achieving full recovery of the O&M costs, *and there is need for close monitoring of the financial performance of WUC.*

Capital cost data were collected from WUC and DWA. Annual capital costs have risen from BWP600 million in 2010-11 to around BWP1.3 billion in 2012-13. The total capital expenditures during this period have been BWP5.6 billion with an average annual expenditure of BWP927.9 million. Figure 11 shows the trend in real capital expenditures: no increase in 2008-09 to 2011-2 but a significant in 2012-13 and 2013-14. It is likely that this increase refers to the construction of dams and to repairs of the NSC.

[19] WUC may recommend tariff adjustments, which need to be approved by the Minister of Minerals, Energy and Water Resources.

Figure 11: Trend in capital expenditures of WUC and DWA (constant 2006 prices; BWP).

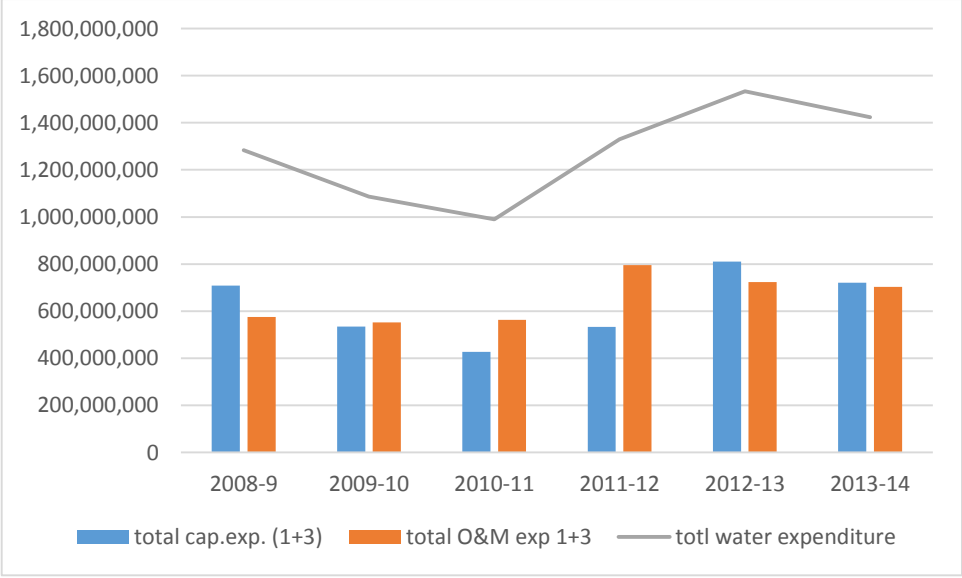


Sources: data provided by DWA and WUC.

The nature of the capital costs of DWA and WUC differs significantly and reflect the different mandates. DWA invests mostly in water infrastructure development (Figure 12), in particular reservoir development (52%) and village water and sanitation schemes (44%). Groundwater development attracted little investments during this period (4%). In contrast, 85% of WUC capital expenditures in 2013-14 went to purchasing vehicles to support their operations.

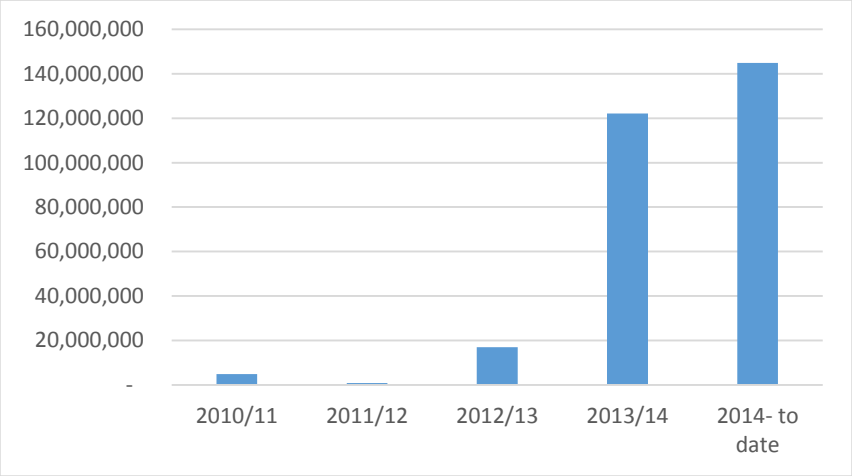
The overall costs of the water sector are high. In real terms aggregate annual water expenditures have ranged from BWP1 to 1.5 billion (Figure 12). The average annual O&M and capital expenditures are almost the same, but slight variations exists from year to year.

Figure 12: Annual aggregate O&M and capital costs (constant 2006 prices; BWP)



To assist WUC with the implementation of the WSR programme, government provides WUC with funds for *emergency expenditures*. These have not been included in the O&M and capital costs above, and are therefore an extra (temporary) expenditure category. The total budgeted costs of the emergency projects are estimated at BWP987 million, of which a third (BWP326 million) was spent between 2010/11 and November 2014. Figure 13 shows a rapid growth in annual emergency expenditures to well over BWP120 million per annum. Most of these expenditures are associated with water loss reduction activities and rehabilitation of well fields and boreholes. In brief, repair and upgrading of deficient water supply systems and projects (e.g. NSC and village reticulation systems).

Figure 13: Trend in WUC emergency projects' expenditure (Constant 2006 BWP)



Source: adapted from WUC data.

The largest portion of the emergency expenditures is spent in the Mahalapye MC (37.5%, presumably this includes the costs of the bypass in the NSC), followed by Molepolole (15.1%), Gaborone (9.3%), Ghanzi and Selibe Phikwe (7% each).

7.3 Water use efficiency

7.3.1 Introduction

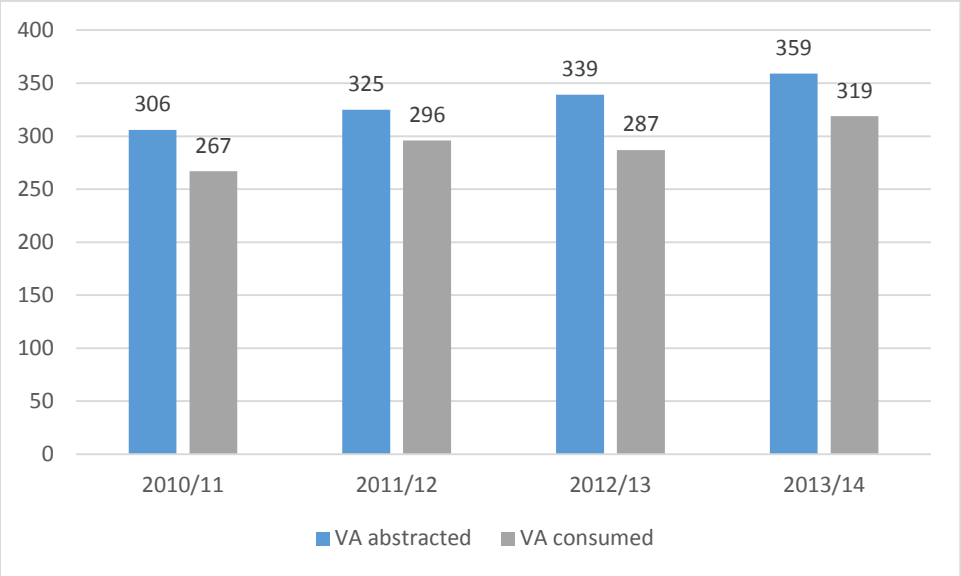
Water use efficiency can be measured in different ways, closely associated with economic and development objectives and parameters. The current assessment focuses on the value added (National Accounts), which is associated with economic growth and development, and employment creation (employment statistics), which is associated with livelihood improvements and poverty reduction. Efficiency can also be measured in future in terms of impact on food production/ security, foreign exchange and balance of trade. This requires, for example, linking the water accounts with the social accounting matrix, core welfare indicator surveys, trade and foreign exchange statistics.

7.3.1 Value added generation

Sectoral water use and consumption for the period 2010-11 to 2013-14 was linked with the value added by sector obtained from the National Accounts. The value added/m^3 by sector was calculated in constant prices (BWP 2006). The results of the analysis are shown in Figure 14. The valued added/m^3 has increased significantly since 2010-11: more economic value is produced by unit of water (decoupling of GDP and water consumption). While this may be good news from a water conservation

perspective and shows that the economy is diversifying in the right direction, it should be noted that the figures also reflect hardships for enterprises that currently suffer acute water supply constraints and interrupted water supply.

Figure 14: Trend in Botswana's average value added/m³ of water (constant 2006 BWP)



The average value added was calculated for economic sectors and the results are shown in Figure 15. Transport and communication and the transport sectors generates most value added per m^3. The energy sector generates negative value added/m^3 (BWP-482), which reflects their serious recent electricity generation challenges and on-going plant construction. The agricultural sector generates the lowest positive value added/m^3 (BWP2.7/m^3) at a long distance followed by the mining sector (BWP296/m^3). Government and the manufacturing sectors follow (BWP769/m^3 and BWP1 627/m^3 resp.). The transport and construction sectors generate the highest value added (over BWP15 000/m^3). These results confirm the results of earlier WA reports and need to be considered in the economic diversification and trade policies as well as for IWRM implementation.

A breakdown of the agricultural sector shows that water efficiency in the livestock sector is higher than in the crop production sector[20]. However, the water efficiency of the crop sector appears to improve while that of the livestock sector is rather volatile: high in 201-11, low in 2011-12 and recovering afterwards (Figure 16).

[20] The water accounts do not include rainfall for rain-fed crop production. The accounts only record water deliberate abstracted from the environment for the economy. Water abstracted for irrigation is included.

