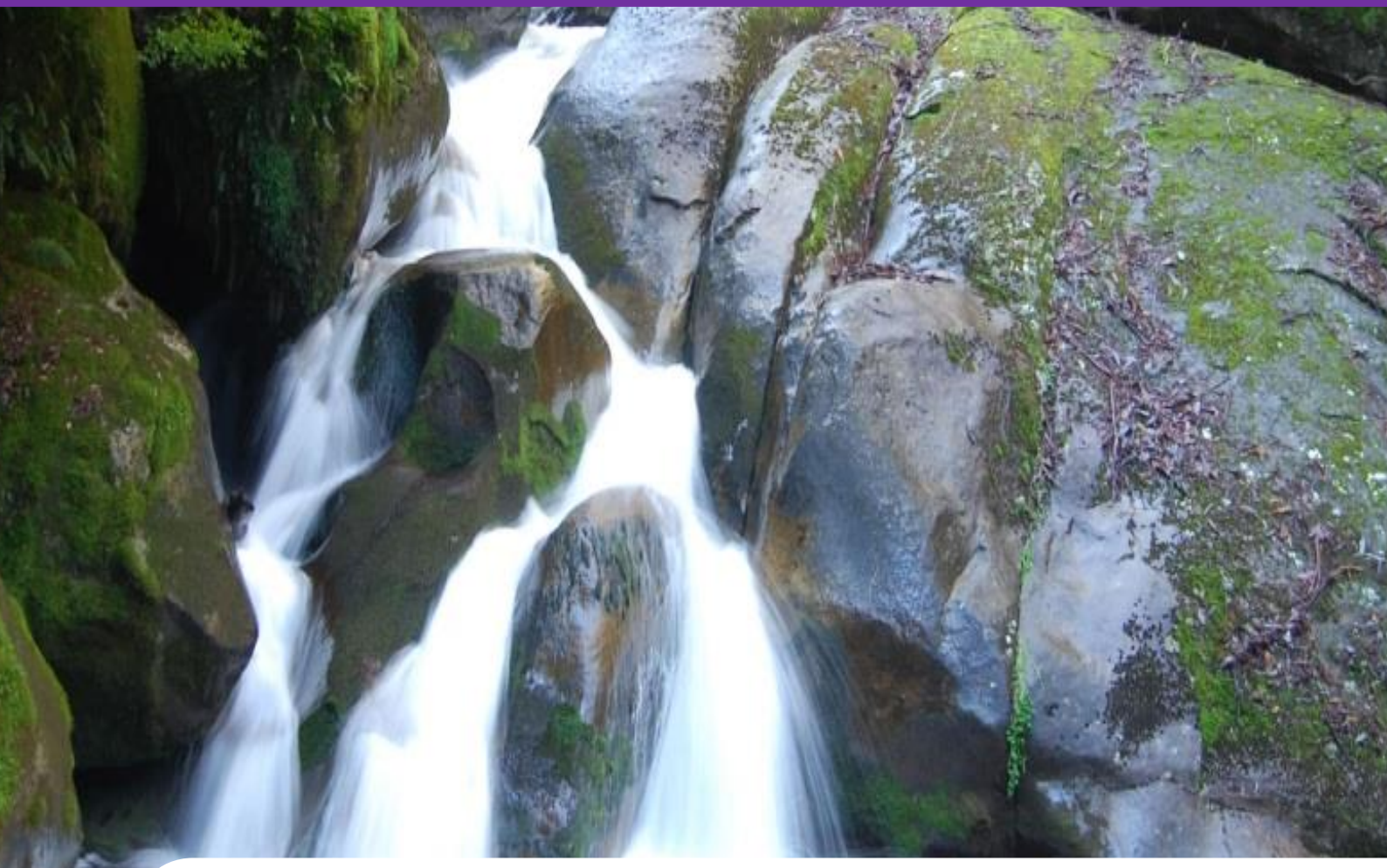
Botswana

Country Water Resource Profile



nepad water centres of excellence

NEPAD Planning and Coordinating Agency
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Botswana

Country Water Resource Profile

NEPAD Planning and Coordinating Agency
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List of Acronyms

AMCOST	African Ministers Council on Science and Technology
AMCOW	African Ministers Council on Water
AU	African Union
CoE	Centre of Excellence
CSIR	Council for Scientific and Industrial Research, South Africa
CSO	Central Statistics Office
DGS	Department of Geological Survey
CWRP	Country Water Resources Profile
DWA	Department of Water Affairs
EC	European Commission
EIA	Environmental Impact Assessments
FAO	Food and Agricultural Organisation
GCM	global climate models
GEF	Global Environmental Facility
GoB	Government of Botswana
GWP-SA	Global Water Partnership, Southern Africa
JRC	Joint Research Centre
IPCC	International Panel on Climate Change
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LIMCOM	Limpopo River basin Commission
MDGs	Millennium Development Goals
MMEWR	Ministry of Minerals, Energy and Water Resources
NEPAD	New Partnership for Africa's Development
NMPWWS	National Master Plan for Wastewater and Sanitation
NSC	North South Carrier
OKACOM	Okavango River Basin Commission
ORASECOM	Orange-Senqu River Basin Commission
RBO	River Basin Organisation
RSAP III	Regional Strategic Action Plan (2012-2015)

SANWATCE	Southern African Water Centres of Excellence
SADC	Southern African Development Community
SEA	Strategic Environmental Assessments
SIWI	Stockholm International Water Institute
R&D	Research and Development
RSTI	Research, Science, Technology and Innovation
S&T	Science and Technology
UB	University of Botswana, Botswana
UEM	University of Eduardo Montlane, Mozambique
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Science and Cultural Organisation
SU	Stellenbosch University, South Africa
TAC	Technical Advisory Committee
UKZN	University of KwaZulu-Natal, South Africa
UNIMA	University of Malawi, Malawi
UNZA	University of Zambia, Zambia
UWC	University of Western Cape, South Africa
WAB	Water Apportionment Board
WDM	Water Demand Management
WE	Water Efficiency
WIN-SA	Water Information Network - South Africa
WISA	Water Institute of Southern Africa
WRB	Water Resources Board
WRC	Water Research Commission (South Africa)
WSR	Water Sector Reform
WUC	Water Utilities Corporation
ZAMCOM	Zambezi River Basin Commission

MAP OF BOTSWANA

Source: www.geographicguide.net

Acknowledgements

The AU/NEPAD SANWATCE would like to thank the European Commission (EC) Joint Research Centre (JRC) for making the Country Water Resources Profiles possible. This profile was put together by Dr. P.K. Kenabatho, Department of Environmental Science, University of Botswana and Prof. B.P. Parida, Department of Civil Engineering, University of Botswana at the University of Botswana.

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Our Origins: Network for Water Centres of Excellence

In September 2000, African countries and the international community adopted the Millennium Development Goals (MDGs) at the United Nations (UN) Millennium Summit. African leaders identified water scarcity and related insecurity due to water stress as one of the sources of the continent's underdevelopment and increasing social and economic decline.

To combat these developments and *"ensure sustainable access to safe and adequate clean water supply and sanitation, especially for the poor",* the African Ministerial Council on Science and Technology (AMCOST), a body of the African Union (AU), decided in 2003 that science and technology (S&T) is to constitute one of the flagship programmes of its implanting agency, the New Partnership for African Development (NEPAD).

AMCOST decided that S&T will play an important role in water development, supply and management and that S&T is crucial for assessing, monitoring and ensuring water quality. The flagship programme should strengthen the continent's capabilities to harness and apply S&T to address challenges of securing adequate clean water as well as managing the continent's resources to become a basis for national and regional cooperation and development.

Three years later, in 2006, the AMCOST and the African Ministerial Conference on Water (AMCOW) met in Cairo, Egypt to reiterate the importance of S&T. By resolution, the delegates committed themselves to establishing an African Network of Excellence in Water Sciences and Technology Development. Along AU/NEPAD policy, the water centres of excellence are to be established on a regional level, as of 2013, the Southern African Network of Water Centres of Excellence (SANWATCE) is constituted of eight institutions across Southern Africa:

- University of Botswana (UB),
- University of Zambia (UNZA),
- University of Malawi (UNIMA),

- University of Eduardo Mondlane (UEM) in Mozambique, as well as
- In South Africa: Stellenbosch University (SU) which also serves as the network Hub, University of KwaZulu-Natal (UKZN), University of the Western Cape (UWC), and the Council for Scientific and Industrial Research (CSIR).

