Integrated Water Resources Management Plan

for the

Cuvelai – Etosha Basin

Assessment of current basin Water Resources Management situation

November 2013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

BMC	Basin Management Committee
CEB	Cuvelai – Etosha Basin
DRFN	Desert Research Foundation of Namibia
DWAF	Department of Water Affairs and Forestry
DWSSC	Directorate of Water Supply and Sanitation Coordination
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GmbH)
GROWAS	Groundwater Information System
GWP	Global Water Partnership
IT	Information Technology
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resources Management Plan
KBMC	Kuiseb Basin Management Committee
KWMB	Karst Water Management Body
M&E	Monitoring and Evaluation
MAWF	Ministry of Agriculture, Water and Forestry
MDG	Millennium Development Goals
MET	Ministry of Environment and Tourism
MLR	Ministry of Lands and Resettlement
MoF	Ministry of Finance
MRLGHRD	Ministry of Regional and Local Government Housing and Rural Development
MTEF	Medium Term Expenditure Framework
NDP	National Development Plan
NGO	Non-Governmental Organisation
NHIES	Namibia Household Income and Expenditure Survey
NIWEG	National Irrigation Water Efficiency Group
NPC	National Planning Commission
NWP	National Water Policy
O&M	Operation and Maintenance
OKACOM	Permanent Okavango River Basin Water Commission
ORASECOM	Orange-Senqu River Commission
PET	Potential Evapo-transpiration
PJTC	Kunene Permanent Joint Technical Commission

PST	Performance Support Team
RUWIS	Rural Water Information System
S&AP	Strategy and Action Plan
SADC	Southern Africa Development Council
SIDA	Swedish International Development Agency
SOE	State Owned Enterprise
UNDP	United Nations Development Program
UNESCO	United Nations Education Scientific and Cultural Organisation
URV	Unit Reference Value
WaSAC	Water (and Sanitation) Advisory Council
WDM	Water Demand Management
WHO	World Health Organisation
WPC	Water Point Committee
WR	Water Regulator
WRC	Water Research Council
WRMA	Water Resources Management Act
WSASP	Water Supply and Sanitation Sector Policy
WSS	Water and Sanitation Sector
WSSD	World Summit on Sustainable Development
ZAMCOM	Zambezi Watercourse Commission

INTEGRATED WATER RESOURCES MANAGEMENT PLAN FOR THE CUVELAI – ETOSHA BASIN

1. INTRODUCTION

Integrated Water Resources Management (IWRM) has been identified as essential for the sustainable management of the water sector in Namibia. The original call to implement IWRM on a worldwide scale was made at the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002, where the international community took an important step towards adopting more sustainable models for water management. This call was directed at all countries to introduce integrated water resource management and to develop water efficiency plans. The WSSD Plan of Implementation included the provision of support to developing countries to prepare IWRM Plans.

In August 2010 Namibia completed a National IWRM Plan and the proposed Plan was adopted by Cabinet in June 2012. This Plan was described as concrete, realistic, practical, feasible, affordable and executable. The plan addressed capacity building is supported by all stakeholders (with ownership and clear responsibilities) and has the potential to make a difference to water management in Namibia.

In order to make the implementation of the National IWRM Plan more practical by addressing water management issues at the river basin level, it was felt necessary to prepare specific IWRM plans for each river basin in Namibia and to apply the concepts adopted in the National IWRM Plan according to the actual situation in each basin

This document sets the background for an IWRM Plan for the Cuvelai – Etosha Basin (CEB) which has been divided into four sub-basins for better management. They are called:

1. The Iishana Sub-Basin,
2. The Niipele Sub-Basin,
3. The Olushandja Sub-Basin and
4. The Tsumeb Sub-Basin.

The institutions responsible for IWRM in the CEB are the Basin Management Committees (BMCs) and the IWRM Plan will serve as the guideline document for those institutions, as well as all the other institutions such as Ministries, Regional and Local Authorities, NamWater and other stakeholders responsible for water and sanitation management in the CEB.

The Ministry of Agriculture, Water and Forestry obtained assistance from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) to compile the first single basin-focused IWRM plan in Namibia. This support made it possible to appoint the DRFN to undertake the task to prepare the IWRM Plan for the Cuvelai – Etosha Basin.

2. BACKGROUNDTO INTEGRATED WATER RESOURCES MANAGEMENT

2.1 IWRM PRINCIPLES

Integrated Water Resources Management is based on the fact that the management of many different aspects regarding the protection, use and disposal of finite water resources are interdependent. Water allocations and management decisions consider the effects of each use on all the others. They take account of overall social and economic goals, including the achievement of sustainable development. Different user groups such as farmers, communities and environmentalists, can influence decisions and strategies for water resource development and management. Additional benefits accrue when informed users apply local self-regulation to issues such as water conservation and catchment protection because this is far more effective than central regulation and surveillance can achieve.

The International Conference on Water and Environment, Dublin, Ireland, January 1992 gave rise to four principles that served as the basis for most of the subsequent reform in the water sector. The four Dublin principles are:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels
3. Women play a central part in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognized as an economic good.

As stated by the Global Water Partnership: *"IWRM is a challenge to conventional practices, attitudes and professional certainties. It confronts entrenched sectorial interests and requires that the water resource is managed holistically for the benefit of all. No one pretends that meeting the IWRM challenge will be easy but it is vital that a start is made now to avert the burgeoning crisis."*

It should be noted that IWRM places an emphasis on stakeholder participation and decision making at the lowest appropriate level.

3. THE NAMIBIAN PERSPECTIVE ON IWRM

3.1 GENERAL

IWRM in Namibia is based on an understanding of the arid climate, the water cycle as it relates to the flow of water sources through the environment and the water balance as it relates to the arid climate conditions dominated by relatively low rainfall and high evaporation. These issues dictate the approach that should be followed to manage scarce water resources on integrated bases to ensure water security for all water users to sustain socio-economic growth and prosperity for all in Namibia.

3.2 THE CLIMATE

Climate has a major influence on water resources management and Namibia is regarded as the most arid country in Africa south of the Sahara. This is confirmed by the low precipitation and very high potential evaporation. It is well known that the distribution of rain over time and space is much more variable in dry climates compared to wetter climates. This leads to a high spatial and temporal variability of rainfall, both within and between years.

Rainfall in Namibia commonly falls as intense local showers during the summer months between October and May. The mean annual rainfall varies between a maximum of about 650mm in the north east to less than 50mm along the coast. See **Figure 1** for more information about the rainfall distribution in Namibia,

In areas of water deficiency, potential evaporation or potential evapo-transpiration (PET) is an important measure, usually calculated in the unit of rainfall, i.e. mm. PET is defined as the amount of water which would evaporate from the soil and transpire from standard vegetation coverage, provided there is an unrestricted amount of water in the soil.

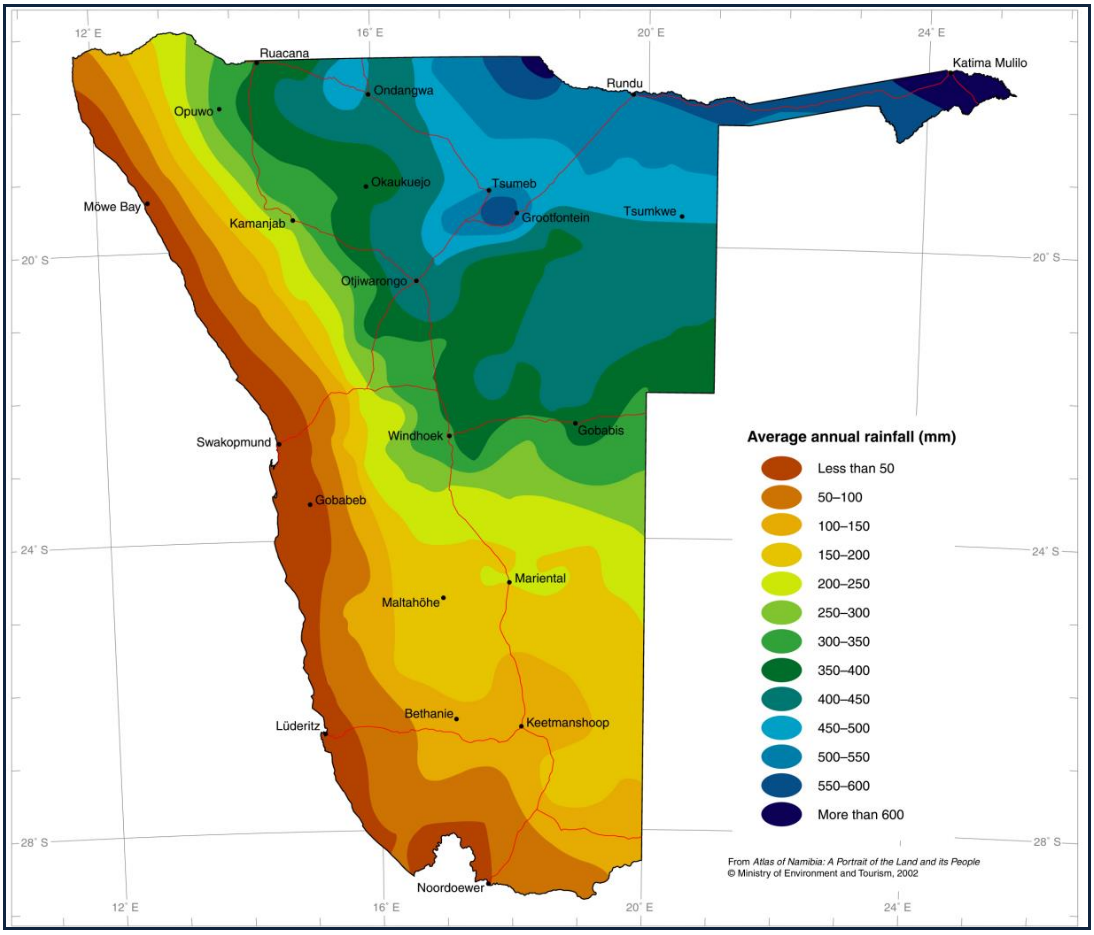

Figure 1: Average annual rainfall distribution in Namibia

PET depends on several meteorological elements, i.e. air temperature, air humidity, wind speed and solar radiation. The mean annual potential evaporation varies between about 1 600mm along the coast to more than 2 600mm in the interior of the country and exceeds the mean annual rainfall for the Namibia throughout year. The average annual potential evaporation in Namibia is presented in **Figure 2.**

Another feature of the dry Namibian climate is the severe impacts drought has on the biological production. The majority of the population is living in the rural areas and is very dependent on the climate for their livelihoods. During multi-year droughts the biological production commonly drops dramatically and reserves of food, grazing for livestock, livestock numbers and water are severely depleted (Moorsom 1995). This has huge impacts on the population.