Figure 15: Average annual value added per m³ by sector (2010-11 to 2013-14; constant 2006 BWP)

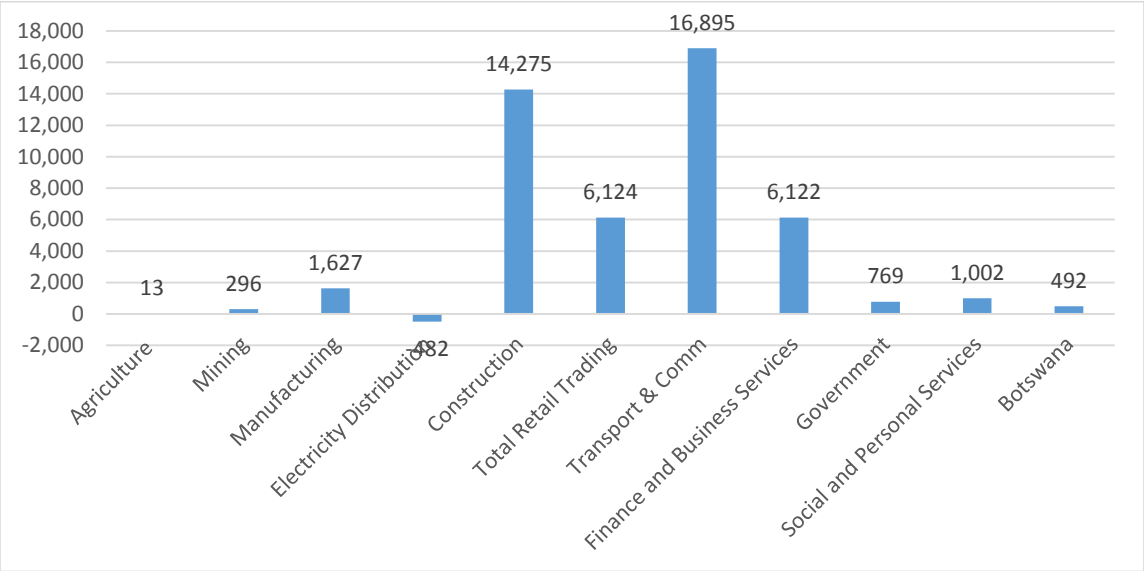
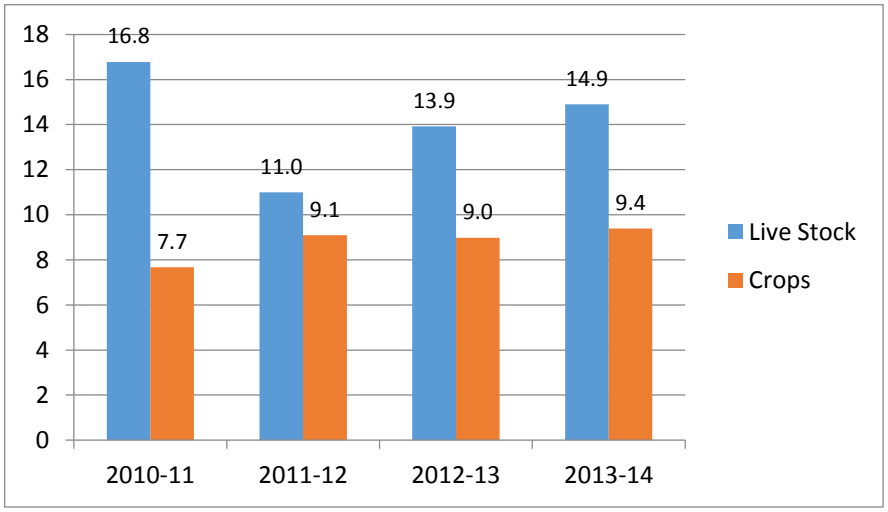


Figure 16: Value added in crop and livestock subsectors (2010-11 to 2013-14; BWP 2006)



7.3.2 Employment creation

Employment figures were constructed from three major sources, i.e. formal employment statistics, informal employment and employment in the traditional agricultural sector. Formal employment data are available on a quarterly basis by economic sector. The 2007 Informal Sector Study provides the most recent informal employment figures by sector. The latter excludes the traditional agriculture, for which data are reported in the annual Agricultural Statistics. To prepare a comprehensive employment figure, the following was assumed:

1. The proportion of informal and formal employment by economic sector of 2007 is also valid for more recent years; with this assumption, informal employment by sector was calculated for the years 2010-11 up to 2012-13 (the most recent year with formal employment figures);

2. Each agricultural holding in the traditional agricultural sector is associated with one full-time job plus the labour hired, which is reported in the Agricultural Statistics.

The employment figures were then linked with the water use and consumption by economic sector to estimate the number of jobs created per 000 m^3 used and consumed. The results are shown in Table 16. Current water consumption is associated with 4.1 jobs in the formal, informal sectors and in traditional agriculture. The construction and transport sectors create most jobs per thousand m^3 consumed, followed by wholesale and trade and to a lesser extent service sectors such as hotels and banks. The agricultural and mining sector create fewer jobs than the country's average.

Table 16: Job creation per 000 m^3 of water consumed by economic sector.

Sector	2010-11	2011-12	2012-13	2013-14	Average
Agriculture	2.2	2.2	2.4	n.a.	2.2
Mining & quarrying	0.3	0.4	0.3	n.a.	0.3
Manufacturing	15.7	12.6	13.2	n.a.	13.8
Electricity & water	40.0	32.0	12.9	n.a.	28.3
Construction	77.5	71.0	66.4	n.a.	71.7
Wholesale & retail trade	42.6	56.0	46.0	n.a.	48.2
Hotels & restaurants	22.7	20.7	22.6	n.a.	22.0
Transport	85.8	87.9	87.5	n.a.	87.0
Finance & business activities	28.8	17.0	16.6	n.a.	20.8
Education, health, social and community activities	4.0	5.2	3.3	n.a.	4.2
Central government	8.3	11.3	8.3	n.a.	9.3
Botswana	**4.1**	**4.1**	**4.1**	n.a.	**4.1**

Note: n.a. = not available

7.4 Financial water losses and water subsidies

Government uses a combination of water use charges and public funds for water resource management in settlements. WUC applies a rising block tariff with the objective of recovering its capital and operational expenditures (enshrined in the WUC Act). As shown earlier in Figure 10, this objective is currently far from being achieved.

The private sector largely finances its own water supplies outside settlements. The Water Apportionment Board (WAB) has very low charges water users for application of rights to abstract water from surface and groundwater resources; no volume related charge exist as yet[21] for the actual amount of water abstracted by self-providers.

Water charges

The WUC tariff proposals need to be approved by the Minister of MMEWR. The current tariffs are supposed to be based on full recovery of the marginal supply costs, but do not include the environmental external costs and foregone benefits that are part of environmental pricing. This objective is far from being achieved. The major objective of the rising block tariffs is to ensure that water is affordable for the basic needs of small users, who are de-facto subsidised by the large users, who pay more in the higher blocks. Rising charges also offer an incentive to conserve water as monthly

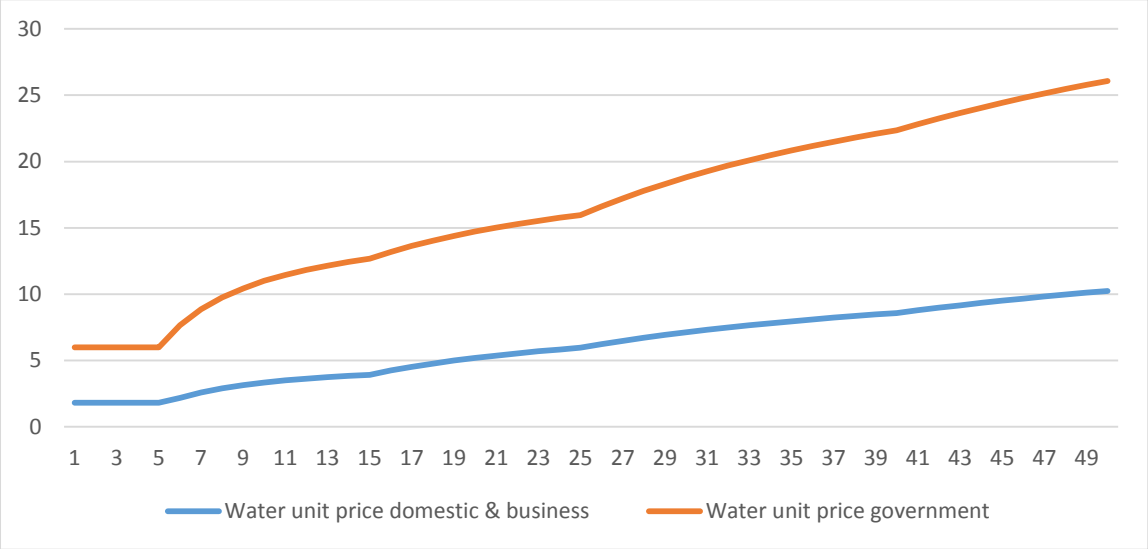
[21] Such a charge has been proposed in the draft Water Policy.

water bills escalate with higher water consumption. Currently, there are only two client groups: business and domestic customers; and central and local government. Currently, tariffs for domestic users and business still differ from area to area according to:

a. Areas that were formerly serviced by district councils (LAs);
b. Major villages that were under DWA (old DWA) as well as
c. Cities and towns (old WUC).

The tariffs for government are uniform countrywide. Tariffs still differ (but differences are being reduced) for businesses and domestic users to smoothen the transition of water provision by DWA and DCs to WUC. Government tariffs are roughly 2.5 times as high as the tariffs for domestic users and businesses (Figure 17). Assuming annual government consumption of around 10 Mm^3, this means that government pays BWP100 million while business and households would pay BWP40 million. Taking into account the average O&M costs of BWP15/m^3, it is furthermore clear that WUC makes losses on all domestic users and business with a monthly consumption of up to 50 m^3 and government institutions with a consumption of no more than 25 m^3/month.

Figure 17: Monthly average unit water tariff by level of consumption (1-50 m^3) (BWP/m^3)



In terms of area, the old WUC areas are charged more than the settlements and villages that used to be under the DWA and DCs[22]. Gaborone and Lobatse incur the highest charges because water has to be transported by NSC.

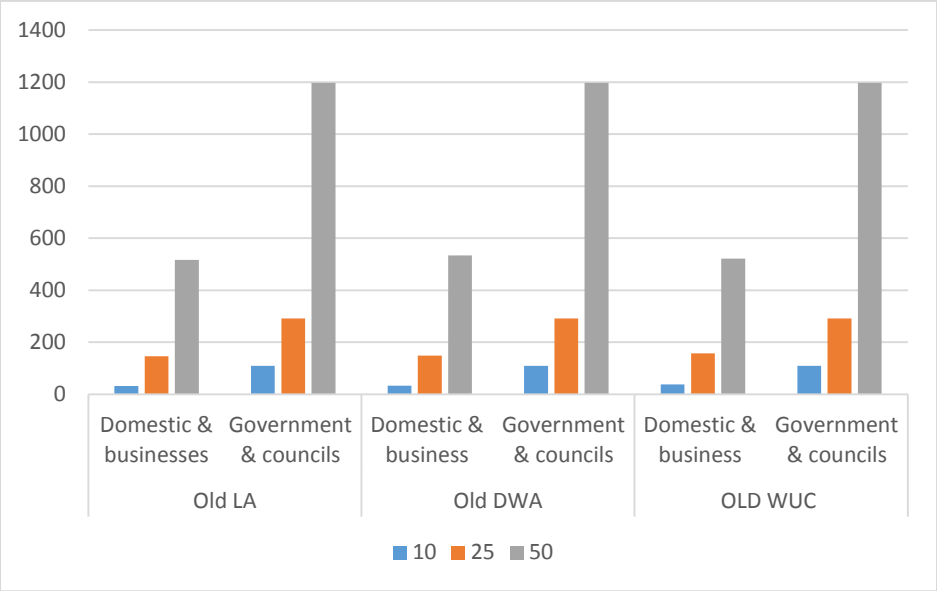
Subsidies

In order to meet the basic needs and ensure that the less privileged can afford water, the rates of the first 5 m^3 consumed per month are low and subsidised by higher charges in the upper tariff bands. Government subsidises water use in urban and rural settlements. For the self-providers, there are no general subsidies, although the Ministry of Agriculture offers subsidies for livestock water provision and some mines get cheap water from WUC (e.g. BCL). Generally, self-providers pay the user costs but do not pay a water rent.