The Ministerial Mandate, as instituted in Cairo (2006), provides the AU/NEPAD SANWATCE with the following executive mandate:

1. Facilitate, and where applicable, conduct selective research on water issues;

2. Serve as a Higher Education (PhD; postdoctoral; staff exchange) soundboard to the Southern African Development Community (SADC) region on regional water matters;

3. Collaborate with other networks and institutions in specialised areas;

4. Set the SADC water research agenda;

5. Establish a continental water research agenda which is based on / derived from the SADC regional water agenda.

This can be achieved, amongst other means, through one-on-one engagement with AMCOW and AMCOST through the SADC Technical Advisory Committee (TAC), in order to observe political direction and engage so as to provide evidence-based research.

Various research and capacity development initiatives, institutions and networks can be found within the SADC-region, most notably the SADC Water Division; WaterNet; Global Water Partnership-Southern Africa (GWP-SA); the International Water Management Institute (IWMI); the Water Research Commission (WRC); Cap-Net; Water Institute of Southern Africa (WISA); the Water Information Network-South Africa (WIN-SA); Africa Portal; United Nations Educational, Scientific and Cultural Organization's (UNESCO) Framework Programme for Research, Education and Training in Water (FETWater) and the UNESCO initiatives, including Chairs, as well as Category I and II centres.

It has been established, through the assessment of the Research and Development (R&D) value-chain, that the AU/NEPAD SANWATCE has an important role to play within the high-end scientific research and capacity sphere (M.Sc.; PhD; postdoctoral and Staff Exchange taking into consideration current Masters Programmes being offered by partners, such as WaterNet).

The AU/NEPAD SANWATCE is one of the African regional networks. The regional Hub and Secretariat is currently being hosted by SU in South Africa. Membership to the Network is open to all countries in the Southern African sub-region and current members are: Botswana, Malawi, Mozambique, South Africa and Zambia.

AU/NEPAD SANWATCE's vision statement:

The AU/NEPAD SANWATCE will contribute to the improved human and environmental well-being through research and development in water and sanitation.

Importance of the Country Water Resources Profile

The five Country Water Resources Profiles (CWRPs) have been prepared by the respective AU/NEPAD SANWATCE country teams in 2013 as part of a regional workshop series.

Each CWRP combines physical hydrology [water resource and its exploitation] with a look at water service delivery [infrastructure], the social setting of the country and the management of water, in terms of allocation and distribution. To some extent it also investigates international obligations and relationships related to shared transboundary water resources. It tries to get the base of water information in place, so that there can be a realistic assessment of what gaps there are in S&T and R&D.

With the country's educational resources and institutions also identified, the AU/NEPAD SANWATCE country team and other national stakeholders can use these profiles as a starting point to assess and characterize: i) Where the meaningful applied knowledge in the country's water sector exists and ii) what needs there are beyond that for future cross-sectoral social developments and economic growth.

As this approach cross cuts the essential six Policy Principal Areas outlined in the EC JRC's Water Project Toolkit (WPT) [Social, Economic, Technical, Information/Education/Communication, Environmental and Institutional/management], it should stimulate a more integrative and sustainable approach towards exploitation and management practices resulting in increased efficiency and more equitable water use strategies, as well as more pertinent infrastructure development choices.

Executive Summary

The aim of this Country Water Resources Profile (CWRP) is to highlight important issues around the water sector in Botswana, including some challenges and opportunities facing the sector and how the Centres of Excellence (CoEs) can contribute to improve the situation in the sector.

Important findings include that the Botswana water sector is undergoing a restructuring and institutional re-arrangement to streamline water resources management and supply with the aim of increasing efficiency, accountability and providing an enabling environment through policy formulation.

However, there are some challenges observed in terms of the skills gap in the sector, water losses in the reticulation systems, as well as lack of additional dam sites to increase the water supply beyond the existing dams. Other challenges include the need to use shared waters to meet the growing water demand as well as challenges due to climate change.

Botswana: Water Profile

Hydrology

Botswana's location in the sub-tropical high pressure belt of southern hemisphere (in the interior of Southern Africa) influences the type of rainfall. As a semi-arid country, rainfall is low, erratic and highly variable in space and time and drought is a recurrent element in the country. In general, rainfall varies from as little as around 300mm/year in the south western part of the country (the Kalahari area) to around 600mm in the northern parts of the country (the Chobe area) (**Error! Reference source not found.**). Most rains are due to convection processes and tend to occur in the afternoons. Inter-annual variability in rainfall is high and is highly linked to climate variables; mainly temperature which has a strong but inverse relationship with rainfall (Kenabatho *et al.*, 2012) (Figure 1). This temperature-rainfall relationship may have implications for climate change in that drier conditions may be expected due to projected hotter future climate. On the other hand, high intensity convectional rainfall usually results in flash floods which affect people's life, leading to loss of economic property. For example, in 2000, about five million USD was lost as a result of floods (EM-DAT).

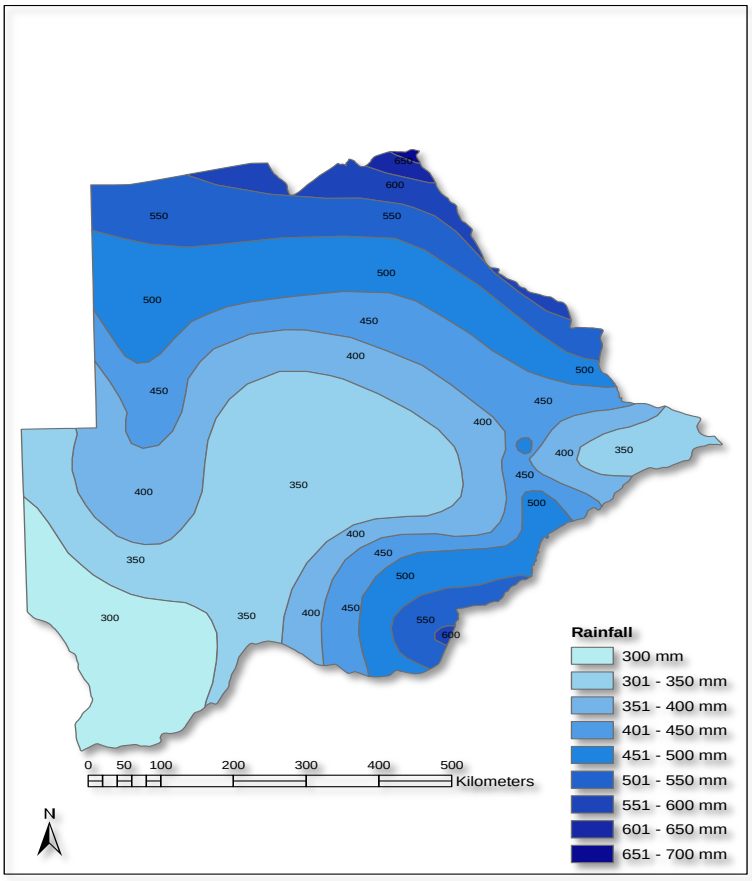

Figure 1. Rainfall variability in Botswana

The low rainfall and high rates of potential evapotranspiration (which is three to four times the amount of rainfall) combined with its very flat topography result in low rates of surface runoff and low rates of recharge to groundwater.

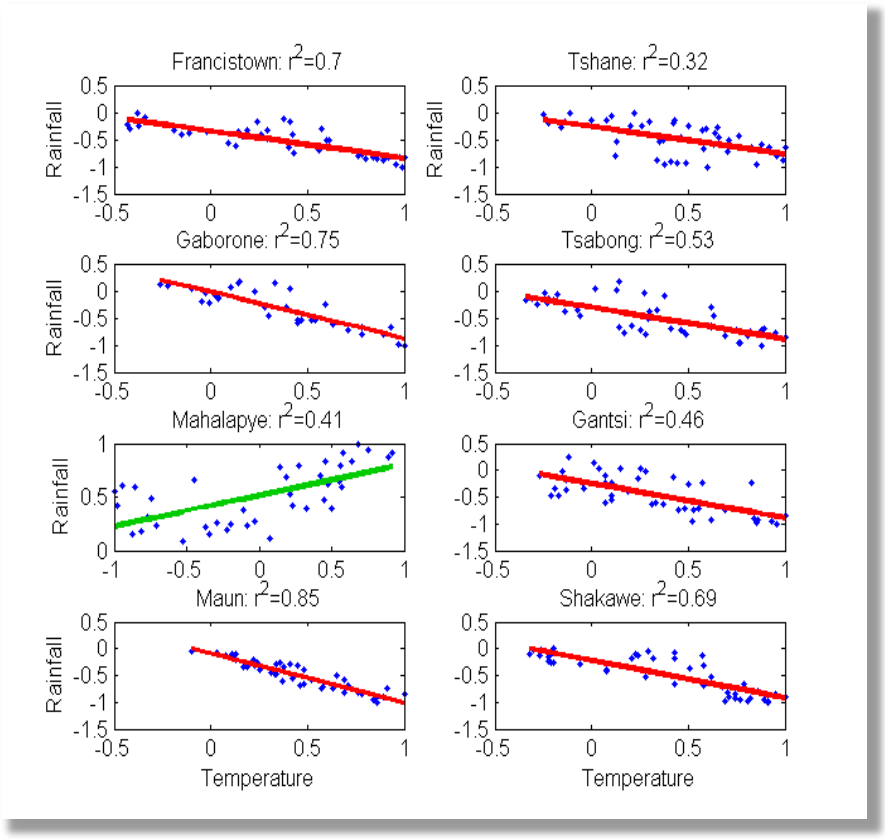

Figure 1. Rainfall and Temperature Relationships for the Main Stations in Botswana