The urban population depends on good rainfall and runoff in the rivers that feed water supply dams and aquifers to sustain their water needs. A failure to meet the water demand in urban areas will have huge impacts on industries, employment and socio-economic activities.

Given these issues, i.e. extremely dry climate, high variability and a large dependency on rainfall to sustain both rural and urban livelihoods, an accurate understanding of Namibia's climate as well as the interaction between climatic and physical determinants is essential for sustainable planning and management of the water sector (Heyns et al. 2009).

This is an important consideration in the annual water balance, for example for dams and other water related works and activities related to crop production and irrigation.

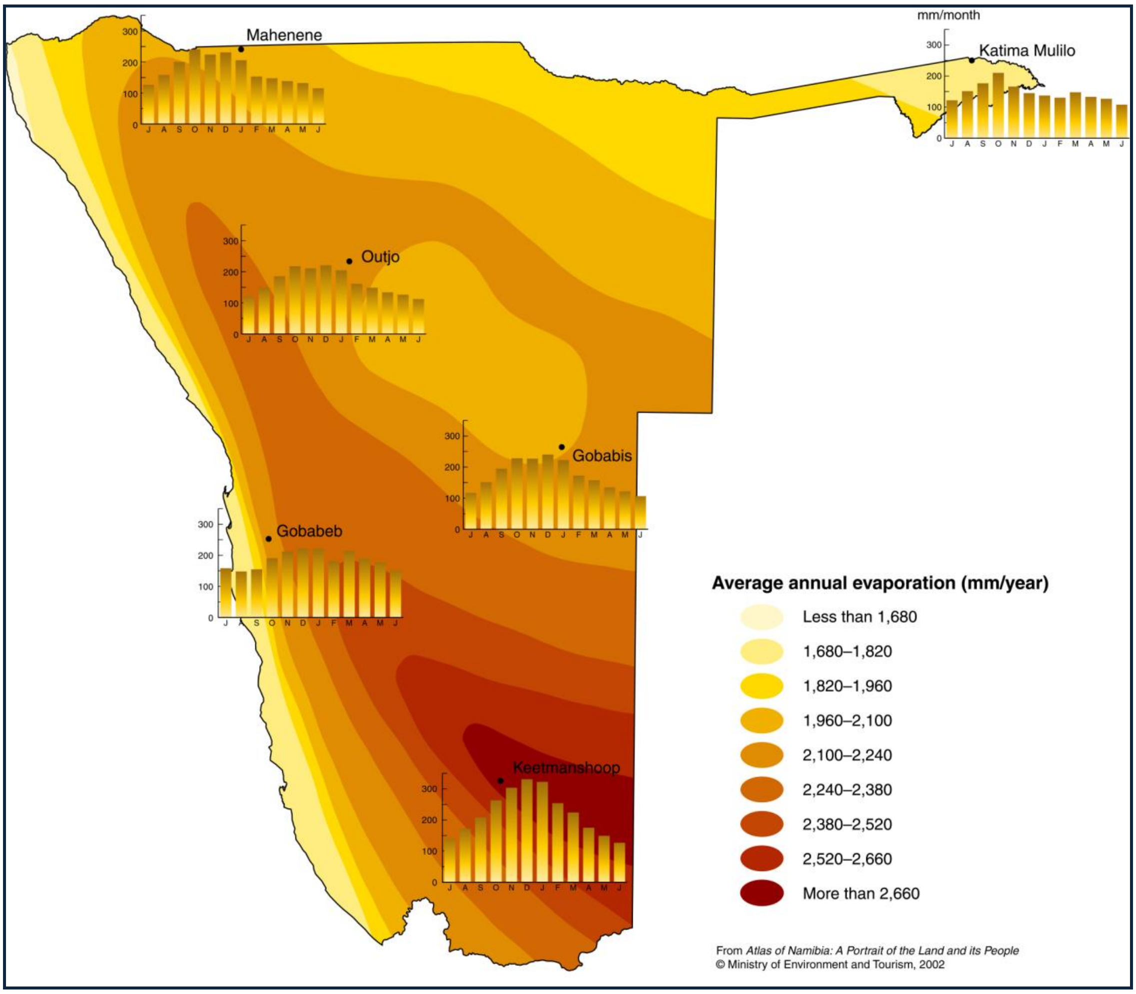

Figure 2: Average annual evaporation in Namibia

As shown in **Figure 1** and **Figure 2** above, the general climate of an area influences the perceptions of rainfall and drought. In the northern sub-humid zone the most critical rainfall shortage is the lack of sustainable rainfall during the main planting and growing season. In the more arid southern Namibia, rain events are few, isolated and extremely variable. In response, the vegetation is adapted to prolonged dry spells, making it difficult to distinguish unusually long dry spells from the normal arid conditions. Environmental degradation of arid lands, especially pastures, may generate a similar perception, where drought becomes a synonym for normal living conditions in a harsh and degraded landscape, relieved only by rare good rains.

Time is another factor influencing the perception of drought. Urban dwellers and industry experience drought when the demand of water is higher than the supply for an extended time, resulting in levels of water reserves dropping so low that supply has to be restricted. On the other hand, a single good rainfall season, filling the reservoirs can often insure the urban dwellers against direct impacts of drought for several years to come, independent of the amount of rainfall.

For the rural communities and especially farmers, drought time scales also vary widely, from the critical short weeks of growing field crops for crop farmers to the more extended cycles of browsing and grazing vegetation growth for stock farmers. Countrywide, the early summer period of dry heat is taxing on livestock after the rainless winter, although normal during average rainfall. However, there are cumulative effects such as serious drought that one year lowers the threshold of hardship and even survival during the next year, especially for small farmers and vulnerable rural groups.

Even though predictions of the future climate in Namibia are still uncertain when it comes to the finer details, most models predict:

1. Increased maximum temperatures ,
2. A longer dry season,
3. Increased humidity and convection, and
4. More intense rainfall.

3.3 THE WATER CYCLE

The water cycle is characterized by the precipitation or rainfall on the land and sea. The rainfall on the land either accumulates in rivers that run off into an open water body like the sea or it infiltrates the soil where it accumulates in aquifers that may also drain underground into a water body. Due to the energy provided by the sun, the water from open water bodies evaporates and forms clouds in the upper atmosphere from where the moisture precipitates in the form of rainfall. See **Figure 3**.

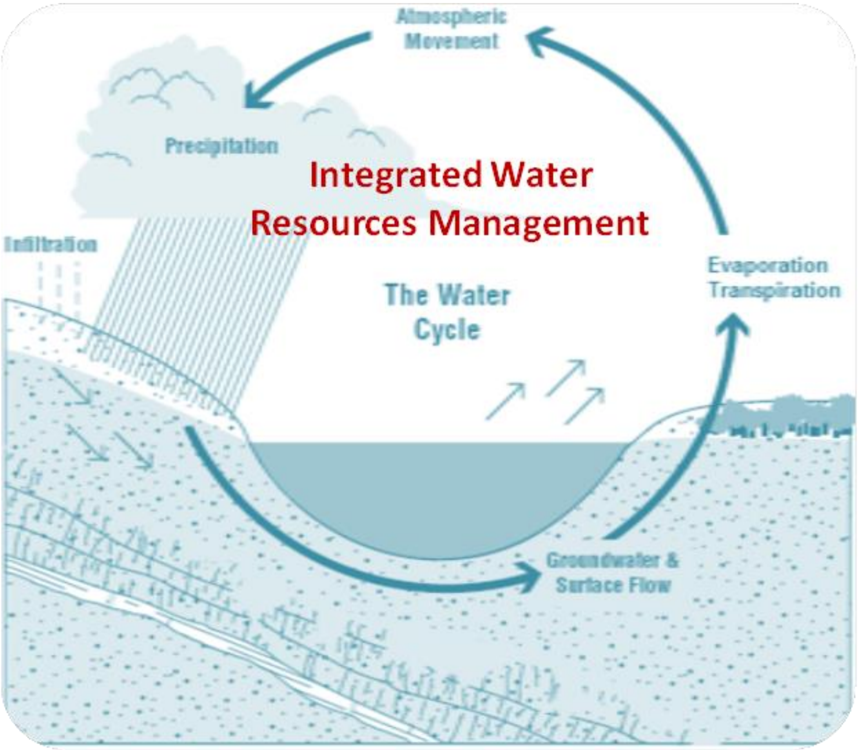

Figure 3: The water cycle

3.4 THE WATER BALANCE

The water balance is central to the way water resources are available and can be utilised. This hydrological balance in Namibia is strongly influenced by the arid and semi-arid climate characterising most of the country. It is estimated that only 2% of the rainfall ends up as surface run-off and a mere 1% becomes available to recharge groundwater. The balance of 97% is lost through evaporation (83%) and evapo-transpiration (14%), as illustrated in **Figure 4** below.