[22] This is probably a temporary difference to gradually increase the price to a uniform nation-wide tariff.

Figures 18 shows the monthly water charge by supply area for domestic users/businesses and for government for three levels of monthly use (10 m^3, 25 m^3 and 50 m^3). Tariffs for government are uniform country-wide. Tariffs for domestic users and businesses have converged but still differ slightly.

Figure 18: Average water charges by monthly water use and supply area (BWP; 2012/13)



Note:

1. Old LA refers to rural villages; old DWA refers to 16 major villages and old WUC refers to towns and cities.
2. 10, 25 and 50 refers to average monthly bill for 10 m^3, 25 m^3 and 50 m^3 respectively.

7.5 Concluding remarks

Government offers strong financial support for the water sector through a government super tariff (around 2.5 times that of domestic and business users). In addition, it offers financial support to cover the current financial losses of WUC. The question is how long government can support this. It appears that government now holds the view that large capital investments in the water sector must be seen as public goods and paid for by public funds, while O&M expenditures should be paid for by the water users. This is currently not the case as revenues currently only cover two thirds of the O&M expenditures and the costs of wastewater treatment is not charged to water consumers. So tariffs need to improve cost recovery of water supply and wastewater treatment and O&M expenditures need to be controlled and decrease where possible as intended under the WSR programme. The WSR programme has not yet led to a decrease in the unit O&M costs. This was one of the objectives of the reforms to increase the efficiency of water service provision. This situation needs to be closely monitored and the causes of the cost increases need to be analysed. It is encouraging that the negative gross margin is becoming smaller.

The rising block tariff offers incentives for water conservation, particularly for domestic users and businesses, which use little water (e.g. less than 50 m^3/month). It would be worthwhile to consider introducing of a separate block tariff for large businesses that would encourage water conservation. Furthermore, it could be argued that water consumption for production, income and employment generation should be prioritised over luxury domestic uses such as swimming pools and excessive watering of gardens (e.g. lawns). This could be achieved by a large rise in domestic use tariff for the upper band (e.g. over 40 m^3).

8 Trend analysis

Botswana's early water accounts cover the period 1990 – 2003. These preceded the SEEA Water Accounting framework. SEEA styled water accounts date have been prepared from 2010/11 onwards. Limited comparison is possible with the findings of the early accounts and therefore caution is required with the time series. This chapter focuses on the long term trends linking the current SEEAW styled WA with the early accounts covering two decades. The results over the last four years are covered under the policy indicators (Chapter 9).

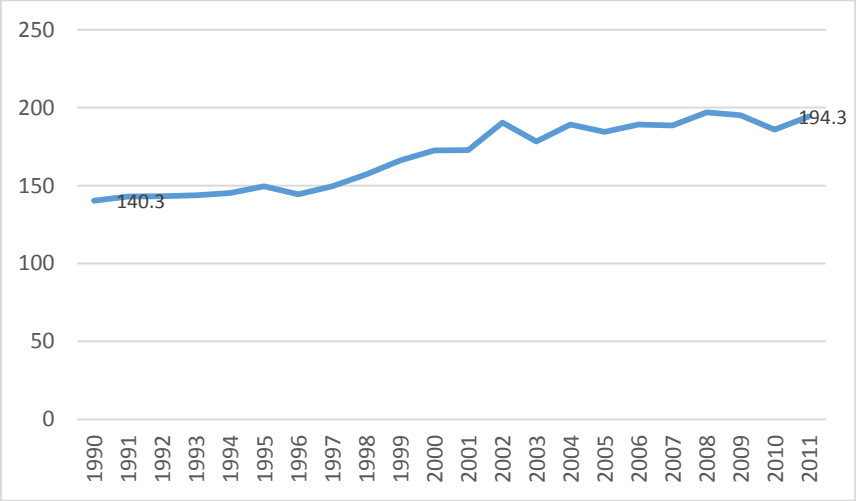
8.1 Water supply and use trends 1990 - 2013

Over the last decade, WUC has been successful in recovering operating costs largely due to low supply costs compared to revenues (DWA and CAR, 2013). Since 2009 however, operating costs have rapidly grown, and exceeded revenues in 2011/2. This situation is not sustainable, and cost control (e.g. greater O & M efficiency) and revenue boosting measures (e.g. tariff adjustment) need to be considered once more recent financial data indicate the same shortfall.

Water abstraction

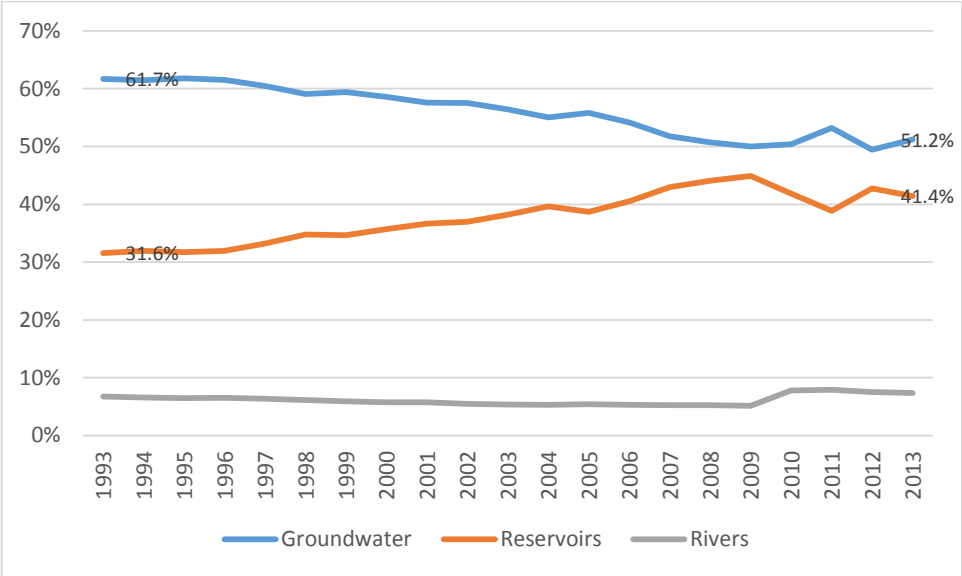
The overall trend in water abstraction is shown in Figure 19. Water abstraction has increased by a third from less than 150 Mm^3 in 1990 to close to 200 Mm^3 in 2013/14. There was a rapid increase in the period 1995-2000; but abstraction has remained largely stable since 2001/02.

Figure 19: Trend in water abstraction (Mm^3)



In terms of water resources, groundwater is the most important source of water, but its share has been decreasing in time from over 60 % to just over 50% (Figure 20). Reservoirs have become more important and now account for just over 40% of water abstraction. This figure is likely to rise further once the new reservoirs are fully incorporated in the water infrastructure network.

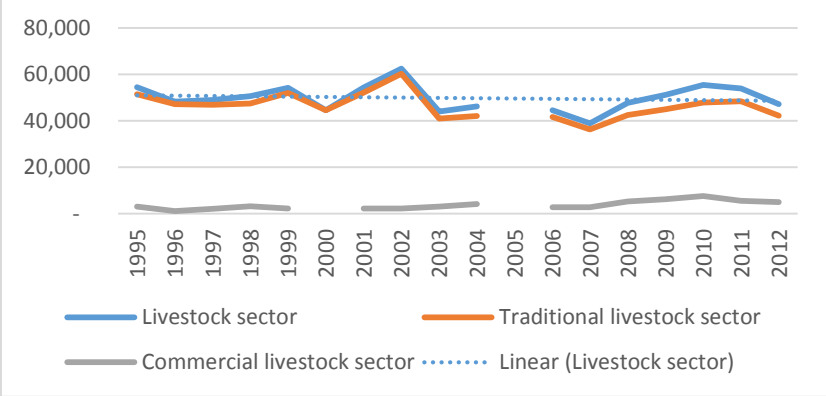
Figure 20: Trend in water abstraction by water sources (as % of total)



The long term trend for the two leading water use sectors have been further investigated and are discussed below.

The trend in livestock water abstraction (and consumption) was established for the period 1995 – 2012/13(Figure 21). There is a long term declining trend due to the decrease in livestock numbers. Water abstraction for the commercial livestock sector is small but has been growing[23].

Figure 21: Water abstraction in the livestock sector (000 m^3; 1995 – 2012/13)

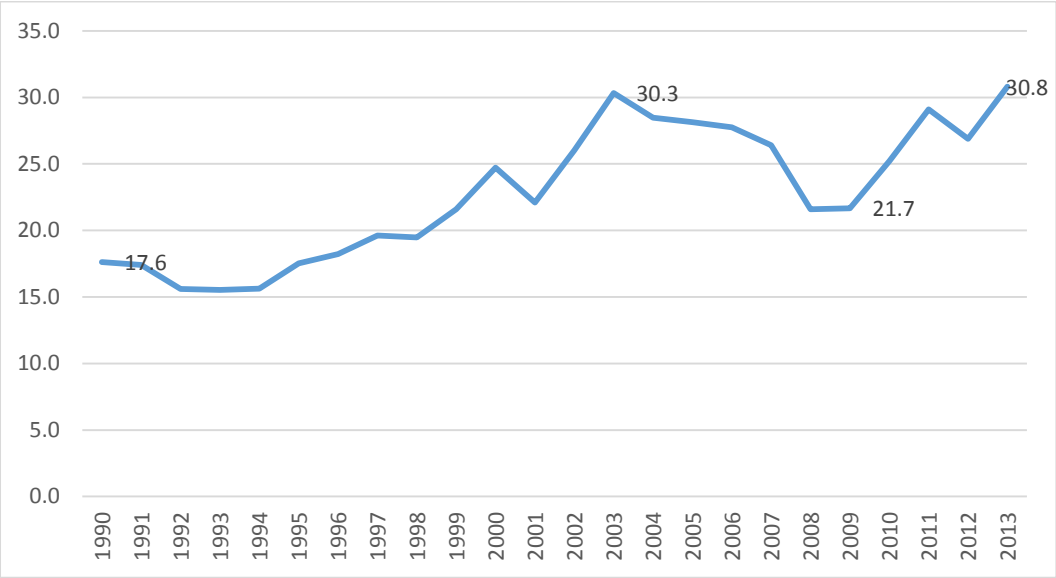


Note: estimates are based on livestock figures from the annual Agricultural Statistics (no statistics in 2000 and 2005).