Recharge rates vary significantly across the country, with a maximum of about 40 mm/year in the northern part of Botswana while most of the Kalahari region experiences less recharge averaged at about 1 mm per annum. The average recharge rate across the country is estimated as 3mm/year. In some cases the aquifers receive no recharge at all and the groundwater abstracted is thousands of years old. It is important to note that almost all groundwater abstraction in Botswana has an element of mining. Abstraction from wellfields generally exceeds the annual recharge rates. As a result the groundwater resources used may never fully recover in the future; hence, a sustainable abstraction is needed in order to provide for the long term wellbeing of those communities which rely upon groundwater.

Figure 2 shows the distribution of groundwater depth, which indicates that the Kalahari area generally has deeper groundwater formations compared to other parts of the country, particularly in the northern and some eastern parts of the country. Similarly, the high yielding aquifers of better groundwater quality are generally found in the northern and eastern part of the country compared to the Kalahari area where the water quality is usually low due to high levels of salinity. However, groundwater is considered a vital resource in Botswana. Many areas of the country are reliant upon it for their water supply needs, be they domestic, agricultural or industrial. Most rural villages are wholly dependent upon borehole water supplies. For example, there are more than 25,000 officially registered boreholes in Botswana of which over 10,000 are Government of Botswana (GoB) owned water supply boreholes. The remainder are privately owned boreholes. The number of unregistered boreholes is unknown but could easily be in excess of 5000.

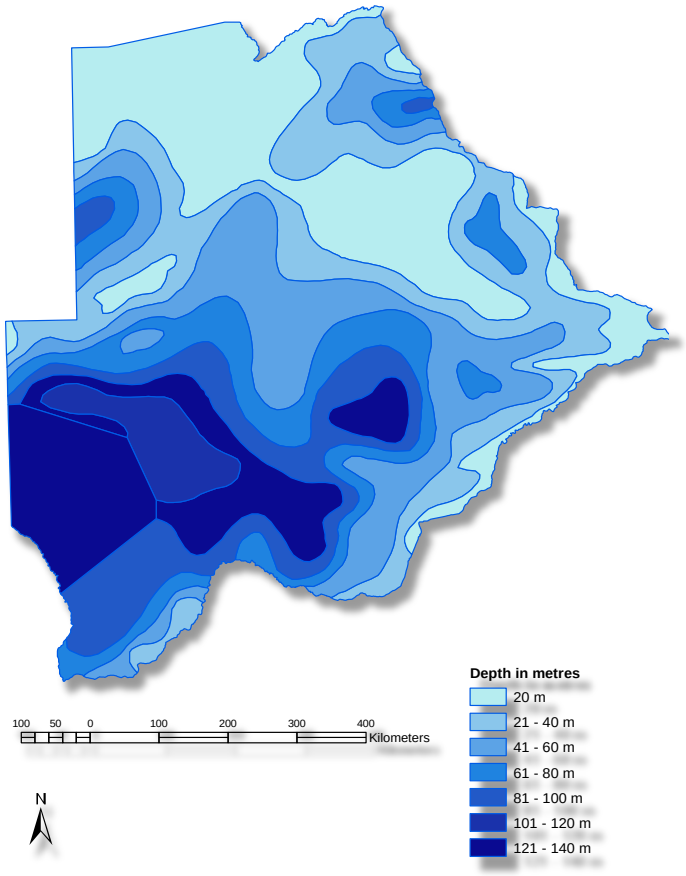

Figure 2. Average Depth of Groundwater

In addition, the mining industry (which is the most important source of income for the country) depends on this important resource. However, the continued use of groundwater other than for purposes of potable use (including livestock watering) is not recommended (SMEC and EHES, 2006). It has been estimated that 80% of Botswana's inhabitants receive their water supply from underground resources (DWA, 2000). However, this figure may have reduced due to the construction of an

inter-basin water transfer scheme called the North South Carrier (NSC) (SMEC and EHES, 2006). The NSC transfers water from some distance of about 450km in the north eastern part of Botswana to the southern part of the country (mainly Gaborone City) where the demand for water is high mainly due to high population and increased industrial activities.

Another important issue relates to groundwater pollution, where some wellfields show evidence of groundwater pollution. For example, the Ramotswa dolomitic wellfields located some 10 km south east of the city of Gaborone within the Gaborone dam catchment area has been polluted largely due to seepage from pit latrines and septic tanks (Figure 3). The well fields have been closed since 1995 and efforts are made to rehabilitate them though this is proving to be a costly exercise.

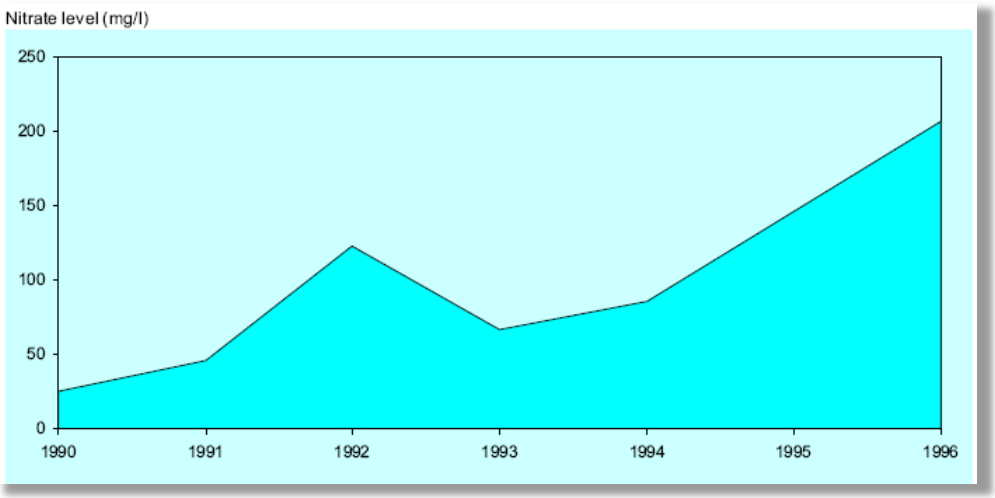

Figure 3. Water Quality Trends from a Borehole in the Ramotswa Wellfields

Regarding surface water resources, all rivers originating in the country are ephemeral with an average flow duration of 10–70 days in a year. On average, runoff is very low, with an estimated annual average flow of 0.6 *mm* for the whole country. An exception is the Okavango and the Linyanti-Chobe Rivers which have relative high flow rates and they originate outside the country, in the uplands of Angola. For this reason, the country can be divided into six major basins (Figure 4), five of which are shared with the neighbouring countries. These are summarised in **Error! Reference source not found.** :

The Limpopo basin is in the eastern part of the country where the Limpopo River forms the eastern border between Botswana and South Africa. Most rivers in eastern Botswana drain into the Limpopo River. The basin is very important for water resources in Botswana since most dams are located in that basin, including the Digatlhong dam, which has recently been completed and will be the largest dam in Botswana with a capacity of close to 400 Million cubic metres.

Makgadikgadi drainage basin is situated to the west of the Limpopo basin to form the Makgadikgadi pans. On the eastern side of the pans, the Mosope, Mosetse and the Nata Rivers all drain into the Makgadikgadi pans. The Boteti River feeds the western side of the wetland, which is part of the Okavango wetland system. The Nata River is the largest of the rivers draining into the Makgadikgadi pans. It drains a total area of 21,216 km^2, most of it is located in Zimbabwe.