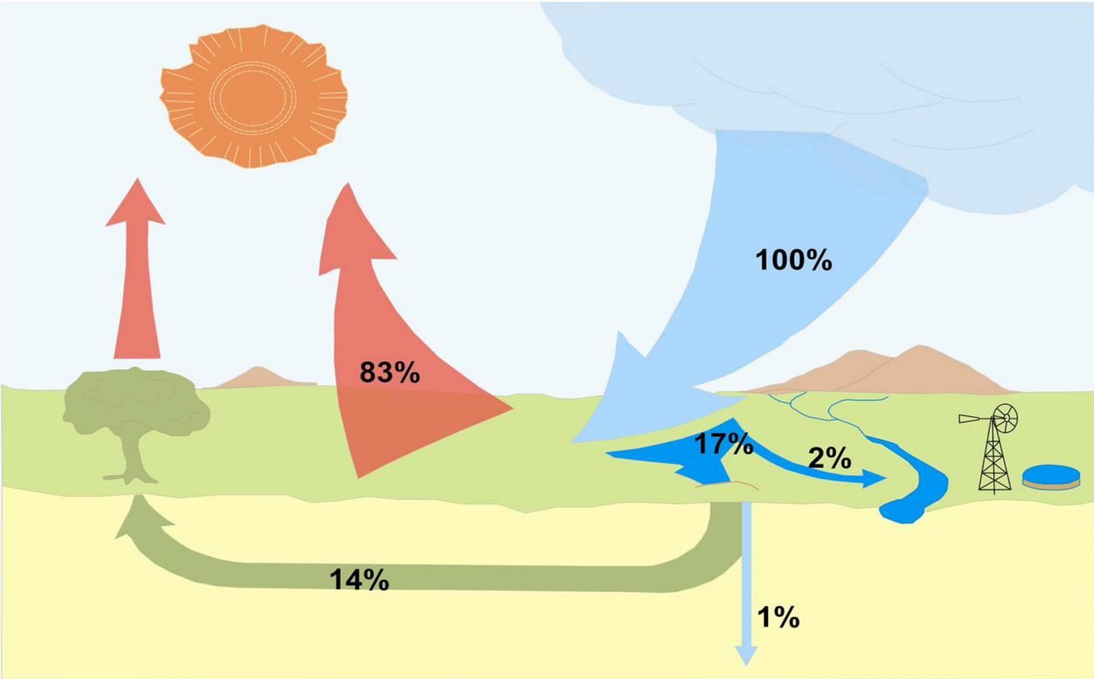

Figure 4: the water balance in Namibia

3.5 THE AVAILABILITY OF WATER RESOURCES

Due to the aridity of the Namibian climate all rivers in the interior of the country are ephemeral, meaning that they only flow when rainfall is sufficient, normally only for short periods during the rainfall season. This limits the potential of the surface water sources and the recharge of groundwater.

As far as the hydrogeology of Namibia is concerned all water available as groundwater originates from rainfall, whether from recent precipitation or rain that fell in prehistoric times. The occurrence of groundwater depends on a combination of sufficient rainfall and favourable geo-hydrological conditions. The largest part of the country is covered by geologically ancient rocks which are inherently impervious. Groundwater is found in secondary structures along joints, bedding planes, shear zones and faults. Groundwater is a very important source of water during the dry season when surface water sources have dried up. See **Figure 5** on the next page for a map showing the major aquifers and the groundwater potential of the aquifers in the country.

However, the northern and southern international boundaries of Namibia are marked by the perennial rivers, flowing continuously through the year. These are the Kunene River in the northwest, the Okavango River in the central north, the Zambezi and Kwando Rivers in the northeast and the Orange River in the south. Namibia has access to the water of those rivers and has a right to use the water, but the water is also shared with the other neighbouring riparian states and all the basin states have an obligation to manage and use those rivers in terms of the relevant rules of International Water Law.

3.6 WATER RESOURCE POTENTIAL PER WATER BASIN

About 88% of the water potential Namibia’s lies in the perennial rivers on the northern and southern borders, while 80% of the land area relies solely on groundwater. The surface water and groundwater potential of each water basin in Namibia is shown in **Figure 6** on the next page and according to that the CEB has a surface water potential of 180 (water imported from the Kunene River) and a groundwater potential of 32Mm³/a.

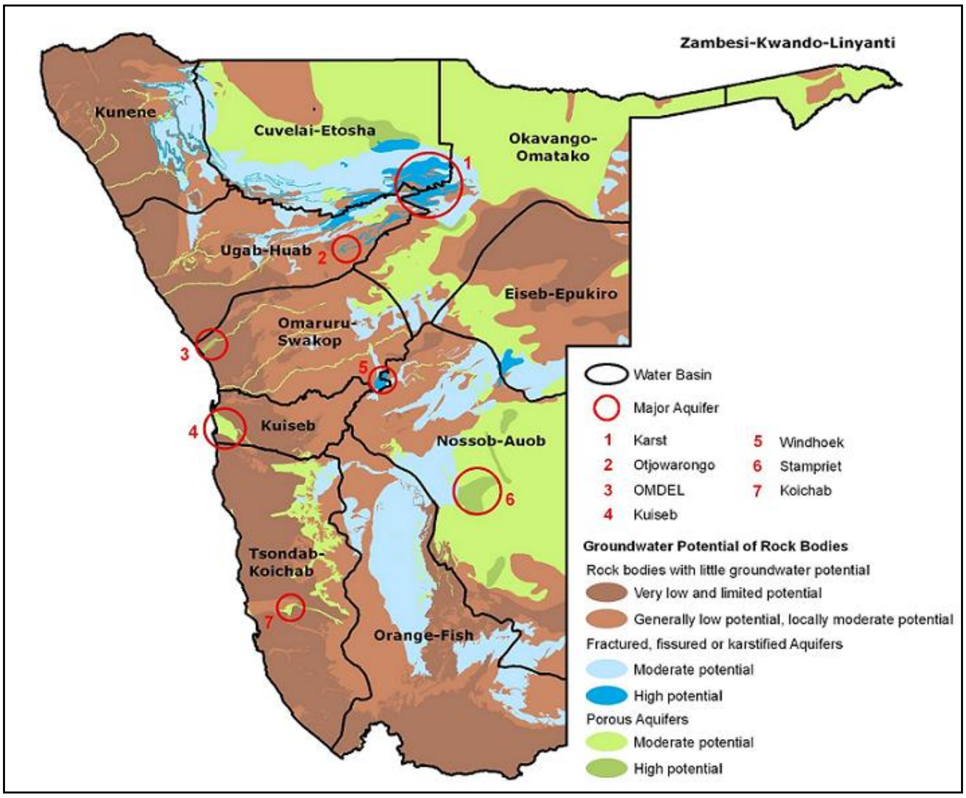

Figure 5: Groundwater potential and major aquifers

Figure 6 presents the water potential of each water basin, split into surface water and groundwater potential

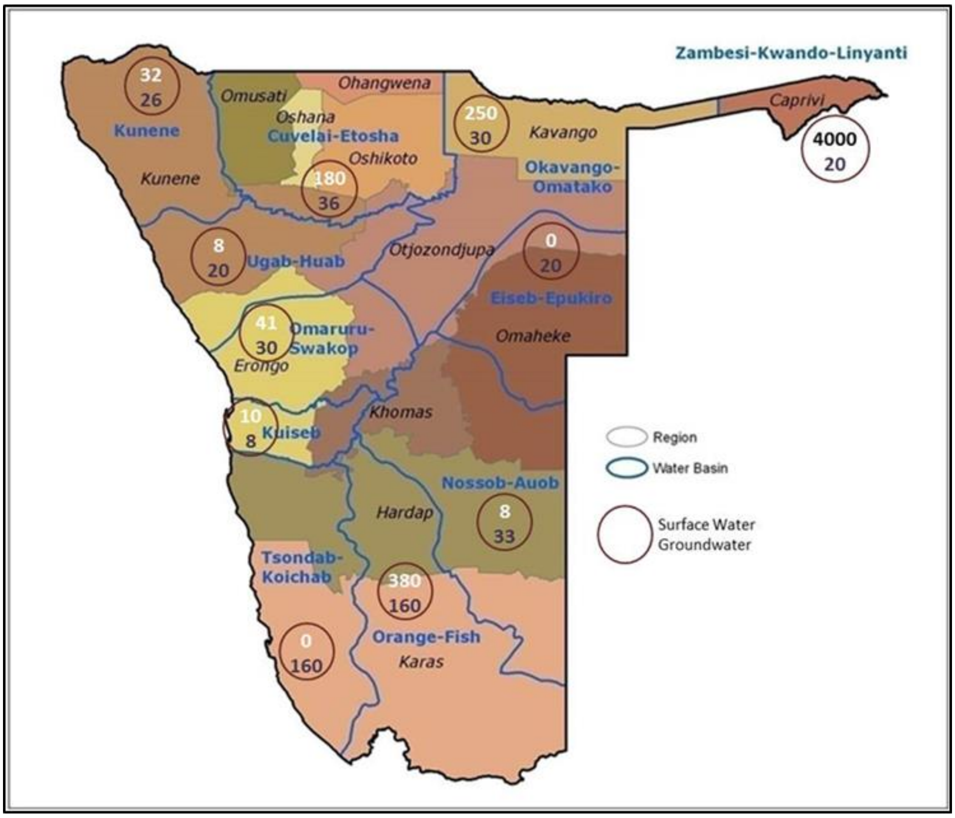

Figure 6: Water potential of the water basins in Namibia

3.7 WATER DEMAND

Over the next 30 years, the water demand in Namibia will increase rapidly in some areas (in particular, all expanding urban areas) and only moderately in others. The water demands per sector are illustrated in **Table 1.** The current challenge of distributing the available water to where it will be most needed will be exacerbated and expensive new water sources (for example desalination plants, new dams, long pipelines and infrastructure to import water from international watercourses) will have to be developed.

Table 1: Projected water demand for Namibia

CONSUMER GROUP	DEMAND IN Mm^3/a				
	2008	2015	2020	2025	2030
Urban	66.0	80.0	91.1	103.5	117.2
Rural Domestic	10.3	10.6	10.9	11.1	11.4
Livestock	86.8	86.8	86.8	86.8	86.8
Irrigation	135.3	204.6	344.6	379.8	497.2
Mining	16.1	17.2	18.1	19.1	20.3
Tourism	19.6	27.5	31.9	35.2	38.9
TOTAL	**334.1**	**426.7**	**583.4**	**635.6**	**771.7**

In general, it can be concluded that Namibia has sufficient water to meet the development goals of 2030. However, the demand centres are often located in remote areas that are long distances away from sustainable water sources and will be major challenges for sustainable and affordable water supply.

4. THE NATIONAL IWRM PLAN FOR NAMIBIA

4.1 INTEGRATED WATER RESOURCES MANAGEMENT IN NAMIBIA

Integrated Water Resources Management is defined as: '*A process that promotes the co-ordinated development, management and use of water, land and related natural resources in order to optimize the resultant economic, social and environmental welfare in an equitable manner without compromising the sustainability of vital ecosystems* (adapted from Global Water Partnership).