The trend in water abstraction from mining is very different from the livestock trend. Abstraction for mining has almost doubled since 1990 (Figure 22). It rose rapidly during the second half of the 1990s due to expansion of diamond mining, but showed great volatility with growth during the first decade of the 21st century. Water abstraction declined to 21.7 Mm^3 in 2008 and 2009 but since increased to 30.8 Mm^3.

[23] Commercial livestock data are poor. Figures are based on a mail survey among commercial farmers and the response rates (and livestock numbers) vary greatly from year to year.

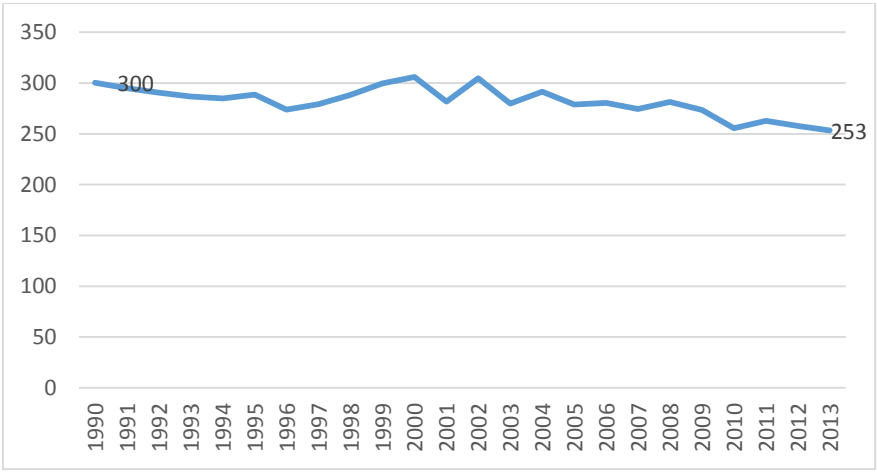
Figure 22: Trend in water abstraction by the mining sector (Mm^3)



Note: the mining sector in this figure covers diamonds copper/nickel and coal. Consumption is higher as some mines receive water from WUC.

Finally, the long-term trend of per capita water abstraction was established. Per capita water abstraction has decreased from 300 L/p/d in 1990 to 253 L/p/d in 2013 (Figure 23). This finding needs to be carefully interpreted. From a resource perspective, it could be argued that population growth and water abstraction are decoupled and people can do more with fewer water resources. From a service delivery perspective, it may also mean that water service providers cannot abstract sufficient water to meet people's needs due to water infrastructure limitations.

Figure 23: Trend in p.c. water abstraction (L/p/d)

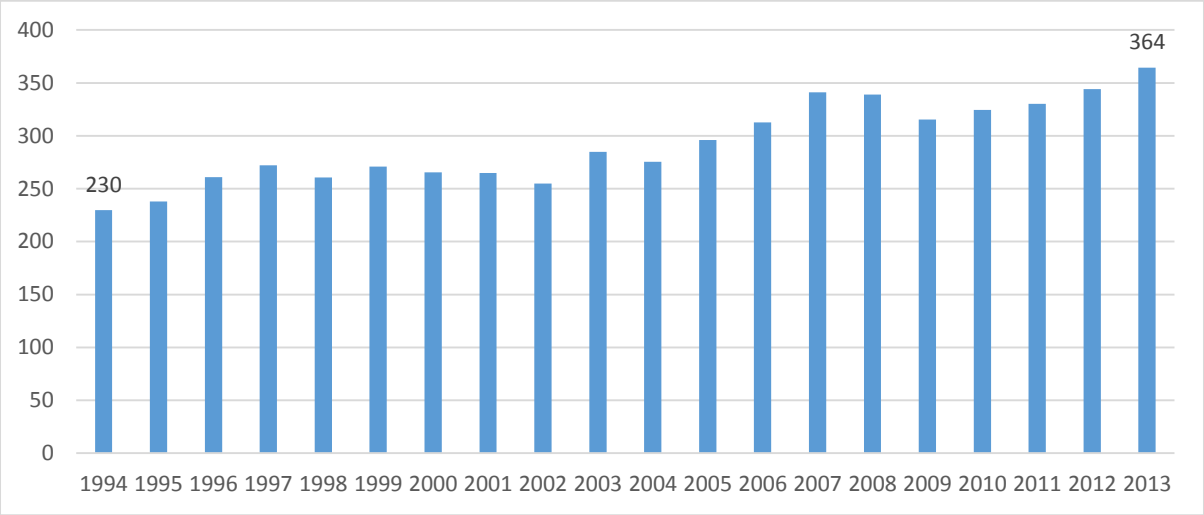


<u>Water use efficiency</u>

The long term trends in value added/ m^3 and formal employment/ thousand m^3 are shown in Figures 24 and 25 respectively.

The value added/m^3 has increased significantly in real terms from BWP 230/ m^3 to BWP364/m^3. The value added/m^3 of water has increased by 63% over the period 1994 – 2013/14. The value added/ m^3 decreased during the economic crisis of 2008-10 largely due to the large decrease in diamond revenues and negative economic growth.

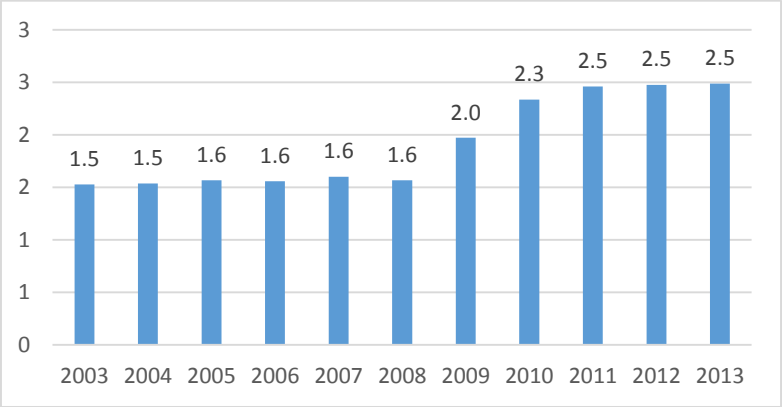
Figure 24: Trend in value added/ m^3 of abstracted water (constant 2006 BWP)



Note: caution is required with use of absolute figures due to differences in VA data sets (e.g. due to use of calendar and government years) and possible inaccuracies in the differentiation between abstraction and consumption prior to the use of the SEEA framework.

There has also been a trend towards increased formal employment per thousand m^3 (Figure 25). Currently, 1 more formal job is created than in 2003. This is probably due to the expansion of the service industries.

Figure 25: Trend in formal jobs/ 000 m^3 used



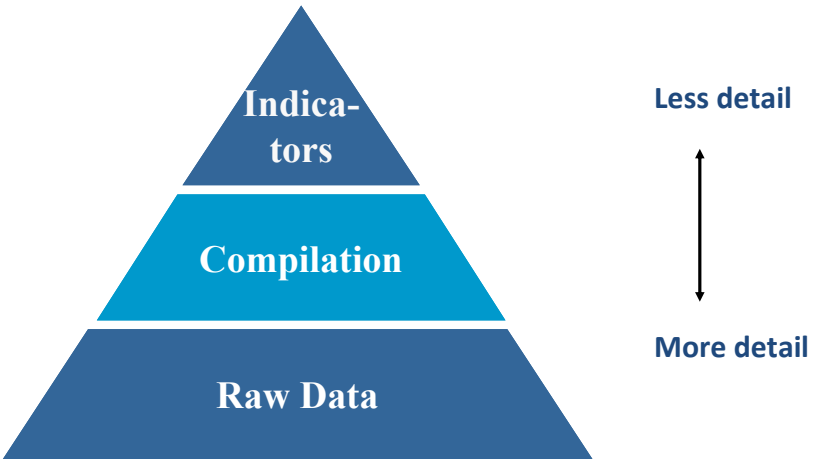
9 Water resources policy indicators

This chapter discusses the findings of the water accounts through a limited number of policy indicators. The chapter is particularly meant for resource and development planners as well as decision makers, who need the broader picture and not the detailed accounts.

9.1 Introduction

Policy makers need concise information that can assist with decision making. They do not have time to go through very detailed information. Indicators serve this purpose for natural capital accounting, and in this case water accounting. A limited number of SMART indicators (specific, measurable, attainable, relevant and time bound) are needed. UNSD has prepared guidelines for the compilation of SEEA of water accounts and statistics. Indicators aim to present processed and compiled data in summary form of a limited number of figures (Figure 26). While detail is lost, the indicators are more appealing to policy and decision makers as they focus on the issues that are most relevant to them and leave out less relevant information. Indicators related to water accounts need to inform macro-economic and development planning as well as water resource management and governance.

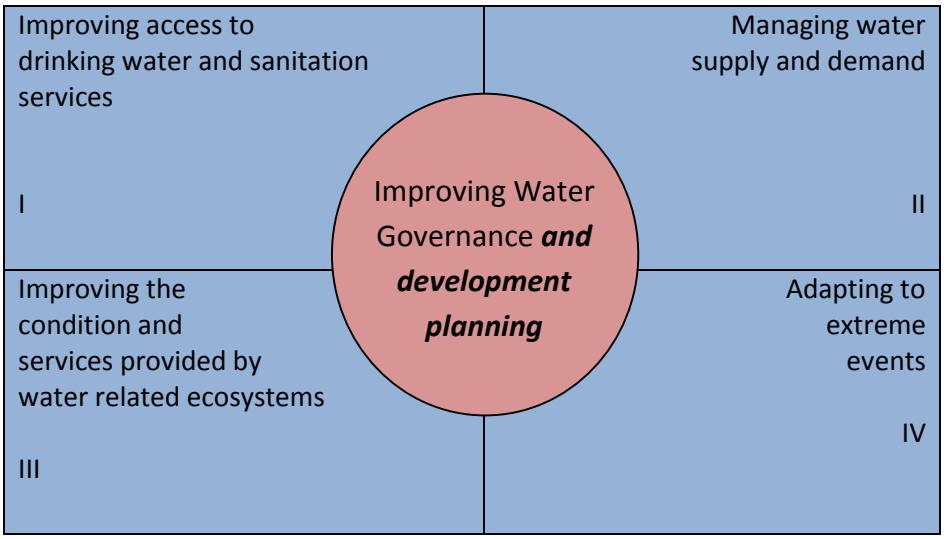
Figure 26: The information pyramid



Source: UNSD, 2014 (version 26).