Table 1. Major River Basins in Botswana

Source: Department of Surveys and Mapping, 2001.

Drainage Basin	Region	Major Rivers	Area (km^2)
Limpopo	East	Notwane, Metsemotlhaba, Mahalapswe, Shashe, Tati, Ntshe, Ramokgwebana, Taupye, Bonwapitse, Thune, Lotsane	80 000
Makgadikgadi	North	Nata, Thamalakane, Boteti	30 000
Okavango	North-West	Okavango	97 000
Kwando/Linyanti/Chobe	North	Chobe River	26 000
Molopo/Nossop	South	Molopo	71 000
Uncoordinated (internal)	**Central**		**259 000**

Kwando/Linyanti/Chobe Rivers are in the northern part of the country. The Kwando originates in Angola and enters Botswana through the Caprivi Strip in Namibia. In Botswana, it spreads out into the Linyanti swamps, which drains into the Savuti and Linyanti Rivers, eventually reaching the Chobe River, which attracts large numbers of wildlife and tourists.

Figure 4. Major Drainage Basins in Botswana

Okavango River basin and Delta system is in the northwest. This comprises the Okavango River, the Okavango Delta, and the outlets from the delta. The system also extends down the Boteti River to the Makgadikgadi pans. The delta is one of Botswana's major tourist attractions. The Okavango River enters Botswana through the Caprivi Strip from Angola. At that point its mean discharge is about 350 m^3/s but it largely dissipates into the Okavango Delta, an area of 12 000 km^2 of permanent and seasonal swamps. The outflow from the Delta is only about 14 m^3/s, or about 4% of the inflow, and is usually lost through evaporation before it reaches the Makgadikgadi Pans.

It is worth noting that no significant amounts of water are abstracted from the Okavango and Chobe Rivers due to the low population density in the areas, minimal irrigation demands and the sensitivity of the Okavango wetland system, which is protected under the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (commonly referred to as RAMSAR Convention). As a RAMSAR site there are strict limitations on the establishment of any regional large scale water supply scheme (SMEC and EHES, 2006).

Internal drainage system: The remaining part of the country is the uncoordinated internal drainage system. All runoff is lost through evaporation and seepage. In the central Kgalagadi, there are some fossil river channels, which run in an easterly direction. These rarely ever carry any significant runoff and the drainage system is not considered at all for any significant surface water supply scheme.

In view of the above, the country is considered to have exhausted all its suitable sites for dam construction; hence, the need to consider and negotiate for shared water resources with other riparian states. This can be done mainly by making use of the established river basin commissions most of which relate to the above river basins such as the Limpopo River basin Commission (LIMCOM), the Okavango River Basin Commission (OKACOM), the Orange-Senqu River Basin Commission (ORASECOM) and the Zambezi River Basin Commission (ZAMCOM). These are platforms through which Botswana can make requests for using international waters to meet its increasing future water demand.

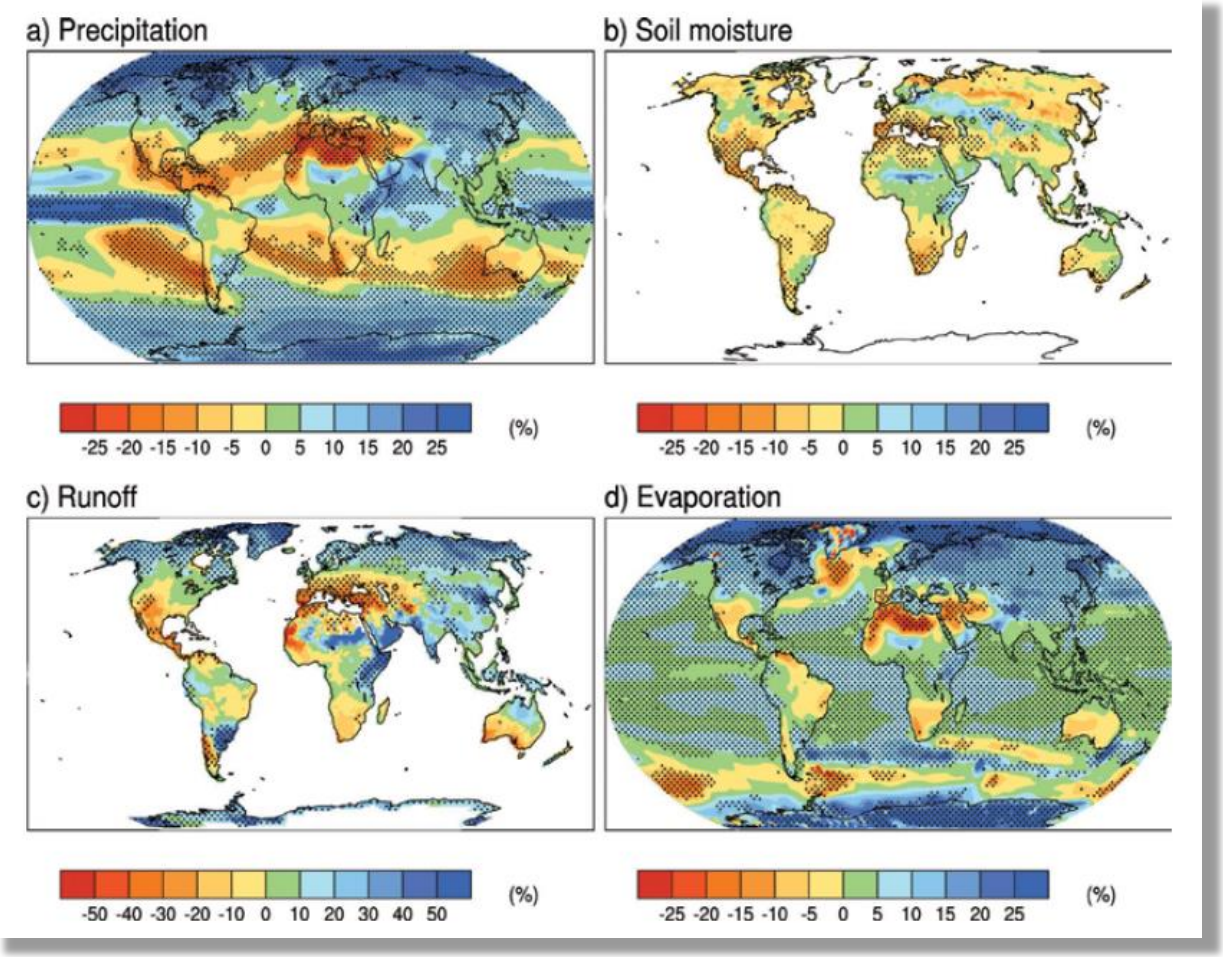

Figure 5. Climate Change Impacts from 15-GCM Model Annual Means for SRES A1B for the Period 2080-2099 Relative to 1980-1999.

In terms of climate change, the global projections as indicated in Figure 5 shows that precipitation and related elements are likely to decrease as a results of increased temperatures in most parts of southern Africa (including Botswana) on the basis of results obtained from 15 different global climate models (GCMs) (Bates et al, 2008). These results are in agreement with studies conducted locally on the basis of 6 GCMs which indicate average temperature and rainfall projections of between -22 and -51% obtained from 6 rainfall stations across Botswana for the 2070-2099 periods using the International Panel on Climate Change (IPCC) A2 emission scenario (Kenabatho *et al*., 2012). These projections may worsen the already limited water resources of the country.

Other issues include effects of urbanisation and land use change on runoff availability. A study by Parida *et al.* (2006) has shown that changes in runoff coefficient are also affected by land use change (52% contribution) in addition to climate change (48%). This indicates that watershed management strategies together with water demand management and appropriate climate adaptation strategies are critical towards improved water resources management in Botswana (possibly through use of indigenous knowledge and participatory approach and technological interventions). In support of this, UN-Water advices that adaptation to climate change is mainly about better water management

Socio-economic Setting

Most of Botswana's population is concentrated in the eastern region of the country, along the border with South Africa and Zimbabwe. According to the Central Statistics Office (CSO, 2001), SMEC and EHES (2006), in 2001, 87% of the population were located in the districts of North-East, Central, Kgatleng, South-East, Kweneng and Southern, which together comprise the Eastern and South-Eastern Planning Regions. The northern region, which includes the fertile Okavango Delta, has 8.5% of the country's population, while the western region, which is dominated by the Kalahari Desert, is sparsely populated. In 2001, just over 54% of Botswana's population was classified as urban, as opposed to 45.2% in 1991 and 17.7% in 1981, making it one

of the most urbanised countries in sub-Saharan Africa. In 2001, more than 900,000 people were living in urban areas, as opposed to some 600,000 in 1991. One of the reasons for Botswana's rapid urbanisation process is the increase that has occurred in the number of areas that are classified as urban. In 1971, the only urban-designated areas were the towns of Lobatse and Francistown, the new capital of Gaborone and two new mining towns. The settlement areas Palapye and Tlokweng were reclassified as urban in 1981, while a large number of villages were declared as urban areas in 1991. Since 1991, additional villages were declared as Planning Areas and therefore acquired urban status. All in all, the number of areas/settlements designated as urban increased from five in 1971 to 35 in 2001. Rural-urban migration processes have also contributed to the increase in the country's urban population, and significant growth has been witnessed around the towns and cities. For example, in 1981, 15% of the country's population lived in Gaborone and its satellite settlements, increasing to 21% in 1991 and 26% in 2001 (CSO, 2001, SMEC and EHES, 2006).