The overall long-term goal of the National IWRM Plan in Namibia is to achieve a sustainable water resources management regime contributing to social equity, economic efficiency and environmental sustainability. This is particularly important in Namibia with its low and varied rainfall coupled to extremely high evaporation and a number of water management issues that must be attended through proper planning, appropriate capacity building and funding strategies

Due its dry climate and unpredictable rainfall, water resource challenges in Namibia can only be addressed through a high degree of efficient water resource management. The key challenges of the water sector to address the technical, institutional, financial and socio-economic issues in Namibia were covered in the National IWRM Plan. A similar plan is required for the Cuvelai – Etosha Basin.

4.2 WATER SECTOR PRIORITIES

The Water Sector priorities in Namibia are guided by a number of policies developed within the Ministry of Agriculture, Water and Forestry. The existing key water policies, namely the 2000 National Water Policy (NWP) and the 2008 Water Supply and Sanitation Sector Policy (WSASP), are in harmony with the IWRM principles. The intended replacement of the Water Act 54 (Act No 54 of 1956) by the Water Resources Management Act (WRMA), presently under review, also supports IWRM principles. However, some aspects of the sector policies have not yet been implemented and should be implemented as soon as possible. Moreover, the reviewed WRMA still requires promulgation. New policies that are most urgently required must address the issues of bulk water and end user tariffs, water tariff subsidies and the reduction of bush encroachment to enhance groundwater recharge.

The broad objectives of the Namibian water sector, as well as the individual basin objectives, are to achieve the efficient supply and allocation of water to ensure equitable access to water resources and sanitation. This will contribute to the long-term social and economic development of Namibia and the individual basins. This is based on ensuring the environmental sustainability of water use and re-use; full participation of stakeholders and a strong institutional capacity from local to national level.

The sector priorities focus on providing basic water supply and sanitation services to all Namibians, at an affordable cost. This will be achieved through the combined efforts of the government and the beneficiaries, based on community participation and the acceptance of mutual responsibility.

4.3 VISION 2030

In 2004, the government launched Namibia's Vision 2030 that provides the overarching framework for the development of Namibia with the main goals of improving the quality of life of its people and achieving the status of a developed country by the year 2030. Water resources development will significantly contribute to the achievement of the Vision goals and in this respect will provide the framework for the water sector policy and strategy goals and objectives. Good progress regarding water supply coverage has been made since independence. If implementation continues at the current rate, and with steady financial and human resources backing the programme, 100 per cent coverage for both urban and rural areas could be achieved by the year 2030. Progress regarding appropriate sanitation coverage has been less comprehensive since Independence, however, and a greater focus on this part of the sector is required.

To achieve the targets for water and sanitation, the strategy to be followed is to encourage both users and beneficiaries to participate in the management and regulation of access to water and sanitation, in rural areas through the further extension of responsibilities of the Basin Management Committees and rural Water Point Committees.

4.4 OBJECTIVE OF THE NATIONAL IWRM PLAN

As stated above, the overall long-term objective of the IWRM Plan for Namibia is to enable Namibia to achieve a sustainable water resource management regime contributing to social equity, economic efficiency and environmental sustainability in the country. The following issues drive the need for IWRM:

- Shortcomings in the management of water; a focus on developing new sources rather than managing existing ones better; and top-down sector approaches to water management that result in uncoordinated development and management of the resource,
- Growth in population, increased economic activity and improved standards of living lead to increased competition for and conflicts over the limited freshwater resources,
- A combination of social inequity and economic marginalization forces people living in poverty to overexploit land and other natural resources, with damaging impacts on water resources,
- Water demand has increased faster than the growth in population in many places;
- The threat of pollution increases the risk of water scarcity,
- More and more development means greater impacts on the environment,
- Current concerns about climate variability and climate change demand improved management of water resources to cope with potentially more intense floods and droughts.

4.5 APPROACH AND METHODOLOGY FOLLOWED IN THE DEVELOPMENT OF THE NATIONAL IWRM PLAN FOR NAMIBIA

An overview of the approach and methodology followed in the development of the National IWRM Plan for Namibia is presented diagrammatically in **Figure 7** below. Essentially the same approach, based on the national plan was followed for development of the Cuvelai – Etosha Basin IWRM Plan.

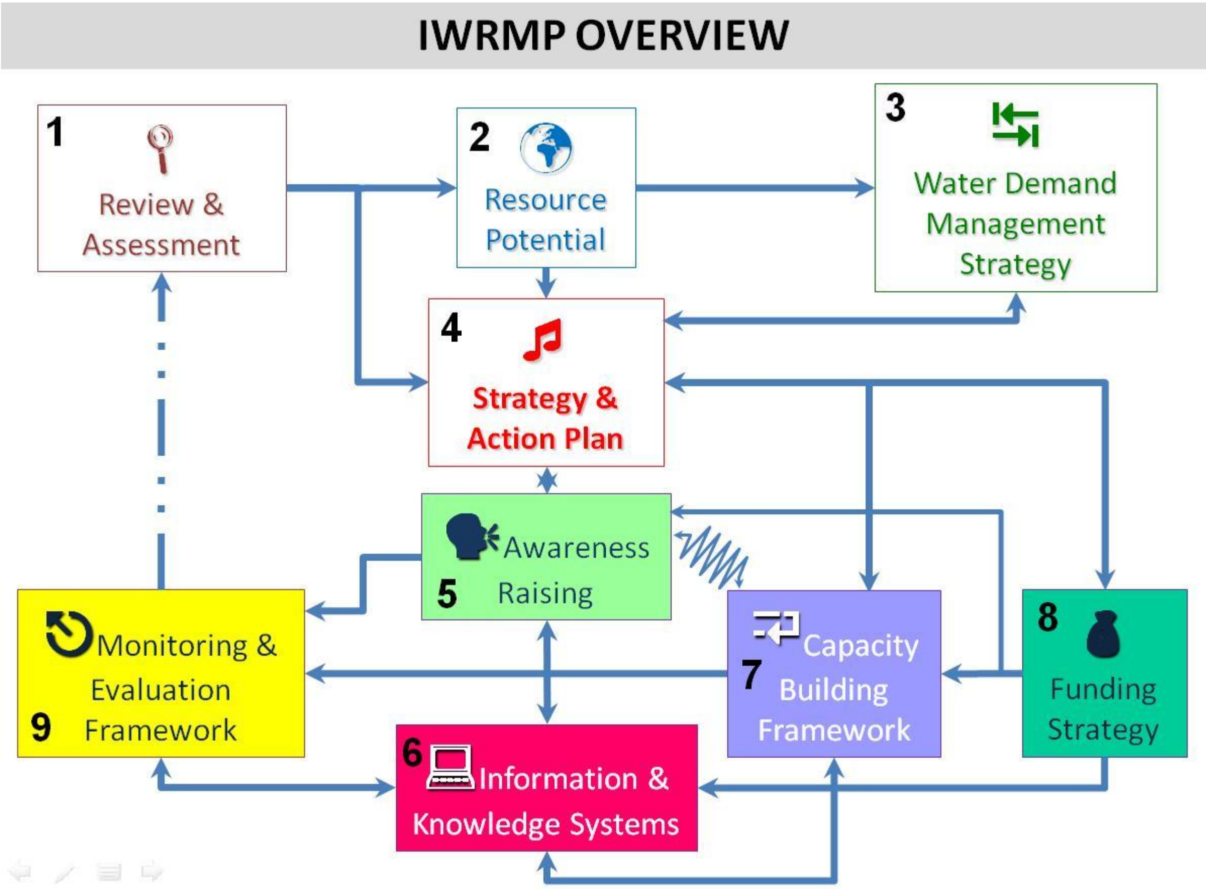

Figure 7: Overview of the IWRM Plan development

In view of the arid nature of the climate of the country, a vast array of activities has taken place over many years to ensure water security. These have resulted in the development of policies, legislation, plans and strategies to achieve the overall goals of water resource management and sustainable water use in Namibia. However, these activities did not always embody the basic philosophy of IWRM that places an emphasis on stakeholder participation and decision making at the lowest appropriate level. In order to embody the accepted IWRM principles and to consolidate these activities in a comprehensive IWRM Plan for the future, the Project to develop the plan was designed in such a way that eight thematic reports were prepared which lay the foundation for the formulation of the National IWRM Plan.

The study to prepare the National IWRM Plan reiterated that most of Namibia has an arid to semi-arid climate. Significant features of this climate are high maximum temperatures and high spatial and temporal variability of rainfall, both within and between years. For the future it has been predicted that maximum temperatures will increase and less rainfall will fall during a shorter rainfall season. However, when it rains the rainfall will be more intense due to increased frequency of convective storms, coupled to increased humidity and temperatures. A number of approaches have been developed/tested/proposed to enhance the ability of Namibia to cope with the present and future water demands under highly variable climatic conditions, and are illustrated in **Figure 8.**