The UNSD WA guidelines focus primarily on water resource management and governance and neglect macro-economic and development planning. Consequently, the next development planning dimension has been added (in bold and italics) to water governance in Figure 26 and 27 that shows the areas of indicator needs.

Figure 27: Broad grouping of water policy objectives



Source: adapted from UNSD, 2014.

The UNSD (2014) suggests possible indicators for each grouping (see appendix 4). The SEEA Water (UN, 2012) suggests a different grouping of indicators that can be derived from water accounts: a. Water resource availability; b. Water use for human activities, pressure on water resources and opportunities to increase water efficiency; c. Opportunities to increase effective water supply through return flow management re use and system losses; and d. Water cost and pricing.

During 2014/15, Botswana has developed its own policy indicators based on the above mentioned international best practices and its own policy needs and directions. Recent policy documents have the following strategic areas:

a. IWRM distinguishes ten strategic areas: increasing allocative efficiency, improving water supply & demand management, mainstreaming of IWRM in development and land use planning, enhancing the enabling IWRM environment, development of a catchment area management approach, joined management of shared water resources, capacity building IWRM & WDM, stakeholder participation in IWRM, maintaining water quality & pollution control and safeguarding of ecological water requirements and prevention of environmental degradation.
b. The draft final water policy distinguishes strategic areas: water for economic growth, domestic water supply & sanitation, water for energy, water demand management & water conservation, water for economic sectors such as agriculture, mining, industry & tourism, International cooperation, research and development, monitoring and evaluation and water for the environment

The following criteria were used to identify and select indicators. The indicators should:

1. Be relevant to policy needs for water resource management and development planning. This means for;
    a. Water resource management: indicators must be relevant for the 2013 IWRM-WE plan, draft final Water Policy, 2006 Review of NWMP and for transboundary water resource management plans for RBOs in which Botswana is a member state;

   b. Development planning: indicators must be relevant for NDP11, economic diversification drive, trade policy, poverty reduction, food & energy security;
2. Use data from existing water accounts and/or other water statistics and regularly collected (to develop the required time series);
3. Be SMART: simple, measurable, accountable, representative and transparent
4. Limited number of indicators (3-5 per key area);

Based on the above, four groups of indicators have been established for: *water availability*, *human water use and consumption*, *water efficiency*, and *water costing and pricing*. The results for these are discussed in section 9.3. First, possible indicators for the new Sustainable Development Goal 6 are outlined in section 9.2.

9.2 Policy indicators for the new Sustainable Development Goals

Efforts are on-going to replace the MGDs with global Sustainable Development Goals in 2016. One of the SDG (6) is to "*ensure availability and sustainable management of water and sanitation for all*". Countries will be required to monitor and report on the progress made towards achieving these goals. Interestingly, implementation of SEEA is SDG indicator 58. Botswana performs well with this new SDG: water and mineral accounts in place; energy and ecosystem accounts under development. The indicators associated with the 6th SDG are shown in Table 17.

Table 17: Proposed indicators for Sustainable Development Goal 6

	Proposed indicators for SDG 6	**2001**	**2011**
49	% of population with access to safely managed water services		90.5
50	% of population using safely managed sanitation services	66.7	84.7
51	% of wastewater flows treated to national standards		
52	**Complementary national indicators:**		
	% of population reporting practicing open defecation	23.3	15.3
	% of population with basic hand washing facilities at home		
	% of population connected to collective sewers or with on-site storage of wastewater		
	% of pupils enrolled in schools providing basic drinking water and adequate sanitation	Most if not all schools have water and sanitation facilities	Most if not all schools have water and sanitation facilities
	% of beneficiaries using health facilities that provide basic water and adequate sanitation	Most if not all health facilities; Good access to health facilities	Most if not all health facilities; Good access to health facilities
	% of flows of treated wastewater that are directly and safely reused (national target of 96% re-use for 2030; national master plan for wastewater and sanitation)	Very low; around 10%	Low but slight increase;
	To be developed: • Transboundary river management indicator • IWEM indicator • ICPs and capacity building in water & sanitation sector • Participation of local communities in improved water & sanitation management		

Source: Leadership Council of the Sustainable Development Solutions Network, 2015.

9.3 Policy indicators for 2010-2014

9.3.1 Water resources availability

It is important for policy and decisions makers to know how much renewable water resources are available, how much of these are internal and/or external or shared, how much of these resources are actually managed through dams and well fields, and how the amount of renewable water resources relates to population size (per capita renewable water resources).

Botswana is a semi-arid country and most of its surface water sources are shared with neighbouring countries (e.g. Okavango, Chobe-Zambezi, Limpopo and Orange) and their use and management is subject to the SADC Shared WaterCourse Protocol. Some groundwater water sources are also transboundary. The stock accounts show the actual amount of water in reservoirs in contrast to the reservoir's capacities. The actual amounts of water stored in reservoirs is often well below the capacity. The current water availability indicators are summarised below (Table 18).

Availability of total and internal renewable resources is usually based on an average for a period. The 2014 WA report showed that for the period 2000 – 2010, the average TRWR and IRWR was 12 123 Mm^3 and 3 683 Mm^3 respectively. Botswana is highly dependent on shared water resources (70%). Even IRWR (mostly rainfall) are sufficiently available, as the average Motswana has 4 983 L/d available. The real policy issue is capturing more of the RWR and making these accessible and affordable to the population.

Table 18: Policy indicators for water availability of reservoirs

Indicator	Source	Unit	2010/11	2011/12	2012/13	2013/14
Water storage capacity reservoirs	Stock accounts	Mm^3	422	422	422	462
Safe yields reservoirs	Stock accounts	Mm^3	73.5	73.5	73.5	80.1
Per capita water storage capacity	Stock accounts	L/p/d	582	571	560	602
Per capita water storage safe yields	Stock accounts	L/p/d	101	99	98	104

Note: storage excludes Ntimbale, Dikgatlhong and Thune dam because of lack of data (for details see chapter 4).

Similar indicators need to be developed for ground water, waste water and water in perennial rivers. Currently, no annual figures can be compiled due to WA data limitations. The following is however known:

a. Well fields are regularly mined, i.e. abstraction exceeds the sustainable yields.
b. The amount of wastewater is rapidly increasing due to expansion of sewerage systems and wastewater treatment facilities and population growth. Only a small portion of the outflows is currently re-used or recycled (probably in the order of 10 to 20%).

The amount of water in perennial rivers is large (around 8.7 billion m^3) but spatially restricted to the Chobe/Zambezi, Limpopo and Okavango Delta. These resources are shared with neighbouring countries and environmentally sensitive (especially the Okavango and Chobe/Zambezi). With respect to water resources availability demand analysis is done using NWMP projections and this highlights the importance of reviewing the national water master plan in the 2015/16 financial year. Completion of major dams (Dikgatlhong, Thune and Lotsane) with associated works on the NSC2 will ensure

availability till 2030. Completion of all phases of the Chobe-Zambezi scheme will increase availability period by another 20 years. It is important for water resources planners to pursue conjunctive use of ground and surface water. This will assist in meeting demand and help overcome the high evaporation loss challenges. Use of water of the Lesotho Highlands Project needs to be investigated (on-going) and the water supply for Middlepits from South Arica has been completed. This will greatly assist in meeting demand in the dry Kgalagadi district.

The indicators show a large amount of available water resources and high reliance on external water resources; most available water resources evaporate and only a fraction results in run-off or groundwater recharge. Furthermore, the safe yields of reservoirs are very low as compared to their capacity and safe yields of reservoirs well below per capita water consumptions (see below). From an IWRM perspective, there is need to develop groundwater resources, increase safe yields through interconnection ground and surface water sources and increase the efficiency of water uses. Moreover, methods of capturing a larger share of available water resources need to be investigated.

9.3.2 Water use for human activities

Understanding water use is important for policy and decision makers as it shows the pressure on water resources and productive uses along with household use. Furthermore the indicators show per capita water consumption and abstraction, which can be compared with p.c. safe reservoir yields and/or sustainable groundwater use. Importantly, it also gives insights in existing water stress situations, for example by comparing per capita water consumption with the p.c. annually stored water. Finally, the accounts provide insights in the importance of water service providers and the self-providers (whose role is often overlooked in IWRM) and in reliance on groundwater and surface water (reservoirs and rivers). The current indicators are presented below (Table 19). The abstraction and consumption figures are most important. Water use includes water abstracted by WUC as well as water delivered by WUC to its clients, (a form of double counting) and is therefore higher than the abstraction and consumption.

Table 19 shows per capita annual overall water abstraction, use and consumption. The WA figures are in this case combined with demographic data (based on the Population and Housing Census 2011). The indicators show a small decrease in the period 2010-14. Table 19 also shows the trend in daily *domestic* water consumption per capita. Per capita daily water consumption is around 50 L/p/d. It is likely that (teething) problems with the implementation of the water sector reforms have adversely affected water supply and consumption. The water crisis in south eastern Botswana have also suppressed supply and consumption.

Table 19: Water use indicators.

			2010/11	2011/12	2012/13	2013/14
Total water abstraction		**Mm^3**	197.2	194.4	194.1	194.4
Abstraction for own use		Mm^3	99.5	103.4	91.5	94.9
Abstraction for distribution		Mm^3	97.7	91	102.6	99.5
Imported water		Mm^3	7.3	7.2	7.7	6.5
Abstraction by source:						
	Groundwater	Mm^3	99.3	103.4	95.9	99.6
	Reservoirs	Mm^3	82.5	75.6	83.4	80.6
	Rivers	Mm^3	15.4	15.4	14.6	14.3
Total water consumption			172.5	171.6	178.3	169.8
Households		Mm^3	37.2	38	37.9	40.8
Government		Mm^3	15.7	11.5	16.1	11.3
Agriculture		Mm^3	74.6	74.6	66.2	66.2
Mining		Mm^3	32.4	34.6	40.8	38
Other prod. Sectors		Mm^3	12.6	12.8	17.3	13.5
Per capita:						
Abstraction		L/p/d	271.9	263.0	257.7	253.3
Consumption		L/p/d	237.9	232.1	236.7	221.3
Household water consumption		L/p/d	51.3	51.4	50.3	53.2

Water consumption over the four year period is largely stagnant. While this is a short period, the reasons need to be better understood. The stagnation may be due to drought conditions, particularly in south-eastern Botswana, with associated demand restrictions, and to the implementation challenges faced by WUC in implementing the WSR. The final draft Water Policy of 2012 gives first priority to human water consumption. Performance of WUC needs to be analysed to ensure sufficient water is supplied to meet household needs and this will be one of the key roles of the proposed Energy and Water Regulatory Body (EWRB).