Regarding access to water, there has been a remarkable increase in the population's access to piped/tapped (i.e. piped indoors, piped outdoors and communal tap) since 1981 when only 56% of the country's population had access to piped/tapped water. By 1991, this had increased to 77% (52.5% of households with access to piped/tapped water lived in Cities/Towns and Urban Villages and 24.5%lived in Rural Areas), and in 2001 the figure was 87.7% (56.9% located in Cities/Towns and Urban Villages and 30.8% in Rural Areas). In total, 50% of all households had access to on-plot reticulated water (piped indoors and piped outdoors), while 37.7% relied on communal standpipes. The number of households drawing water directly from boreholes had decreased from 7.5% in 1991 to 5.1% in 2001 (CSO, 2001, SMEC and EHES, 2006).

Water Demand and Supply Forecast

Table 1 shows statistics for water use from 1992 to 2003 (CAR, 2013) which indicate that agriculture was the main user of water, followed by household and mining, respectively. However, the use of water for mining has more than doubled by 2003

and is expected to increase due to proliferation of other mining companies in recent years. Although agriculture has remained stable up to 2003, these figures are likely to increase due to the government's initiatives for diversifying the economy from mining to agriculture and tourism. This has seen a number of programmes introduced in the last five years targeted at improving agriculture in the country. On the other hand, the use of surface water is growing faster than that of groundwater due to the construction of new dams and the NSC as mentioned in section **Error! Reference source not found.**. However, groundwater still accounts for 56% of the total water use (CAR, 2013). But Wastewater is hardly used (3 Mm^3) even though its supply (29 Mm^3 in 2003) has grown faster than overall water demand. The use of waste water for non-potable uses is therefore strongly encouraged, particularly in areas where infrastructure exists so as to augment the limited water supplies. This is because water demand is increasing faster than the existing and planned water supply schemes. For example, annual water consumption has increased from 140 Mm^3 in 1990 to 170 Mm^3 in 2003 (although the Department of Water Affairs (DWA) is expected to up-date these figures as and when the information becomes available). As of 2010, water demand was estimated to be 193 Mm^3, and expected to be 228.7 Mm^3 in 2020, and 285.8 Mm^3 in 2030. This growth would occur mostly in the settlements due to increased domestic use, as well as private sector and public sector development. However, this estimate wrongly makes no provision for mining expansion, assumes modest expansion for irrigation, hence mining and irrigation may escalate these figures (CAR, 2013). Also, the use of groundwater for purposes other than potable use is strongly discouraged since abstraction already exceeds recharges in most well fields. To partly address this problem, further supply of groundwater is only considered feasible in areas not yet fully investigated, and therefore groundwater exploration should remain a continuous activity until the entire country is covered and documented. The mining sector may have to explore the use of non-potable (polluted or saline) groundwater for mining processing (CAR, 2013).

Table 1. Statistics for Water Demand and Water Use by Category

User category	**1992**	**1996**	**2000**	**2003**
Agriculture (1)	**72.9**	**70.6**	**76.0**	**63.**
Mining (3) *Doubled***	**12.8**	**14.4**	**24.1**	**26.8**
Manufacturing	3.9	2.1	4.0	5.1
Water + electricity	0.0	0.8	0.5	0.7
Construction	0.0	0.4	0.4	0.4
Trade	0.2	0.7	1.0	1.2
Hotels and restaurants	0.2	0.5	0.8	0.8
Transport + communication	0.0	0.2	0.2	0.3
Insurance, banking, business	0.0	0.5	0.7	0.8
Social and personal services	0	1.2	1.7	2.4
Government	8.7	8.8	11.1	11.5
Household use (2)	**36.1**	**41.1**	**48.1**	**56.9**
Water Utilities Corporation private sector	7.7	0.0	0.0	0.0
Grand total	140.3	141.3	168.6	170.3

Major Water Management Issues

According to SMEC and EHES (2006), Botswana is at a water divide; it has developed its resources at great expense and is wasting half of them through inefficient management practices and uncontrolled leakage. It does not require mandatory monitoring or reporting of losses of its suppliers and has not addressed inefficiency by users. Demand is escalating with a population becoming more affluent; Sources are running out and sites for future development are more distant and therefore more expensive. Whether the country can continue on this path depends on the depth of the government's financial resources. However, as part of the

recommendations from the SMEC and EHES, there is a significant commitment (by the government) to move from a supply oriented position to a water demand management strategy in line with the integrated water resources management (IWRM) principles. Notably, the country is in a transition mode through a Water Sector Reform (WSR), which mainly seeks to transform institutional, policy and management landscapes in the water sector. This is done through institutional re-arrangement. For example, the number of institutions previously involved in water supply has been significantly reduced, leaving mainly the DWA and the Water Utilities Corporation (WUC) with complimentary national mandates as discussed in section **Error! Reference source not found.**. Furthermore, a new national water policy has been formulated and was approved by the Cabinet and is awaiting discussion in parliament this year. The new policy draws heavily from IWRM principles, and has benefited from recent policies developed mainly within southern Africa. For example, the policy aims to provide a

> *"national framework work that will facilitate access to water of suitable quality and standards for the citizenry and provide the foundations for sustainable development of water resources in support of economic growth, diversification and poverty eradication".*

Another important milestone is the development of IWRM/Water Efficiency (WE) plans, which was funded by United Nations Development Program (UNDP)/Global Environmental Facility (GEF) through the assistance of GWP. Under the title "Accruing multiple global benefits through Integrated Water Resource Management/Water Use Efficiency Planning: A demonstration project for sub-Saharan Africa", the project aims to facilitate the development of national processes, procedures, methods and options for efficient and equitable IWRM. The development and implementation of a dynamic IWRM/WE plan for Botswana will address both national and transboundary water management priorities and will be supported by and contribute to regional knowledge management process, directly contributing to the increase awareness and capacity of national and regional stakeholders to engage in IWRM process. In addition, the project has implemented a number of pilot projects for water conservation through conjunctive use of Grey-water Re-use and rainwater harvesting in selected schools of Botswana with the aim to demonstrate

tangible impacts on the ground and further document and disseminate lessons learnt across the Southern African region.

Main Policy and Strategy Documents, Communication Channels and Media Links to Water Issues

The national water policy referred to in section **Error! Reference source not found.** will replace the old Water Act of 1968. Similarly, through the Water sector Reform, the Water Utilities Act of 1970 (amended 1978) may be amended to align it with the new mandate of WUC, where it now supplies water to the whole country as opposed to urban areas. The current transformation in the water sector should be credited mainly to the National Water Master Plan of 1991 (SMEC and Knight Piesold, 1991), followed by the review of the National Water Master Plan of 2006 (SMEC and EHES, 2006). Other important pieces of documents include the National Master Plan for Wastewater and Sanitation (NMPWWS; SMEC *et.al*. 2003), which proposed a change of mind-set where waste water is now viewed as an alternative water resource, rather than waste.

The National Water Policy of 2012 (draft)

The draft policy, which at the time of writing was approved by the Cabinet and awaiting discussion in Parliament, aims to provide a framework that will facilitate access to good quality water by all users and also advocates for sustainable development of water resources in support of economic growth, diversification and poverty eradication. This policy is premised on the core principles of sustainable development taking into consideration the objectives of IWRM. The policy adopts a decentralised catchment area approach with the overarching guiding principles that include equity, efficiency and environmental sustainability (CAR, 2013).