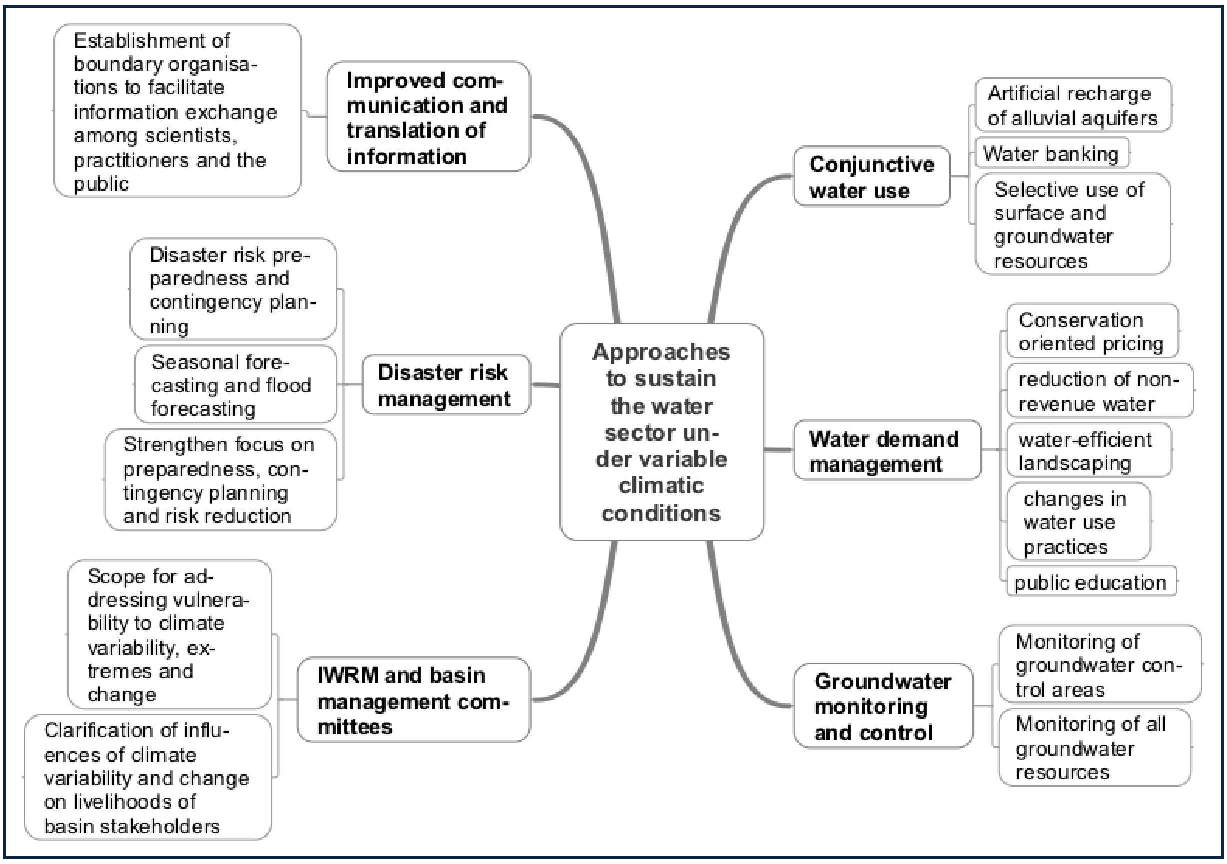

Figure 8: Approaches to enhance the ability of Namibia to sustain the water sector under increasingly variable climatic conditions and climate change

The six main approaches shown in bold text were incorporated into the National IWRM Plan for Namibia as they all have the potential to contribute to improved water management. This approach has also been applied to IWRM Plan for the Cuvelai – Etosha Basin.

As can be seen, the implementation of IWRM goes hand-in-hand with the participation of the Basin Management Committees in the management of a basin. This illustrates the importance of the BMCs to execute their functions and responsibilities regarding the implementation the IWRM Plan for the CEB. This is critical and necessary to ensure continued water provision to an increasing population with increasing demands for water under current climate variability and predicted future climate change.

4.6 SUMMARY OF THE EXISTING SITUATION IN NAMIBIA RELEVANT TO THE CEB

Below is an overview of the existing integrated water resources management issues in Namibia that are relevant to the situation in the Cuvelai – Etosha Basin:

4.6.1 Water policy, legislation and regulation

Below are the existing policies and legal framework that apply to the CEB:

- Existing key water policies, namely the 2000 National Water Policy (NWP) and the 2008 Water Supply and Sanitation Sector Policy (WSASP), are in harmony with IWRM principles. Some aspects of the policies are not yet implemented.

- The existing Water Act will soon be replaced by the revised Water Resources Management Act (WRMA) and will remove constraints to the implementation of IWRM.
- Legislation to provide continuous financial and managerial support to Basin Management Committees such as the Cuvelai – Etosha Basin is provided for in the WRMA.

4.6.2 Institutional structures responsible for water

A number of water service providers with different responsibilities are involved in water and sanitation infrastructure planning and development. Improved communication and cooperation between these bodies are essentially weak. The relevant institutions include:

- NamWater, responsible for bulk water supply, developed a water supply infrastructure development and capital replacement master water plan for the central north water supply area;
- Department of Water Affairs and Forestry, responsible for resource management and rural water supply and sanitation coordination, developed a National Sanitation Strategy for the period 2010/11 – 2014/15;
- Regional Authorities, responsible for small scale water supply to small communities;
- Local Authorities, some responsible for their own bulk water supply, water reticulation and sanitation while others are just responsible for water reticulation and sanitation;
- Private Sector, responsible for water supply in agriculture, mining and tourism.

4.6.3 Water institutional development

- The DWAF institutional structure will soon be fully aligned with IWRM and to support BMCs.
- Coordination between central and decentralised structures, e.g. BMCs concerning water management, needs improvement
- BMCs have been established in the four Sub-Basins of the Cuvelai – Etosha Basin with one overarching BMC.

4.6.4 National and basin-level resource management

Capacity for environmental resource management at national level is weak. Similarly, capacity at basin level is also limited. This includes issues related to:

- Water resource conservation;
- Regular groundwater level monitoring;
- Resource security related to availability during droughts and pollution;
- Effective and efficient resource use;
- Reduction of water wastage in all sectors;
- Land use and rangeland management in the face of overgrazing;
- Wetland treatment systems for waste water disposal;

- Grey water recycling for reuse in agriculture and agro-forestry; and
- Control over bush encroachment to enhance groundwater recharge.

4.6.5 Service provider capacity

Service providers generally lack capacity to implement IWRM to an acceptable level. This includes capacity for activities such as:

- Establishment of a fair tariff structure based on principles of cost recovery and social responsibility;
- Training to improve skills levels, particularly at the rural levels.

4.6.6 Stakeholder capacity building

Areas where strengthening of stakeholder capacity is essential include:

- Management of BMCs, e.g. in the Cuvelai – Etosha Basin;
- Pollution prevention and source protection;
- Community engagement in BMCs and WPCs;
- Legal empowerment of BMCs with clarification of the legal role of BMCs and their obligations;
- Advisory role of BMCs to stakeholders in their basins;
- Financial resources of BMCs to perform their duties adequately.

4.6.7 Data and information gaps in the water sector

- Division of Geo-hydrology lacks time series data for water quality in boreholes;
- Division of Hydrology:
  - Lacks volunteers collecting data for the Division;
  - Insufficient staff to conduct sufficient monitoring and interaction with clients;
  - Backlog in processing collected data due to insufficient staff;
- Division of Water Environment has low reliability/high maintenance of automatic climate stations and poor data quality;
- Directorate of Rural Water Supply stores most of its data in Excel sheets;
- NamWater stores data in hard copies;
- Only 50-60% of permit holding local authorities report their abstraction figures to DWAF and most of their data is stored in Excel sheets;
- Regional Councils have limited historical data available;
- The CEB BMCs has no water resources management plan or guidelines for data, information and knowledge management. In addition, there are no structured monitoring programmed in any of the basins in Namibia. Appropriate water infrastructure designs as well as harmonising investment plans with policies require on-

going attention in all basins and calls for capacity strengthening as stated in paragraph 4.4.6 above;

- The Tourism sector has no or limited reporting on water abstraction and consumption.

4.6.8 Stakeholder engagement and gender issues

Issues requiring on-going attention for IWRM include:

- Funding the drought management strategy;
- Addressing consequences of climate change require the integration of investments in:
  - Improved flood management;
  - Extended hydrological gauging networks;
  - Improved hydrological modelling;
  - Improved groundwater modelling;
  - Improved data processing;
  - Appropriate drought management;
  - Enhanced disaster risk management;
  - Improved communication and transfer of information.

4.6.9 Cost recovery

In the context of IWRM, water is both an economic and social good and therefore the cost of water and sanitation services must be recovered to ensure performance and make those services financially viable.

- Life cycle costs of water supply infrastructure must be determined before capital investments are made;
- Ensure that tariff structures and pricing of water services are equitable, affordable and reasonable;
- Revenue collection must be done and should be improved;
- Income must be appropriated correctly to maintain water and sanitation services;
- Income generated through water sales must be appropriated in the water sector.

4.6.10 Investments in resource management

Issues requiring on-going attention for IWRM include:

- Funding for water resource investigations should be increased;
- Funding water resource conservation should be included in all policies and programmes for the management and use of water resources;
- Funding of the national sanitation strategy
- Fund the drought management strategy;
- To address consequences of climate change, integrate investments in:

- Improved flood management;
- Extended hydrological gauging networks;
- Improved hydrological modelling;
- Enhanced disaster risk management;
- Improved communication and transfer of information.

4.6.11 Equitable access to water

By 2030, equitable access to water should be supported by:

- Water pricing that reflects the cost of water supply;
- Subsidies being fully transparent and mainly restricted to lifeline amounts for low income users;
- Greater dissemination and use of Namibia's Natural Resource Accounting programme, to inform policies and future development;
- An increase in the reuse and recycling of water;
- An increase in the use of alternative water sources such as water derived from desalination and other unconventional sources;
- An increase in the number of basin management committees that are established and functioning.

4.7 WATER DEMAND TRENDS

The following trend in water demand increases are foreseen if Vision 2030 is realised:

4.7.1 Urban water sector

The urban population in Namibia will increase dramatically to 2.24 million or 75% of the total population in 2030 due to urbanization. A similar high rate of urbanization is expected in the CEB, in combination with rising income and industrial development that will increase urban water demand significantly. The rural to urban migration requires major capital investment to provide access to water and sanitation services especially to the poor that cannot afford to pay for these services.

4.7.2 Rural Domestic water sector

The rural water demand consists primarily of the use of potable water for domestic purposes at households, schools, clinics and for livestock. With the high rate of urbanization, the rural population will not increase significantly while livestock numbers will vary over time according to the availability of grazing as determined by the rainfall. The water demand is therefore not expected to increase significantly over time, but may vary between maximums and minimums due the climate conditions.

4.7.3 Irrigation water sector

According to the Green Scheme Policy, most new irrigation schemes will be concentrated along the perennial rivers which will increase the water requirements in these areas significantly. In the CEB water is imported from the Calueque Dam on the Kunene in Angola to supply the irrigation projects in the northern parts of the CEB (Etunda, Mahenene, and in the Olushandja Dam basin). Water use efficiency and pollution will be major focus areas for proper water management to prevent international conflicts. In the Tsumeb sub-basin groundwater is used.

4.7.4 Livestock water sector

Due to the limitation of the livestock carrying capacity of the land it is foreseen that the number of stock will be variable as influenced mainly by annual rainfall and availability of grazing. The water demand of livestock in the CEB will be variable over time as dictated by the availability of grazing and will basically remain stable. The policy of value addition within the meat industry will require, and may lead to an increase in the number and capacity of abattoirs in the CEB. The effluent from abattoirs may contaminate water resources if not carefully managed. The biggest threat to water resources as a result of overgrazing is bush encroachment which reduces the recharge of groundwater sources.