The indicators show that water abstraction is just under 200 Mm^3. The self-providers play a major role in the water sector as their combined abstraction (mostly mines and farmers) exceeds that of water service providers. IWRM therefore needs to focus more on self-providers than hitherto. Botswana is reliant on groundwater as per capita total water use is 260 to 270 L/p/d, compared with safe yields from reservoirs of around 100 L/p/d. The new water reservoirs urgently need to be brought into the water transfer system to increase the safe yields and reduce the pressure on well fields, many of which are mined. Agriculture is the largest water using sector followed by the mining sector. Households use more water than the mining sector, so water demand management campaigns need to target households too. Once returns are fully incorporated into the accounts, the indicators will show how much water is abstracted from the environment and how much is returned to it through losses and discharges. While this is important information to assess how much water is left for the environment, the accounts will not specify the ecological water requirements.

The SEEA WA frameworks also provides for handling issues such as water quality and re-use/ recycling of treated wastewater. These aspects are, however, not yet covered in the Botswana water accounts, and no indicators have been developed.

9.3.3 Water costs, pricing and incentives for water conservation

Water costs and pricing are important for policy and decision makers to guide tariff setting, provide incentives for water conservation and to monitor the country's competitiveness as compared to other countries. At the moment, the main water service provider WUC is required to recover full costs. Government subsidises the household and private sector by paying higher water tariffs than the latter. Most self-providers pay their own capital and recurrent expenditures; some farmers benefit from subsidies (e.g. irrigation and livestock). Rising costs without tariff increases burdens government finances. Indicators for the expenditures and revenues in the public water sector are presented in Table 20.

Table 20: Indicators for water costs and revenues in the public sector

		2010/11	2011/12	2012/13	2013/14
O&M expenditures	O&M/ m^3 abstracted	9.54	12.83	11.99	12.37
	O&M/ m^3 sold	12.47	19.09	15.12	15.58
Revenues	Revenues/m^3 abstracted	7.36	6.09	8.02	9.72
	Revenues/m^3 sold	9.63	9.04	10.11	12.24
% O&M cost recovery		77.1%	47.5%	66.9%	78.6%
Non revenue water	NRW as % of abstraction	23.6%	32.8%	20.7%	20.6%
Capital expenditures of the public sector	BWP million	600.1	818.7	1,336.0	1,236.8

Basic water needs to be affordable to all but this needs to be balanced with operational efficiency of and cost recovery by WUC. The situation needs to be closely monitored and further analysis is needed to assess water delivery efficiency of WUC, appropriate tariffs and possible (targeted) government subsidies[24]. More analysis and possible adjustment of tariffs for major consumers need to be done. This should be balanced off by contribution of this sectors to the economy. Incentives have to be given for efficient use of water and promotion of reusing technologies.

The current water accounts provide some information on the recurrent expenditures and revenues of WUC and DWA (provided water to major villages). The indicators show the following:

- ✓ For DWA, the average revenues/m^3 used was BWP 10.05 compared to recurrent expenditures of BWP11.06, leading to a shortfall of 10% (period 2002/3- 2010/11).
- ✓ For WUC, the average revenues/ m^3 sold BWP 10.14 compared to recurrent expenditures of BWP5.43 (period 2002/3 – 2010/11), leading to a considerable surplus of 87%. However, WUC revenues dropped below the rising recurrent costs in 2011-12.

The indicators show that WUC provided water in urban areas at around half of the recurrent costs of DWA, which supplied large villages. The water sector reforms, which make WUC responsible for water supply countrywide, seems to be justified. However, the recurrent expenditures of WUC have sharply increased since the implementation of the water sector reforms, while the revenues dropped, leading to financial losses. This is unsustainable and needs to be urgently addressed (see section 10.2).

[24] For example, there seems to be no justification as to why government tariffs are much higher than those for businesses and households.

Due to inadequate data, no indicators can be populated for the private sector, and yet it is known that water costs are a significant production costs for the mining and livestock sectors. The following indicators would be important:

a. O&M expenditures
b. Capital expenditures;
c. Water losses.

9.3.4 Water use efficiency indicators

Water efficiency indicators have been prepared for value added and for employment. Value added figures are available from the National Accounts. Employment data are available from the Employment Statistics (formal employment only). Additional assumptions were made to estimate total employment:

- ✓ Informal sector employment is the same percentage of formal employment as in 200 (last year for which informal employment figures are available). Informal sector employment excludes the traditional agriculture sector; therefore
- ✓ Employment in the traditional agricultural sector has been estimated at one full time job per agricultural holding.

The indicators are shown in Table 21. The value added per m^3 is increasing (which is a long term trend, see chapter 8). Employment creation per thousand m^3 is largely stable.

Table 21: Value added and employment creation per unit of water (2010-2014)

Variable	Sub variable	Unit	2010/11	2011/12	2012/13	2013/14
Value added	VA abstracted water prod. use	BP constant 2006/m^3	317	342	358	377
	VA consumed water prod. use	BP constant 2006/m^3	446	481	476	549
	VA all abstracted water for productive use	BP constant 2006/m^3	350	374	375	417
	VA all consumed water	BP constant 2006/m^3	446	481	476	549
Employment	Formal employment	Jobs/000 m^3 consumed	2.3	2.5	2.5	2.5
	All employment	Jobs/ 000m^3 consumed	4.1	4.1	4.1	4.1

Note: water for productive use excludes domestic use and water imports.

Water losses are only known for WUC. The losses are around 25% as shown in Table 22. The low losses for 2012/13 cannot easily be explained and are due to high amounts of water distributed to government and mining in this particular year. Poor data quality may be among the causes (see earlier discussion in chapter 5).

Table 22: Estimated water losses by WUC (as % of abstraction & imports)

	2010/11	2011/12	2012/13	2013/14
Water losses	25.3	25.1	17.6	25.2

Taking into account water scarcity in the country, the WAB needs to start allocating productive water rights based on value added by an economic sector (and possibly on other indicators such as employment generation and poverty reduction). Economic sectors need to account for water use when they apply for additional water rights. This will boost economic growth. More analysis on non-formal employment especially in the agricultural sector to ensure more accurate reporting of the value added. Inspection function and random surveys of sectors is needed to see how efficient they are. The SIWI-DWA partnership project on raw water abstraction strategy will go a long way in laying the ground and assisting in this endeavour.

10 Water accounting institutional capacity and setup

This chapter discusses the institutionalisation of Botswana's water accounts together with the capacity to maintain, update and expand the accounts and utilise the findings in development planning, sectoral and water management policies.

10.1 Introduction

Proper institutionalisation of water accounting is arguably the most important component to sustain the preparation and expansion of water accounts in future. History has made this clear in Botswana as earlier water accounting efforts remained largely 'projects' without an adequate institutional base. As a result, they were one-off exercises that were not maintained.

Botswana is now in a better position to institutionalise the WA due to several recent developments. Firstly, the water sector reforms (2009 – 2014) mandated the Department of Water Affairs to assume responsibility for (integrated) water resource management. WA are an important WRM tool as indicated in the 2013 IWRM-WE Plan, and the draft Water Policy and the 2013 IWRM-WE Plan. These documents indicate that WA are needed and should be housed at DWA. Secondly, NCA has high level policy support in Botswana through the Presidential signing of the May 2012 Gaborone Declaration on Sustainability in Africa and through two 2012 meetings of the Botswana Economic Advisory Council (BEAC), which prioritised the development of water accounts as the first activity of the WAVES Botswana programme (CAR and Econsult, 2012). These developments offer a favourable environment for successful institutionalisation of the WA.

10.2 Post WSR DWA

The new DWA mandate may be described as: "*to develop, manage, and protect the country's water resources for sustainable contribution to the growth of the economy*." This mandate includes reducing vulnerability of the water resources systems to hydrologic variability and climate change through comprehensive planning and risk management. The new organizational structure proposed is designed for a forward-looking, modern organization staffed and equipped to address the water resources challenges of the 21st Century. Specifically, the new Department Water Affairs will plan the following roles in the sector:

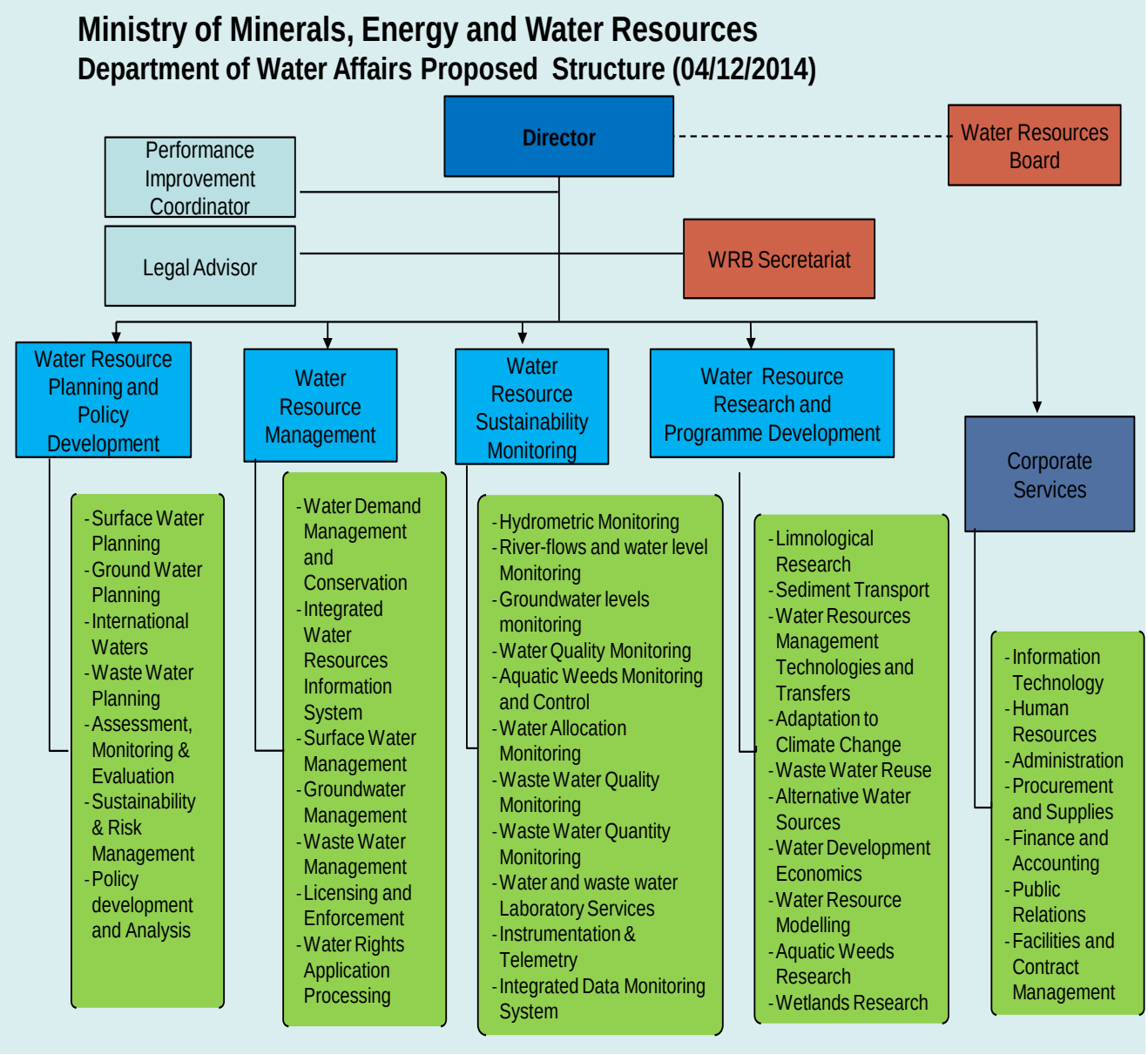
a. Strategic planning: this requires an on-going assessment of the economic role of water in the country's development and planning efforts;
b. Analysis and research: as Botswana is a water scarce country, research and development is needed to meet the challenges faced by the urban and rural population, as well as mining and industry. DWA will offer research support to the Water Resources Board (WRB);
c. Management. The limited water resources of the country need active demand management as well as water use and abstraction control;
d. Development and Services. The new DWA will need a service oriented approach working with the water-using sectors (agriculture, mining and industry, energy, etc.) to ensure that water is used efficiently while the resources are managed in a sustainable manner.

At the completion of this phase of the WSR programme, the 'new' DWA will assume a major role in water resources management and will focus on water resources policy, planning, development and monitoring; provide strategic technical services for investigations, studies, and special projects; operate the water laboratory; and serve as the Technical Secretariat for the new Water Resources

Council. DWA will transfer its water supply service delivery responsibilities to the Water Utility Corporation (WUC).

The guiding principles for the new DWA structure are drawn from the WSR process. The proposed DWA structure allows the Department to focus on a few critical areas of direct significance to the sustainable management of water resources in Botswana. The DWA will consist of an office of the Director with ancillary support units, three Directorates, the Department of Corporate Services, and the Secretariat to the Water Resources Council. The proposed organisational structure is shown in Figure 28.

Figure 28: Proposed DWA organisational structure (December 2014)



So far, the interim Water Unit has been set up headed by Senior Water Resources Engineer and assisted by four Water Resources Engineers, housed under Hydrology and Water Resources division of the DWA. The interim WA Unit will rely on support from data suppliers such as Statistics Botswana, Ministry of Agriculture, WUC and the private sector. The interim WA unit will be housed under Water Resources Planning and Policy Development but will also work closely with Water Resources Research and Programme Development.

The present activities undertaken by the interim Water Accounting Unit (WAU) with the assistance of CAR include data collecting from WUC and enterprises that abstract water for their own use (e.g. mines and agriculture), up-dating the water accounts (physical supply and use accounts), as discussed in this report, working towards monetary accounts with CAR, planning to develop groundwater stock accounts, and carrying out policy analysis of the WA results (based on WA policy indicators). Furthermore, the WAU liaises with other stakeholders to collect the required data and to share the findings and policy recommendations. Furthermore, the unit produces policy briefs with CAR and is preparing a survey among irrigation farmers together with the Ministry of Agriculture to fill data gaps in the irrigation sub-sector. The interim WAU is expected to cooperate with the DWA-SIWI[25] partnership (2015-16) that focuses on raw water abstraction monitoring and pricing, wastewater re-use and recycling and catchment area water management. This cooperation is expected to enhance Botswana's water accounts and vice versa the WA will assist the DWA-SIWI partnership programme.

10.3 Data collection structure

The main sources of data for the water accounts are the water service provider (WUC), water self-providers (mines, farmers and construction and tourist companies operating outside settlements), Statistics Botswana and line ministries/ departments (Ministry of Agriculture, Crop Production, and Ministry of Mineral, Energy and water Resources, dep. of Mines). Data should be annually collected by DWA based on an agreed template with the data providers. It is important that WUC will incorporate an economic classification in its client's base. This will increase the accuracy and consistency of the economic classification, and reduced the work load significantly[13]. DWA will verify the data and enter them into the accounting framework and Excel spread sheets. The next step is to annually analyse the findings and policy implications thereof with the water sectors and development planning stakeholders. It will liaise with other departments and ministries to discuss the policy implications and ensure that the results are integrated into development planning, sectoral planning (e.g. agriculture, mining and tourism) as well as thematic planning such as trade, economic diversification, poverty reduction. In addition, the Unit will closely liaise with other capital accounting units such as the Mineral Accounting Unit and the Energy Accounting Unit. The linkages are shown in Figure 34.

10.4 Organisational structure for Water Accounting and stakeholder involvement

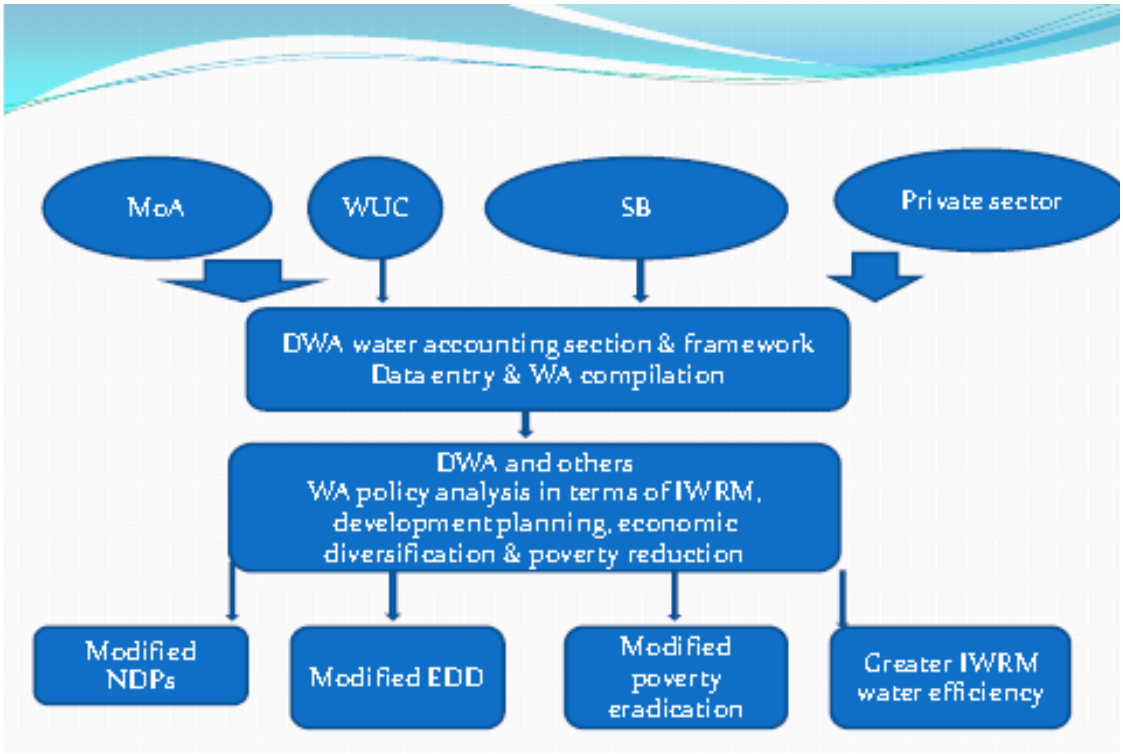
With its water management mandate, DWA needs to be the lead and coordinating institution for water accounting. This is consistent with the draft Water Policy and the IWRM-WE Plan 2013 - 2030. DWA plans to establish a water accounting unit with four staff (2 junior staff, 1 senior staff and a supervisor). This unit will be administratively supported to ensure its efficient operation. The WA Unit staff currently has mostly engineering expertise but will in future broaden its expertise base with socio- economic and environmental economic expertise and IWRM. In other words, the unit will become multidisciplinary.

[25] Stockholm International Water Institute.

As stated above (Figure 29, the Water Accounting Unit is closely linked to and supported by inter-ministerial and interdepartmental working groups, which are responsible for the regular supply of data, expansion of the WA and the policy analysis of the results. The unit also needs to maintain regular contacts with the private sector and civil society. The following working groups (WG) have been established:

a. *Water management regions.* This WG deals mostly with regional data on water abstraction, consumption, losses, costs and revenues from WUC and self-providers. The WG should have members from DW, WUC, SB, Ministry of Agriculture and mines as well as from major self-providers; *Irrigation*. This WG will deal with water abstraction, use and consumption for irrigation. While water use is modest at present, it is expected to grow in future. The WG members consist of DWA, WUC, MoA (irrigation & horticulture), SB, Ministry of Lands and WAB/WRB;

Figure 29: Institutional linkages and linkages with policy and planning areas



Source: DWA and CAR, 2014.

b. *Mining sector*. This WG will deal with water abstraction and use by the mining sector (mostly self-providers). The WG members will be DWA, WUC, Dep. of Mines, mining companies, SB, WAB/WRB and Ministry of Lands; and
c. *Water stock accounts*. This WG mostly deals with stock accounts, initially of dams later also of aquifers. The WG members consist of DWA, WUC, SB and DGS.

In addition, a working group will be established to analyse policy implications of WA findings. This WG is aims specifically to regular review the results of WA and their implications for development

planning, IWRM and land use planning. The members include government (e.g. DWA, WUC, MFDP, Ministry of Lands, MoA, and Department of Mines), private sector and civil society.