Equity: The policy recognises water as a basic human right and hence in its allocation, this will receive priority. The second priority is given to the environment as it is the pillar for economic growth and social development followed by agriculture

and commercial/industrial uses. Gender issues and social equity are also addressed by the policy.

Efficiency: Water is recognised as an economic good, hence the costing and pricing of the resource should consider its economic value. The regulation and delivery of water services' responsibilities are to be separated so as to improve efficiency of these functions.

Sustainability: This principle recognises that freshwater is finite and vulnerable and is essential to sustain the lives of Batswana. The value of water as an environmental asset is recognised and that its management and planning requires all stakeholders to be on board, including the local communities. Catchment management approaches are encouraged and the use of the precautionary principle is highlighted as a strategy that enhances environmental integrity, efficiency, and equity.

The Policy seeks to establish a Water Resources Board (WRB) which has the responsibility for equity and sustainable allocation of water resources as well as the efficient implementation of the IWRM plan. The WRB should be responsible for the coordination, implementation and periodic review of the National IWRM Plan. In addition, a Water Regulator will also be formed and primarily be responsible for ensuring financial sustainability in the water sector, guiding and monitoring the development and implementation of water tariff structures as well as ensuring that service providers comply with service standards.

The policy has identified eleven key focus areas and indicates strategies for addressing issues under each area as summarised below (after CAR, 2013).

Table 2: Some Selected Key Focus Areas of the Draft National Water and Wastewater Policy

Key focus area	Strategy for addressing the issue
Water for growth	• Develop and implement water allocation guidelines for different uses; • Integrate IWRM and development with land use planning; • Institutional reform so as to enhance inter-sectoral coordination and management of water;

	• Utilise shared waters as per the agreements with other riparian states; • Develop and utilise water accounts as a tool for improved water efficiency
Water Demand Management (WDM) and water conservation	• Develop and adopt WDM principles and measures; • Review, strengthen and enforce legal instruments and standards for water conservation; • Develop and adopt a multi-tiered tariff structure and economic instruments; • Implement raw water extraction fee for all withdrawals; • Infuse WDM and water conservation principles in Environmental Impact Assessments (EIAs), feasibility studies, designs and plans for all water development activities; • Employ appropriate technology to promote utilisation of non-conventional sources of water: rainwater harvesting, storm water, grey water and wastewater reuse and recycling; • Promote water efficient devices and practices especially in new buildings; • Maintain water balance records for regular audits of service standards and operational performance; • Promote stakeholder participation especially at the local level and promote local level WDM programmes.
Domestic water supply and sanitation	• WUC to take over all water supply and sanitation services; • Employ full cost accounting structure and cost recovery measures for water supply and sanitation services; • Realistic and affordable tariffs and water charges; • Ensure affordability of households on water supplies such that the maximum water supply costs they incur account for less than 5% of their disposable income; • Investments in water supply and sanitation facilities and rehabilitate village water supply infrastructures (through the national aftercare strategy for rural areas); • Water quality and service standards and community based monitoring and evaluation systems; • Enhance reuse of wastewater to achieve the 96% target by 2030;
Water for environment and tourism	• Harmonise all national and regional policies and legislation related to water and environment; • Develop environmental standards and guidelines for the protection of aquatic ecosystems; • Assess and determine ecological water requirements for all catchments; • Promote Strategic Environmental Assessments (SEAs) and EIAs; • Implement internationally recognised principles on the management of wetlands; • Catchment management principles; • Operationalise the polluter pays principle; • Adopt ecosystem approach in water management;
Water for	• Promote integrated planning and development;

agriculture	• Account for water for agriculture in the national water balance and allocative instruments; • Research and develop affordable and sustainable techniques for increasing water productivity in the agricultural sector; • Adopt water efficient irrigation systems and train farmers and relevant officers; • Promote safe application of treated effluent in agriculture; • Integrate water issues in agricultural policies;
Water for mining and industry	• Determine water balance for all developments and integrate mine dewatering and industrial effluents in the planning framework- licensed water use; • The permitting system to integrate the water fit for purpose guidelines; • Perform regular technical and operation audits; • Regulate and license all test drilling for minerals ; • WDM
Water for energy	• Integrate water development guidelines in the energy equation; • Promote adoption of water efficient technologies
Information management	• Inventory and assessments of water data; • Centralised clearing house mechanism for integration, management and dissemination of water related data; • Integrated water, land cover and land use database; • Catchment based risk management and mitigation measures; • Targeted awareness and education programmes; • Annual report on Botswana's water resources including information on water permits cancelled.
Research and development	• Ensure and secure a sustainable fund for research and development in the water sector; • Partnerships with academia, private sector and international institutions to strengthen and facilitate research and capacity development; • Training programme for water professionals
International cooperation	• Institutional and policy frameworks to integrate transboundary water issues and management; • Adopt guidelines for shared water allocation and benefit sharing; • Monitoring system for international waters and exchange data with other riparian states.
M&E	• Develop measurable indicators to track and assess performance; • Integrated monitoring framework that is fully compatible with national and international standards

Although the policy provides a significant enabling environment for the management of Botswana's water resources, there are areas that need attention. Major areas of concern are highlighted below (CAR, 2013):

- Climate change and its impacts on Botswana's water resources. Adaptation strategies are not alluded to despite the importance of tackling this issue and ensuring that management efforts and use patterns takes cognisance of this.
- Water pricing – Although water pricing is a separate component of the Water sector reform project, it deserves to be spelt out clearly in the policy document.
- Water allocation – one of the principles of the policy is directed as the efficient allocation of water resources. However, the policy fails to give details as to how this allocation will be pursued and what efficiency measures will be considered to ensure that allocative efficiency will be achieved.
- Water is a resource that is essential for all services, hence a necessity for all sectors. Given the nature of water, there are bound to be conflicts between users and competing uses, hence conflict resolution issues should be afforded an opportunity in the policy.
- Although the policy highlights water use for the environment, water protection and issues related to water quality are limited.
- Mobilisation and financing of water infrastructure have not received significant attention in the policy. These could include the use of both financial and economic instruments as measures to be used in accessing financial resources for the development of water related infrastructure.
- Stakeholder participation is an important component that should be stipulated in the policy document. This includes approaches to enhancing stakeholder participation and capacity development efforts to facilitate efficient water resources understanding and management. Water management at all levels (national, regional and catchment/basin) should therefore be adequately highlighted.

Water Services and Water Resource Management Institutional Settings

Botswana is currently implementing recommendations of the recent national water master plan review (SMEC and EHES, 2006). This include (i) institutional

restructuring, (ii) establishment of water policy and strategy that incorporate current issues such as IWRM, (iii) independent agencies that will regulate activates of water utility providers, (iv) establishment of water resources council to oversee the management of water resources in the country. Other water sector reforms include (v) merging of different units within the Department of Geological Survey (DGS) and DWA (for example, the hydrogeology unit at DGS is relocating to DWA; the hydrology section at DWA is merging with Groundwater Division in DWA). (vi) Water Utilities Corporation, unlike in the past where it was only focusing on water supply to urban centres, will now have a new mandate of supplying water throughout the country. Previously, water supply to major villages was done by DWA; local government was in charge of water supply to rural areas. DWA will now focus on the management, protection and monitoring of water resources, including policy direction. The draft national water policy was done through a consultative and participatory approach, in order to align it with the current international best practices of water resources management. Below is a summary of institutions and their new responsibilities (CAR 2013)

Table 3. Water Sector Institutions and Their New Roles

Institution	Responsibility
Department of Water Affairs (DWA)	It has the overall responsibility to assess, plan, develop and maintain water resources for domestic, agricultural, commercial, industrial and other uses in the whole country. In order to effectively implement these leadership roles, DWA will assist and advise in the formulation of water resources development and management policies and legislation. DWA is currently undergoing a significant restructuring under the reform in-order to fully implement its roles and responsibilities.
Water Utilities Corporation	WUC is now responsible for the delivery of freshwater and wastewater treatment services country wide. Thus far, WUC has taken over supply to 373 villages (out of the planned 540 villages). With regards to wastewater management services, all the entities in the country have been completely taken over *except for the Maun area*. WUC seems on track in meeting the take-over target

	of all 540 villages by 2014.
The Water and Energy Regulator	It will be primarily charged with ensuring financial sustainability across the water sector, reducing wastage by facilitating the streamlining of operations and determining revenue requirements to inform regular tariff adjustments. The regulator will also oversee compliance of service standards to ensure efficiency and protect consumer rights. The regulator will, however, regulate more than one sector, e.g. water, energy, and telecommunications. It is expected that it will become financially sustainable in fully assuming its roles and responsibilities.
Water Resources Board (WRB)	It will be an autonomous body supported by Ministry of Minerals, Energy and Water Resources (MMEWR). The WRB will oversee and allocate Botswana's scarce water resources. It will also monitor these resources and develop water related policies. The Board will ensure independence and equity in the sustainable allocation of water resources. The WRB will replace the Water Apportionment Board (WAB) and will have members from the following entities: MMEWR, Ministry of Environment, Wildlife and Tourism, Ministry of Agriculture, large water users, WUC, research and academia as well as civil society. It is envisaged that the Council will be wholly financed from the central government coffers. However, as time goes on, the revenues collected from licensing and water abstraction fees could support the operations of the Council.