4.7.5 Mining water sector

Large mines can consume vast quantities of water but the development of mining in the CEB is basically limited to copper in the Tsumeb sub-basin of the CEB, dolomite at the Ohorongo cement factory and salt at the Otjivalunda salt pans. These mines do not use much water, but mines always constitute a serious groundwater pollution threat for karstic and other secondary aquifers if not properly managed and controlled.

4.7.6 Tourism water sector

The tourism sector was identified as one of the major growth sectors. The development of high quality, low impact consumptive and non-consumptive tourism is encouraged. The large number of lodges established in Namibia (500+) may increase the water requirement in the sector significantly. The number of lodges in the CEB is also increasing. Care must be taken that abstraction of water for lodges in ecologically sensitive areas does not lead to over abstraction of water. If not properly managed, inadequate wastewater and refuse disposal may cause groundwater pollution.

Some of the points that can be highlighted as challenges for sustainable and affordable water supply include:

- Upgrading of existing and construction of new infrastructure to meet growing demands.
- Funds need to be provided for water development to keep pace with demands.
- Efficient operation of water supply schemes is essential.
- Implementation of WDM with sufficient funding to realise the benefits.
- Maintenance of existing infrastructure. Maintenance has fallen way behind what is required. There is a major backlog in capital replacement to replace infrastructure beyond its economic life time. Funding and capacity building are the main concerns here.
- Research and investigations into new resources, particularly groundwater and artificial groundwater recharge.
- Flood management.
- Awareness raising on a continuous basis to ensure respect for water availability.

- Capacity building in the skills to operate and manage new technologies such as seawater desalination. This is required at all skills levels.

5. IWRM PLAN FOR THE CUVELAI – ETOSHA BASIN

5.1 GENERAL BACKGROUND

What is important to be aware of is firstly that the Cuvelai – Etosha Basin (CEB) is located in both Angola and Namibia, which means that the basin is drained by an internationally shared trans-boundary watercourse system. Secondly, the Namibian portion of the basin has been sub-divided into four sub-basins to facilitate the implementation of integrated water resources management in a practical way. However, the northern parts of Namibia have also been divided into a number of administrative Regions and the boundaries of the Regions do not conform exactly to the boundaries of the sub-basins. In fact, the area of the CEB in Namibia covers six of the northern Regions. See **Figure 9** for the boundaries and the names of the Regions in thick black lines.

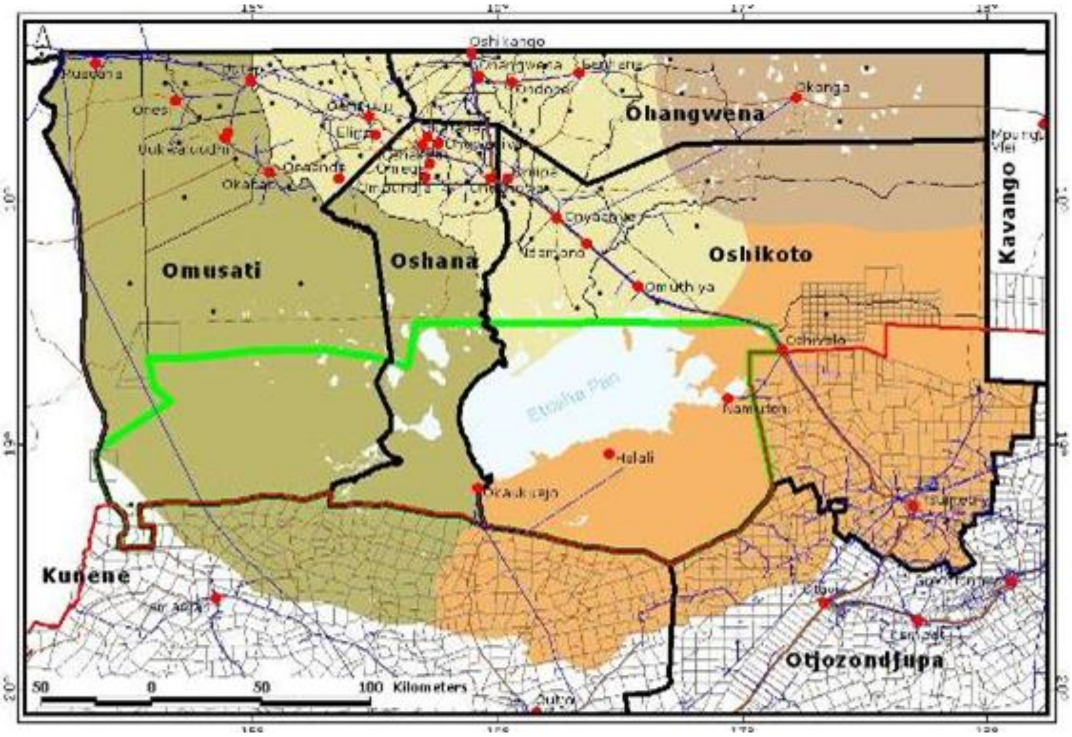

Figure 9: Regions and Regional boundaries in the CEB

Table 2 shows the areas of the Regions and the sub – basins in the CEB.

Table 2: Regions and Sub-basins in the CEB

REGION	SURFACE AREA IN THE BASIN (km²)	SUB-BASIN	SURFACE AREA IN THE BASIN (km²)
Kunene	5 287	**Iishana**	21 199
Ohangwene	10 706	**Niipele**	9 080
Omusati	26 550	**Olushandja**	32 613
Oshana	8 647	**Tsumeb**	29 358
Oshikoto	38 685		

Otjozondjupa	2 375		
TOTAL	**92 250**	**TOTAL**	**92 250**

5.2 GEOGRAPHICAL FEATURES OF THE CEB

5.2.1 Location

The Cuvelai Basin is located in central, southern Angola and central, northern Namibia. See **Figure 10** below.

Figure 10: Location of the Cuvelai –Etoshabasin

The border between Angola and Namibia is a 460 kilometre (km) unfenced cut line running due east from the middle of the Cunene River at the top of the Ruacana Falls in the west to the middle of the Okavango River in the east. The Angolan portion of the basin covers 52 750 square kilometres (km²) or about 36% of the whole basin and the Namibian portion covers 92 250 km² or about 64% of the basin, which means that the total area of the whole basin is about 145 000 km² in extent. The water resources of the basin are trans-boundary in nature and therefore internationally shared between Angola and Namibia.

5.2.2 Topography

The general topography of the basin is characterized by the Serra Encoco hills located in southern Angola and further to the south there is a sandy plain of low relief and a very shallow gradient towards the Etosha Depression in northern Namibia. The headwaters of the Cuvelai watercourse system rises at an elevation of about 1 480 metres (m) above mean sea level in the north of the basin drains southwards over a distance of about 430 km before it terminates in the Etosha Pan at an elevation of about 1 090 m above mean sea level. The flow in the Cuvelai watercourse system is endoreic because it does not terminate in the sea, but in the Etosha Pan. See the drainage pattern in **Figure 11** below.

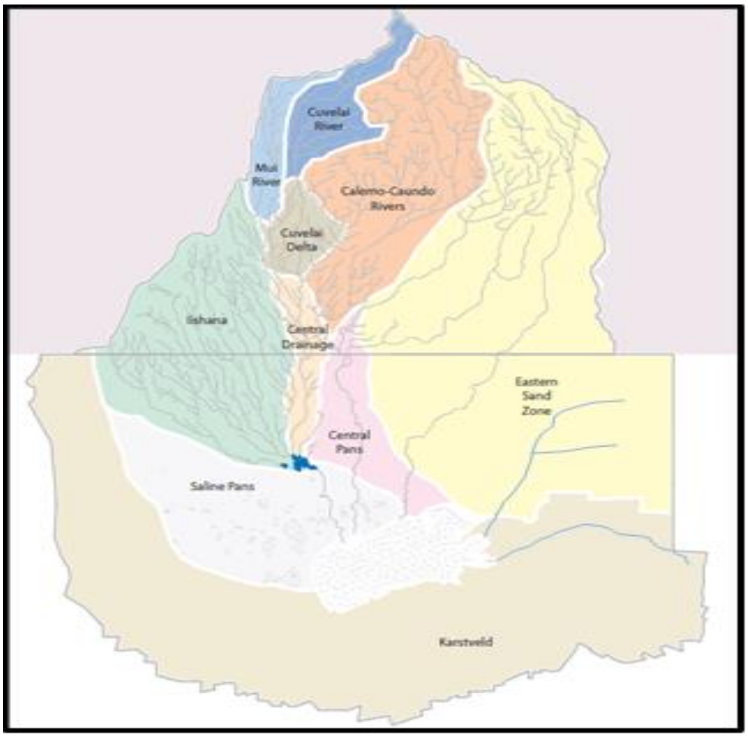

Figure 11: Cuvelai drainage system

At the highlands the source streams such as the Mui and the Cuvelai are perennial and well-defined, fed by annual summer rainfall of more than 1 500 millimetres per annum (mm/a) on average. Although the main stream of the Cuvelai in Angola is perennial for about 100 km up to the town of Evale, the land becomes flatter and the watercourses gradually dissipates into shallow, ephemeral channels as they meander towards the Namibian border. These watercourses are called chanas in Angola and oshanas in Namibia (*iishana* in Oshiwambo). The seasonal flow is ephemeral (intermittent) further downstream in the basin. The watercourse system is also endoreic because the flow never reaches the sea.

Between the border and Ondangwa the gradient of the landscape is approximately 1:2 500 and varies between 1:5 000 and 1:10 000 further south towards the Etosha Pan. The advantage of this is that water moves relatively slow, less than 0.5 metres per second (m/s), through the drainage system and erosion is minimized, although the water still contains a high percentage of colloidal material, making the water turbid.

In the central parts of the basin the drainage pattern is from north to south and there are numerous interconnected shallow ephemeral watercourses and pans. The main watercourses from the north are the Oshana Gwashuui which goes past Ogongo, the Oshana Shalupumbu which runs to the east of Ogongo, the Oshana Cuvelai passing Oshakati and the Oshana Owashigambe passing Oshigambo.