As part of the Water Sector Reforms, the Department has been undergoing through rigorous restructuring and one of the deliverables is the development and approval of the water resources management organisational structure and up to date the new DWA-structure has been developed and submitted to the Directorate of Public Service Management for consideration. Once approved the water accounts unit will be made permanent and fully established and resourced. It is anticipated that the structure would be approved by May 2015.

Regular meetings need to be held by the MMEWR with the main stakeholders to ensure that data are provided to DWA, review progress and resolve any challenges that emerge. The DPS- MMEWR and the MFDP WAVES Coordinating Unit will discuss progress in the WAVES Steering Committee that is established and chaired by MFDP. The Steering Committee guides the overall WAVES activities in Botswana, ensures institutionalization of water accounts and other accounts that will be developed and ensures that policy discussions and recommendations emanating from the NCA findings are incorporated in development planning, in particular the preparation of NDP11 and the work of the four thematic working groups formed by NSO.

10.5 Work plan for future Water Accounting activities

The indicative plan for future WA of the WA Unit is shown in Figure 35.

Figure 30: Work plan of the interim Water Accounting Unit

Item	Immediate term 2014/15	Short term 2015/16	Medium term 2016/2017 and beyond

Activities	• Annual update of the accounts (2013/14 and 2014/15)
	• Irrigation surveys with MoA
	• Feasibility note on groundwater stock accounts
	• Participate in development of 2 policy briefs
	• Establish Water Accounting Unit
		• Annual update of the accounts (2015/16), more automated economic classification
		• Optimized irrigation data with survey results
		• Collaboration with WAB on self providers data (Mines e.t.c)
		• Initial works on groundwater stocks
		• Use of GIS for the accounts including modeling
		  • Spatial and temporal issues in WA
		• Monetary accounts
		• More participation in development of additional policy briefs
			• Automated annual update and classification of the accounts in collaboration with SB
			• Develop atleast 1 policy brief
			• Initial setup for
			  • Emission accounts
			  • Quality accounts
			  • Hybrid and economic accounts
			  • Use of the river basin as geographic reference....SIWI-DWA partnership linkage
			  • soil water and rainwater as per the Australian model
			• Pilot raw water abstraction monitoring in collaboration with DWA-SIWI partnership

Development, Training and capacity building	• Hands on training by CAR • Short courses on NCA and SEEA-Water • Short training on data management with excel • Knowledge sharing with other accounting units • Monetary accounts	• Interaction and knowledge sharing with other NCA teams within the country and the region • Long term training on NCA • Benchmarking with established NCA countries • GIS work on Spatial classification of the accounts	• Activity participation in local, regional and international activities and trainings on NCA and WA

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Appendix 1: Physical water supply and use tables 2010-11 and 2011-12 (in thousand m^3)

2010-11 Physical use table	Agriculture	Mining	Manufacturing	Electricity	Water service providers	Construction	Trade	Hotels	Transport	Finance	Social services	Government	Int. organs	Agric. & industries	HH	Rest of the world	Grand total
Abstraction for own use	74,315	25,167			15									99,498			99,498
Abstraction for distribution					90,410									90,410		7,300	97,710
1. Total abstraction	74,315	25,167	-		90,425	-	-	-	-	-	-	-	-	189,907	-	7,300	197,207
Reservoir water	12,470	-			62,727									75,197		7,300	82,497
Ground water	48,841	25,167			25,317									99,325			99,325
River water	13,004				2,381									15,385			15,385
Abstraction from water resources	74,315	25,167	-		90,425	-	-	-	-	-	-	-	-	189,907		7,300	197,207
2. Water from other economic sectors	264	7,275	2,758	80		369	1,645	786	258	1,329	5,254	15,686	104	35,809	37,218		73,027
Total use of water (1+2)	74,578	32,442	2,758	80	90,425	369	1,645	786	258	1,329	5,254	15,686	104	225,716	37,218	7,300	270,234
Physical supply table																	
4. Supply of water to other economic units					65,727									65,727		7,300	73,027
5. Total returns					24,683									24,683			24,683
Groundwater					24,683									24,683			24,683

6.Total supply of water (=4+5)	-	-	-	-	90,410	-	-	-	-	-	-	-	-	90,410	-	7,300	97,710
7. Consumption	**74,578**	**32,442**	**2,758**	**80**	**15**	**369**	**1,645**	**786**	**258**	**1,329**	**5,254**	**15,686**	**104**	**135,306**	**37,218**	**-**	**172,524**

2011/12 Physical use table	Agric	Mining	Manufacturing	Electricity	Water service providers	Construction	Trade	Hotels	Transport	Finance	Social services	Govt	Int. organs	Agric & industries	HH	Rest of the world	Grand total
Abstraction for own use	74,315	29,108			25									103,448			103,448
Abstraction for distribution					83,715									83,715		7,200	90,915
1. Total abstraction	74,315	29,108	-	-	83,740	-	-	-	-	-	-	-	-	187,164	-	7,200	194,364
Reservoir water	12,470	-			55,935									68,405		7,200	75,605
Ground water	48,841	29,033			25,492									103,366			103,366
River water	13,004	75			2,313									15,392			15,392
Abstraction from water resources	74,315	29,108	-	-	83,740	-	-	-	-	-	-	-	-	187,164		7,200	194,364
2. Water from other economic sectors	289	5,467	3,446	103		405	1,259	872	258	2,254	3,983	11,563	156	30,054	38,048		68,103
Total use of water (1+2)	74,604	34,575	3,446	103	83,740	405	1,259	872	258	2,254	3,983	11,563	156	217,218	38,048	7,200	262,466
Physical supply table																	
4. Supply of water to other economic units					60,903									60,903		7,200	68,103
5. Total returns					22,813									22,813			22,813
5.a.1. Surface water														-			-
5.a.2. Groundwater					22,813									22,813			22,813
6.Total supply of water (=4+5)	-	-	-	-	83,715	-	-	-	-	-	-	-	-	83,715	-	7,200	90,915
7. Consumption	**74,604**	**34,575**	**3,446**	**103**	**25**	**405**	**1,259**	**872**	**258**	**2,254**	**3,983**	**11,563**	**156**	**133,503**	**38,048**	**-**	**171,551**

Appendix 2: Template for data requirements from stakeholders

A2.1 Mines

Variable	Detail - breakdown	Source:
Water abstraction for own use (monthly) in m^3	1. Groundwater (well fields): fresh and saline water 2.Fissure/ pit water 3.Surface water (river – reservoir)	Annual WAB report
Water purchases from WUC in m^3 and BWP)	a.Potable Water b.Raw water	Annual WAB report
Sales of water (in m^3 and BWP)	To: i.WUC ii- x.Economic sectors (ISIC code)	Annual WAB report
Return flows	1.Return flow into sewerage system leaving mining area 2.Recharge of ground water 3.Run-off surface water	Annual WAB report
Annual O&M expenditures on water provision (in BWP)		Annual WAB report
Annual capital expenditures – investment in water infrastructure (in BWP)		Annual WAB report
Production by month in carats, tons etc. and value (BWP)		Annual WAB report

A2.2 WUC

Variable	Level of details
PHYSICAL SUPPLY ACCOUNT	
Water abstraction for own use (monthly) in m^3	1.Groundwater (well fields & boreholes) 2.River abstraction 3.Reservoir abstraction 4. Treated wastewater
Water purchases or donation from elsewhere in Botswana (m^3 and BWP)	
Water imports (Mm^3 and BWP)	
Amount of treated water (potable; m^3)	
PHYSICAL FLOW ACCOUNTS	
Water sales in Mm^3 and BWP	Potable water by sector Raw water by sector
Non revenue water – water losses in m^3	Total and by MC
Wastewater inflow into WWTW (m^3)	By WWTW and total
Outflows from WWTW (m^3)	By WWTW and total
Re-use of WWTW outflows in m^3	By WWTW and total
Recycling of WWTW outflows in m^3	By WWTW and total
MONETARY ACCOUNTS	
O&M expenditures water abstraction = treatment and distribution by month in BWP	By MC and total
Capital expenditures water abstraction & distribution by month or government year in BWP	By MC and total
Emergency expenditures by month or government year in BWP	By MC and total
O&M expenditure wastewater treatment by month or government year in BWP	By MC and total

Capital expenditures wastewater treatment by month or government year in BWP	By MC and total

A2.3 Irrigation farmers

Variable	Details
Irrigated land by month or gov. year in ha	Serviced irrigated land, Annual irrigated land Number of crop cycles
Irrigation technique	Drip irrigation, Pivot irrigation, Sprinkler, Furrow & Other
Water sources abstracted for own use in m^3 by month or gov. year	Boreholes, Reservoir, River & Treated wastewater
Water supplied by service providers by month or gov. year	WUC Other sectors (specify ISIC code)
Water leaving the irrigation farm	Surface run-off, Groundwater recharge?
O&M water expenditures in BWP by month or gov. year	
Capital water expenditures in BWP by month or gov. year	
Production by crop by month & BWP	

Appendix 3: Possible policy indicators derived from water accounts

	Group	Physical WA	Monetary WA
1	**Improving access to drinking water and sanitation services**	• The amount of water supplied by utilities. • The proportion of water supplied that is used by households. • The amount of water used by households. • The losses of water in the water supply networks (or unaccounted for water).	• The sales of water and wastewater. • The price of water and wastewater paid by users. • Household expenses related to income for water and wastewater. • The expenditures on different goods and services necessary for the activities of water supply and sewerage. •
2	**Managing water supply and demand**	• The proportion of renewable inland water resources that are abstracted for the whole economy. • The proportion of total abstractions for the different economic activities. • The amount of wastewater generated, the proportion that is treated, and the proportion that is reused	• Investments required for water supply, including irrigation and drinking water.
3	**Improving the condition and services provided by water related ecosystems**	• The waterborne pollution generated by the economy, as well as the pollution removed by wastewater treatment plants, and the pollution reaching the inland water resources. • Water quality indicators • Actual renewable water resources based on the ecosystem carrying capacity and regulating services. • Ecosystem carrying capacity to absorb the different type of pollutants. • River fragmentation indicators. • Wetland extent. • Environmental flows. • Mean species abundance.	
4	**Adapting to extreme events**	• Economic losses due to hydro-meteorological events. • Actual renewable water resources based on the ecosystem carrying capacity and regulatory services. • Ecosystem carrying capacity to absorb the different type of pollutants. • Environmental flows	
5	**Improving water governance & development planning**	All of the above ***& value added/m3 by sector and for the entire country***	

Source: adapted from UNSD, 2014.