Existing and Planned Water Infrastructure

For surface water, major infrastructure includes dams and water transfer schemes. The existing and planned major dams (for water supply) include the following (which are all located within the Limpopo basin):

	Dam	Catchment area (km^2)	Capacity Mm^3	Sustainable Yields (Mm^3)	Mean annual runoff (Mm^3)	Completion Status
Existing	**Gaborone**	4 300	144.2	10	31	Completed
	Letsibogo	5 690	104	20	57	Completed
	Nnywane	238	2.3	0.3	1.9	Completed
	Bokaa	3 570	18.5	1.1	9	Completed
	Shashe	3 630	85.3	40	84	Completed
	Ntimbale		26.5	2.9		Completed
Planned	**Dikgathong**		398	62		Completion (2012)
	Lotsane		40	6.5		Completed(2012)
	Thuni		90	4.2		Completed (2012)

One of the major water infrastructures is the construction of a water transfer scheme, known as the NSC project. This is a pipeline that carries raw water from Letsibogo dam (northern part of Botswana) to the southern part of the country over a distance of about 400 km to Gaborone. Phase 1 was completed in 2000/1, and Phase 2, once completed, will double the pipeline to carry water from Dikgathong dam. Future plans include extending the pipeline to deliver water from the Zambezi basin. Although this has improved water supply situation in Botswana (albeit with a huge cost), the pipeline has major challenges, mainly including water losses and occasional pipe breakage. For example, the reliability of the NSC has been unsatisfactory since its construction. WUC estimates that it loses 10% of the total

flow and that it has major leaks which must be repaired on the average of 4 times per year (NWMPR, 2006). As of 2006, no comprehensive maintenance reports have been made available to demonstrate the progress being achieved towards resolving the problems. WUC believe that the replacement of the original narrow joints with a re-designed wider jointing system will reduce the frequency of incidents at the valve boxes and improve the reliability of the pipeline.

Regarding groundwater, it is estimated that total groundwater resources is around 100 billion m^3 with an average annual recharge of 1 600 Mm^3 (Dep. of Surveys and Mapping, 2001 and SMEC *et. al.*, 1991). The 2006 NWMPR estimates a (much lower) total sustainable yield of 96 Mm^3 from developed and potential well fields/aquifers. These different figures illustrate that further work is needed on groundwater exploration and development to assess the sustainable amount of groundwater that can be used. Several well fields (Dukwi, Serowe, Kanye, Ghanzi and Tsabong) are already being mined (CAR, 2013).

It is also important to note that most of Botswana's surface water resources are shared with neighbouring countries. Some of the aquifers and river basins transcend Botswana's boundaries. The 2006 NWMPR argues that in future use of shared water resources is inevitable, especially those of the Chobe/ Zambezi River (some 0.5 to 1.7 billion m^3). A large water transfer scheme from the Okavango Delta is not recommended (SMEC and EHES, 2006). Modest abstraction from the Nata River (52.5 Mm^3) is considered a future option. The Limpopo is currently over utilised. Botswana also receives water from Molatedi Dam in South Africa (up to 7.9 Mm^3 per annum), but the amount is under revision based on recent dam yield figures. Botswana is also part of the ORASECOM and entitled to some water. Current water allocations from shared rivers amount to 500 Mm^3 from the Chobe Zambezi and the water transfer from Molatedi Dam (5 – 7 Mm^3 per annum). No formal water allocations have as yet been agreed upon by any of the four River Basin Organisations (RBOs), in which Botswana participates (CAR, 2013).

Water Resources Research & Development (R&D) and Science & Technology (S&T) Institutions (Staffing, Facilities & Funding/Support)

The main institutions that offer research and development in water related issues are institutions of higher learning. These include the (i) University of Botswana (Faculty of Science, Faculty of Engineering and Technology, Okavango Research Institute), (ii) Botswana College of Agriculture, (iii) the newly established Botswana International University of Science and Technology is also expected to offer R & D in water. It is also important to note that water sector institutions provide their in-house training (refresher courses). For example, DWA is partnering with Stockholm International Water Institute (SIWI) for a two-year capacity building programme to support the restructuring of Botswana's water sector.

In 2011, the MMEWR signed a Memorandum of Understanding with SIWI to support the capacity building of DWA, WUC and other water sector stakeholders. The capacity building programme is made up of eight courses on: Corporate transformation and change management; IWRM; research and benchmarking methodologies; water resources policy; integrated data management; climate change and variability in water resources management; water allocation and management; and wastewater management and reuse. Each course consists of three one-week modules, spaced about two months apart. This modular structure enables participants to more effectively integrate their learning into their day-to-day work, and avoids long absences of essential staff from their duties. SIWI will also support the DWA in establishing a Knowledge Services Hub, which will be a national CoE, conducting applied research, monitoring local and global trends in water management, and providing policy advice to the Department. The Hub will also facilitate cross-learning among sector institutions. It is envisaged that the Hub would continue the capacity building process initiated though this partnership.

Another important milestone is the launching of a National Policy on Research, Science, Technology and Innovation (RSTI) in 2012. Through the RSTI, Botswana seeks to

1) Establish strong research capacity, both in the public and private sector;
2) Create an environment conducive to the generation, application, adaptation, dissemination and transfer of suitable technologies;
3) Promote innovation activities;
4) Develop adequate human resource capacity;
5) Develop institutional capacity to coordinate, manage and finance RSTI activities;
6) Promote networking and collaboration to maximise RSTI resources and generate synergies across sectors; and
7) Expand the knowledge base – both indigenous and scientific knowledge.

The policy also provides detailed implementation plan and lists key players, as well acknowledging the role of private sector, research and development institutions in achieving the vision of the RSTI. For example, through the policy, the government commits to an R&D expenditure of 2% of GDP by 2016 in partnership with the private sector. In view of this, the UB and SANWATCE must play a key role in training highly specialised post-graduate researchers who will be required to lead the research within the identified priority areas. As an example of research priority area, the policy is likely to support research that promotes S&T applications to improve the quality, quantity, efficient and effective utilisation and conservation of ground and surface water and adaptation of appropriate technology with the aim of providing a secure water supply to the entire nation.

Although on average Botswana is doing well compared to other countries in southern Africa in terms of access to safe drinking water (Table 4), there is still room for improvement to enable access to sanitation, particularly in rural areas.

Table 4. Access to Water and Sanitation per Country

Country	Population (Mill.)	Safe Water (Urban)%	Safe Water (Rural)%	Sanitation (Urban)%	Sanitation (Rural)%
Angola	10.2	69	15	34	8
Botswana	2.2	99	91	74	39
D.R.C.	52.0	37	23	23	4
Lesotho	2.1	65	54	53	36
Malawi	10.4	80	32	52	24
Mozambique	19.1	47	40	53	15
Namibia	1.8	87	42	77	32
South Africa	43.4	80	40	79	50
Swaziland	1.1	61	44	66	37
Tanzania	35.3	67	45	74	42
Zambia	9.6	64	27	75	32
Zimbabwe	11.3	90	69	90	42

Documented Water Sector Capacity Developments Needs Assessment

Table 5 provides a summary of skills gaps identified during the national water master plan review (SMEC and EHES, 2006). These include, among others: contract management and supervision, environmental assessment, groundwater and hydrogeological modelling, civil engineering computing and software development,

maintenance planning and scheduling, telemetry, Information technology (system development and applications), basic survey techniques, as well as human resources planning and management skills.