In the northwestern part of the basin in Namibia the Oshana Olushandja drains northwards from a watershed to the east of Eunda into the Cunene River and the Oshana Etaka drains from the same watershed in a southeasterly direction to towards Lake Oponono.

The oshanas from the north-west and the north ramify into a delta of drainage channels that converge in the area of Lake Oponono and flow southwards via the Oshana Ekuma towards the Etosha Pan, a flat, saline depression roughly some 7,000 km² in extent. Some of the oshanas from the north, such as the Odila and the Owashigambe and the oshanas in the eastern part of the basin, such as the

Akadhulu and Owambo run from east to west and continues directly into the Etosha Pan. The Omuramba Owambo flows strongly from time to time because it originates to the north of the Otavi Mountain land on the southeastern edge of the Etosha Pan.

5.2.3 Climate

The Cuvelai Basin receives convective seasonal rainfall in summer from October to April. The average precipitation in the upper reaches of the basin in southern Angola is 1 500 millimetres per annum (mm/a) and decreases to about 450 mm/a over the Etosha Pan in the south. The western part of the basin receives less rainfall (about 300 mm/a) than the eastern part (about 550 mm/a). See **Figure 12**.

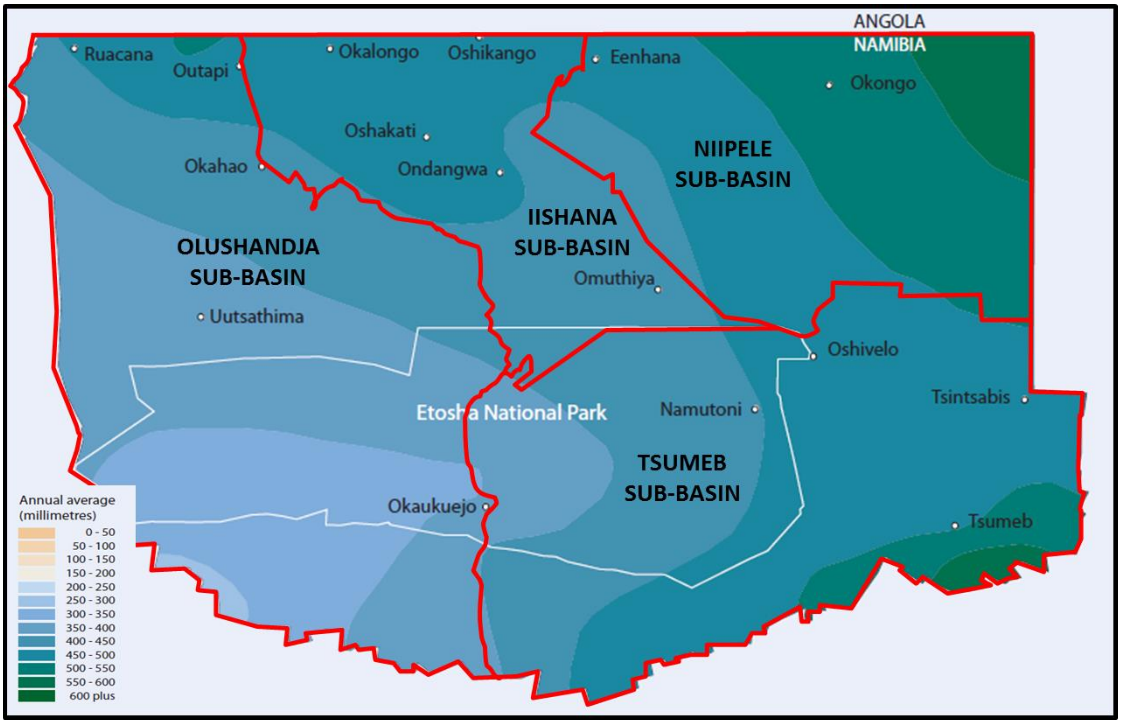

Figure 12: Mean Annual Rainfall. Boundaries of the different sub-basins are shown in red

The rainfall is in general extremely variable, erratic, spatially unevenly distributed, unreliable and therefore totally unpredictable. Major unpredictable droughts and floods also occur from time to time.

The average potential evaporation varies between 2 300 mm/a in Angola and 2 700 mm/a in Namibia. The difference between the mean annual rainfall and the mean annual potential evaporation is an indication of the aridity because the rainfall is much less than the evaporation and the environment quickly desiccate after the rainy season has ended. See **Figure 13.**

The average maximum temperature in the basin during the hottest month in summer is 34 - 36°C and the average minimum temperature in the basin during the coldest month in winter is 6 - 8°C. The temperature can go as high as 40°C in summer, but in winter it remains above freezing point and frost rarely occurs. These conditions cause rapid and high evaporation losses from shallow open water surfaces

Climate change predictions suggest increases in temperature resulting in high evaporation rates and increased salinity in the oshanas. It is further predicted that rainfall in the Cuvelai – Etosha basin will start later and end earlier in the rainy season, with an overall decrease in seasons with average to above average rainfall. Due to the arid and highly variable climate in Namibia, water resource managers and users have to focus on improving the efficiency of water resource use through improved of water demand management practices.

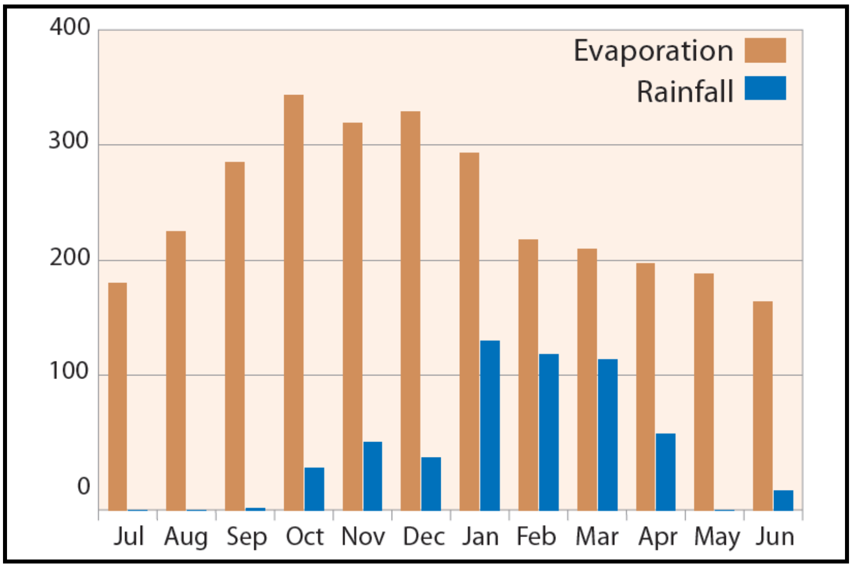

Figure 133: Relationship between Rainfall and Evaporation

5.2.4 Geology and Hydrogeology

A simplified overview of the hydrogeology of the different aquifers in the CEB is given in **Figure 14** and the boundaries of the different sub-basins are shown in red.

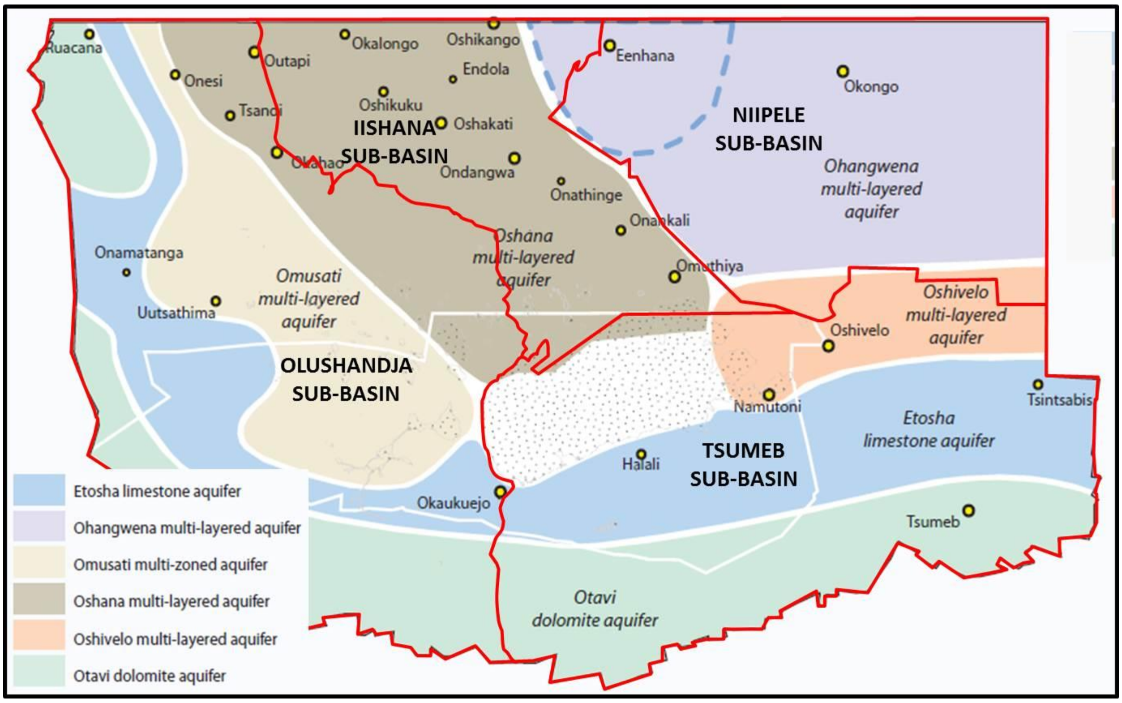

Figure14: Cuvelai aquifer system

The geology of most of the Cuvelai Basin comprises a complex system of Tertiary and Quaternary sedimentary deposits known as the Kalahari Group. The successive layers of sands, sandy clays, sandstones and conglomerates have been deposited 30 to 40 million years ago and are up to 500 m thick. The Kalahari Group is underlain by mudstone, sandstone and conglomerates of the Omingonde Formation of the Karoo Sequence while tillite, shale, sandstone and limestone of the Dwyka Formation is exposed along the western edge of the basin in the Kunene Valley.

In the upper basin in Angola there are outcrops of granite and gneiss while older meta-sediments and meta-volcanic rocks occur.