Table 5. A Summary of Skills Gap from the Water Sector

Division	Staff Required	Skills	Level	Training
Hydrology and Water Resources	Hydrologist	***Contract Management and Supervision***	Professionals and Technicians	Short term
		Environmental Assessment	Professionals	Long term (MSc)
Groundwater Division	Groundwater Modeller	***Planning and Management***	Professionals	Long term (PhD)
		Groundwater Modelling	Professionals	Long term (PhD)
Design, Construction and contracting Service Division	Civil Engineers	*Contract Management and Supervision*	Professionals	Long term
		Civil Engineering Software ***(Civilcad, Mapinfo)***	Professionals Technicians	Long term (BEng) Diploma
		Public Relations	Professionals, Technicians and Artisans	Short term
		Management and Supervision	Professionals and Technicians	
Electro-Mechanical	Electrical and Mechanical Engineers and Technicians	***Maintenance Planning and Scheduling***	Professionals, Technicians and Artisans	
		Contract Management and Supervision	Professionals and Technicians	
		Basic Computing	Professionals and Technicians	All levels
		Telemetry	Professionals and Technicians	Short term and long term: BEng (Controls and Instrumentation)
Operations and Maintenance	Customer Relations Officers; Financial Officers; Water Engineers	***Maintenance***	Professionals, Technicians and Artisans	
		Contract management and Supervision	Professionals and Technicians	
		Data Collection	Professionals and Technicians	All levels
		HR Management	Station Managers	
Water Conservation and Quality Division	Pollution Control Officers; Conservation Officers;	***Presentation Skills***	Professionals, Technicians and Artisans	
		Pollution Control		

	Public Education Officers	***Project Management***		
		Water Harvesting and Demand Management	Professional	Short term (Work attachment)
Information Technology	Technical Officers	***Systems Development***	Professionals and Technicians	
		Applications Development	Professionals and Technicians	
		Billing System Control	Professionals and Technicians	
		Data Security	Professionals and Technicians	
		Project Management	Professionals and Technicians	
Departmental Management	Human Resource Planning	***Public Financial Management and Accounting***	Management	
		Basic Computing	Admin Staff	
		Management and Supervision	Middle managers	
		Human Resource Planning	Professional	
Department of Geological Survey	Hydrogeological Modeller	***Groundwater Modelling***	Professional	Long term (PhD)
		Environmental Geology	Professional	Long term (MSc)
		Field Hydrology	Artisan	Short term
		Contract Management and Supervision	Professional and Technician	
Districts		*Project Management*	Professional Technician and Artisans	
		Supervision and leadership	Professionals	
		Public Relations Skills	Professional Technician and Artisans	
		Staff Supervision	Technicians	
		Basic Survey and Design	Technicians	

Summary/Assessment of Capacity Development Needs (Current Thinking) in the Country

Reflecting on the identified skills gaps in the water sector, and bearing in mind the current water sector reforms includes changes in the mandates, roles and the

institutional arrangement, there is still a need to incorporate other skills. These may include the following:

- Legal skills with expertise in water issues, including international water laws, transboundary water laws and legislation.
    - This may also include training people on negotiation and diplomatic skills, international relations in order to position the country for exploring shared water resources.
- Policy development and analysis experts who will be instrumental during policy formulation and reviews.
- Hydrology and water resources engineers at PhD level, particularly within the DWA's new structure.
- Provide training opportunities on IWRM at Master's level in order to build a culture of incorporating environmental and socio-economic issues in water resources management and development in line with the current global and regional trends.
- There is need for institutional collaborations/partnerships (within the different water sectors) and other sectors such as research institutions and the private sectors to begin to address emerging water issues collectively.
    - In particular, the water CoE can provide backstopping for emerging technologies emanating from peer reviewed research that can be packaged to benefit different aspect of water resources planning such as policy issues, among others.
    - In addition, short courses targeting specific aspects including those highlighted in Table 5 can be offered by the CoE.
- The water utilities corporation should set up some percentage of the revenue collected from water and waste water sales in order to support research that will improve water management in the country. This is in line with international best practices and Botswana should take advantage of the transition period to set up institutions that will manage these funds, as well as setting priority areas for research.

Relation of the Country Situation to the SADC Regional Strategic Action Plan (RSAP) III Process and any Specific Actions Being Undertaken

One of the program areas of the SADC RSAP III are river basin organisations, which is linked to shared river basins as espoused within the SADC Protocol on Shared Water Courses. The water sector in Botswana is very active in these initiatives and efforts have been made to incorporate the requirements of these instruments within the planning processes and policy frameworks that are in existence to date.

Botswana is party to four river basins in the region, (i) LIMCOM, (ii) the OKACOM, (iii) the ORASECOM and the (iv) ZAMCOM. These river basins are well established and Botswana's water sector is very active in the decision making processes, such as sending commissioners to these basins. As mentioned earlier, Botswana has exhausted all her internal dam sites and one of the main sources of water are international waters through shared river basins. This is an opportunity for Botswana to negotiate to use water from these rivers to meet Botswana's current and future water needs. The national water master plan review spells out clearly where and how this could be achieved. For example, Botswana may request to use water from the Chobe-Zambezi and link this with the NSC water transfer scheme. Perhaps as one of the strategies to prepare for international cooperation within the water sector, the DWA has created a position of deputy director-International Waters in the current restructuring exercise. Previously, this position was at a lower level within DWA. In addition, the SADC Water Division has been instrumental and supportive during the water sector reform process by providing general but relevant regional perspective.

Secondly, the RSAP III is premised on IWRM framework, as such the water sector in Botswana has used this niche to leverage funds for an IWRM/WE plan which was highly supported by GWP-SA as an implementing partner for SADC on IWRM issues across the region. The programme was funded by UNDP and GEF from 2008-2013. The IWRM/WE plan, as discussed in section **Error! Reference source not found.**, has addressed among others the three components of (i) capacity development, (ii)

climate change adaptation and (iii) social development, clearly showing the water sector's commitment to supporting the SADC programmes and initiatives. Furthermore, the draft national water policy mentioned in section **Error! Reference source not found.** is also premised on the regional thinking particularly on IWRM, river basin and international cooperation, among others.

Conclusion

This document has provided an overview of the water sector situation in Botswana with the main aim of highlighting important milestones, challenges and opportunities for the water sector in Botswana. The report draws from a number of documents reviewed, both published and unpublished materials around water issues in Botswana and beyond. Important highlights are that (i) the water sector in Botswana is on a transition mode following the recommendation from the national water master plan review in 2006, (ii) the transition has allowed for institutional re-arrangement and restructuring to streamline water resources management and supply with the aim of increasing efficiency and accountability. This has also provided a means for (iii) creating an enabling environment through policy formulation that is premised on IWRM principles. Some of the challenges highlighted include the skills gap in the water sector which hampers water resources development and management in the country. The skills required include engineering skills, information technology, contract management and supervision, project management, data collection and analysis as well as human resources management skills. A strategy is therefore needed in order to fill the identified gaps. Another challenge was that Botswana is left with no choice but to adhere to water demand management strategies, i.e. moving from a supply oriented to a demand management paradigm with the aim of saving the limited water resources in the country. This is evidenced by stringent water demand management strategies such as water restrictions (i.e. prohibition of lawn and garden watering using potable water).

In addition to these, the country has a huge challenge of exploring the use of international waters, indicating the need for trained personnel to address these issues. There are also challenges related to climate change which may negatively

affect water availability in the future, hence the need to develop appropriate adaptation strategies to cope with these challenges.

References

Bates, B.C., Kundzewisz, Z.W., Wu, S., Palutikof, J.P. Eds., (2008): Climate Change and Water Technical Report of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210pp.

CAR (2013):-Botswana Integrated Water Resources Management and Water Efficiency Plans. Draft Main Report-Volume 1. Report prepared for Department of Water Affairs, Ministry of Minerals, Energy and Water Resources, Government of Botswana.

CSO 2001. Central Statistics Office: Population and Housing Census: Population of towns, villages and associated localities. *Ministry of Finance and Development Planning, Gaborone, Botswana*.

Kenabatho, P.K., Parida, B.P., Moalafhi, D.B. (2012). The value of larger scale climate variables in climate change assessment: the case of Botswana's rainfall. Physics and Chemistry of the Earth. 50–52, 64-71.

Parida, BP., Moalafhi, DB., Kenabatho, PK. (2006). Forecasting runoff coefficients using ANN for water resources management: The case of Notwane catchment in Eastern Botswana. Physics and Chemistry of the Earth; 31**,** 928-934.

SMEC *et al.,* (2003).National Master Plan for Wastewater and Sanitation. Report prepared for Government of Botswana.

SMEC and EHES (2006). National Water Master Plan Review: Main Report. M*inistry of Minerals, Energy and Water resources, Botswana Government*

SMEC and Knight Piesold (1991).The National Water Master Plan. Report prepared for Department of Water Affairs, Government of Botswana.