The southern perimeter of the Etosha depression is formed by mountains of low relief comprising dolomites of the Damara Sequence. The dolomites are karstified and provide ample mobility for groundwater to the southern edge of the Etosha Pan where numerous springs and seeps occur. Groundwater is rainwater that has seeped into the ground where it is stored in water-bearing layers known as aquifers.

The direction of the underground flow of water in the Cuvelai aquifer system is shown on **Figure 15.**

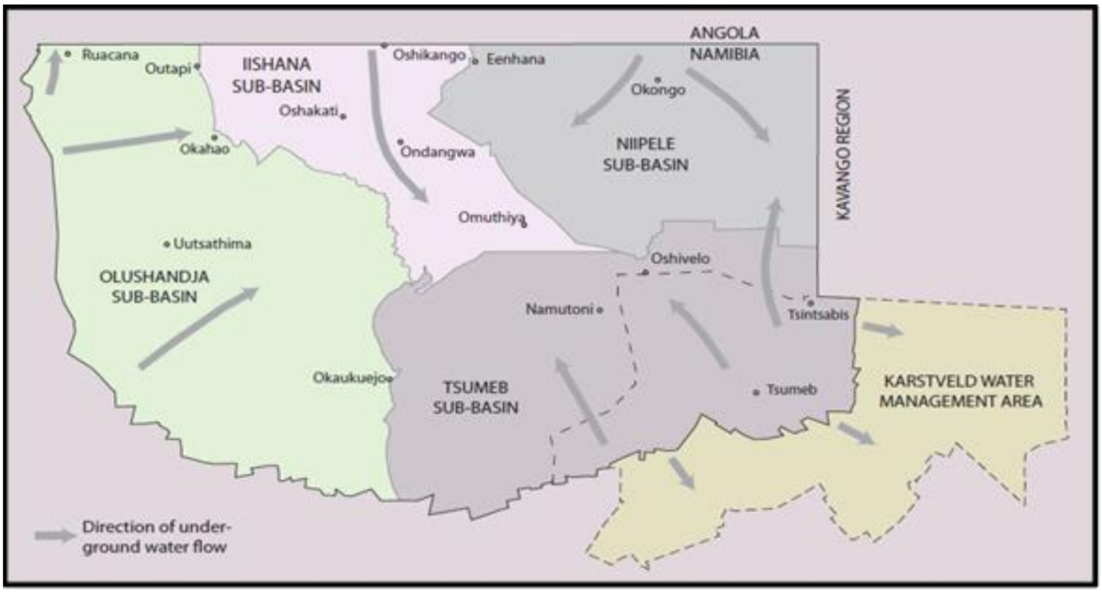

Figure 15: Underground water flow in the aquifer system

5.3 WATER RESOURCES

5.3.1 General

The Cuvelai Basin has access to a number of water sources that can be classified as:

- Water harvested from direct rainfall on the land or on roofs
- Ephemeral surface runoff from rainfall in Angola and Namibia
- Perennial surface runoff (transferred from the adjacent Cunene River basin)
- Groundwater
- Waste water
- Unconventional water sources

The potential of each of these resources will be briefly elaborated.

5.3.2 Rainfall

The surface water sources in the Cuvelai basin in Namibia comes from direct, local summer rainfall. If the convective rainstorms have a high intensity and long duration, ephemeral runoff occurs in the oshanas. The runoff is erratic, and unreliable due to the intensity, variability and unpredictability of the rainfall. Due to the seasonal occurrence of the rainfall, surface runoff is only available during the rainy season and standing open water evaporates very quickly. Rainfall can be harvested *ie* from rooftops.

5.3.3 Ephemeral surface water sources

Very little surface water occurs naturally in the Cuvelai – Etosha Basin during the dry season. Open water is available from shallow wells (Omifimas) in some areas. The flat nature of the terrain presents no opportunities to construct large surface water impoundments where the runoff can be stored for later use during the dry season, but small excavation dams and pumped storage earth dams have been built to supply surface water for some time after the rainy season.

The water flows, or often referred to as floods, are unpredictable and their magnitude vary greatly. Strong floods lead to deeper flooding of lower lying areas and people who have encroached with their homes into those areas are often unprepared for the higher flood events and suffer damage, even loss of life. Exceptionally high flows, locally called *efundjas* occurred at least 11 times since 1941. Those were in 1950, 1954, 1957, 1971, 1976, 1977, 1995, 2004, 2008, 2009 and 2011. It is clear that there were no *efundja* events in the sixties, (1958 to 1971). This means that there are periods of more than ten years where these events do not occur and it may happen again in future in spite of four events in the past ten years. The cycles of highly variable rainfall and concurrent water flows have done much to shape the topography and drainage patterns of the Cuvelai, as well as the characteristics of the soils, the availability of shallow, fresh groundwater, the recharge of aquifers under the ground and the dense concentration of the population in certain areas.

Due to the flat terrain, there are very few places where the floodwaters converge enough to the extent that the flow of water inundating the vast, flat landscape can be measured. It is therefore very difficult to determine and quantify the magnitude of the runoff. However, the occurrence of flood events has been recorded since 1941 (although no information is available for 13 years) and the magnitudes have been estimated as shown in **Table 3** below.

Table 3: Floods in the Cuvelai Basin in Namibia 1941 - 2011

Arbitrary flow description	Number of events over 70 years (13 years with no record)	Magnitude (Mm^3)
Very Good	11	50 – 100
Good	17	15 – 50
Weak	12	0,1 – 15
Negligible or no flow	30	0

The mean annual surface runoff in the CEB is estimated as in excess of 100 million cubic metres per annum (Mm^3/a), but due to its unreliability it is difficult to utilise this water effectively. The Etosha Pan also relies on flow from this system, and the flow is important for groundwater recharge.

Several excavation dams have been constructed in the oshanas to collect seasonal surface runoff when available. The water is primarily used for livestock water supply. Although the dams are expensive to build, the water is free for people and livestock to use. The major disadvantage of earth dams is that they are not good for storing water for a long period of time because most of the water is lost through evaporation. The water in earth dams is usually contaminated and not safe for people to drink, unless it is filtered to make the water clear and aesthetically acceptable and is disinfected or boiled to kill pathogens. Although the surface water is used for stock drinking, and human consumption, it is difficult to quantify the quantity of water used.

Before more reliable water was imported from the Kunene River, the local runoff in the oshanas was utilised for domestic water supply by diverting or catching the runoff in the oshanas in excavation dams. This water was transferred to pumped storage dams to store enough water to provide water for two years in order to bridge at least one dry season with no runoff in the oshanas. The water from the pumped storage dams was treated for supply to domestic consumers. This system has fallen into disuse over time due to the availability of water from the Kunene and the seasonal runoff in the oshanas is basically only used for stock drinking.

5.3.4 Perennial surface water sources

Namibia needs perennial river water in future for the augmentation of its internal surface and ground water resources. All the perennial rivers are on Namibia's borders and are shared with other basin states. The allocation of a reasonable and equitable share in the use of the water from a trans-boundary water resource must be negotiated between the basin states that have an obligation to manage them in terms of the relevant rules of International Law. These negotiations are based on certain underlying principles which are; to adopt a holistic approach with respect to their use, protection and regulation. The following principles should be adopted in such negotiations:

- A basin State has a right to use the water from a shared river;
- The use of the water from shared river by one State cannot be denied by another State;
- One State cannot reserve (claim) water from a shared river for a future use.

A basin State must therefore use the water from a shared river to vest its interest in its right to the water.

There is an international water use agreement between the Governments of Angola and Namibia that Namibia may abstract water from the perennial Kunene River upstream of the Ruacana Falls at the Calueque Dam in Angola. It was agreed that Namibia may abstract water at a maximum rate of 6 (six) cubic metres of water per second (m^3/s), which amounts to about 180 Mm^3/a. Water is at present imported from a pump station at the Calueque Dam. The current pumping capacity of the water transfer system from the pump station is about 2.5 m^3/s or approximately 74 Mm^3/a. This imported water is distributed throughout almost all of the CEB in Namibia where the poor quality of the groundwater makes it unsuitable for human and stock consumption.

5.3.5 Groundwater sources

Although surface water is available in shallow watercourses and pans during the rainy season and for a short time afterwards, the population traditionally utilized the groundwater during the dry months by digging shallow wells next to or in the oshanas.

In the central area in the basin, drinkable water has traditionally been drawn from hand dug wells into the so-called "discontinuous perched aquifer" on the edge of the oshanas at depths to about 3m, but in most cases the water from the wells was not safe to drink due to all kinds of faecal contamination. Water that is below 3 m in depth has increasing levels of salinity and when fresh water runoff is stored in excavation dams that are deeper than 3 m, the fresh water is contaminated by the higher salinity groundwater.

Groundwater is mainly abstracted from the Ohangwena Multi-layered Kalahari aquifer and the Omusati Multi-layered Kalahari aquifer. The deeper water is abstracted by using boreholes. In certain parts of the basin where fresh water in the perched aquifer is found, shallow wells (known as "*omifima*") and deep wells (known as "*oondungu*") are used to get access to water for use in the more isolated villages in the basin. The digging of wells is a laborious activity and as the water table recede the wells must be dug deeper while the salinity of the water increases. The wells are often not optimally located and the permeability of the water into the wells is reduced due to the fine sand and clays in the soil. The sandy sides of the wells tend to collapse, animals may gain access to the water and the open water in the wells pose major health hazards.

In recent studies, it was found that the saline deep aquifer contains sedimentary horizons with fresh water and the water in these layers can be mobilized by isolating them from the saline water horizons by means of more advanced drilling techniques and sophisticated borehole development. Further investigations in the Ohangwena Multi-layered Kalahari aquifer in the north-eastern part of the CEB in Namibia have indicated, that fresh groundwater occur below the saline water at great depth, about 250 – 300 m, but the water is sub-artesian and rise to about 40m to 30m from the surface. This means that the water does not have to be pumped from a great depth and the rate at which the water can be abstracted is between 20 and 30 cubic metres per hour (m^3/a). Further developments are expected in groundwater abstraction from this resource because it has been estimated that the volume of water available is in the order of 5 000 Mm^3 and the water is recharged, but the rate of recharge and the long term sustainable yield of the aquifer must still be determined. If 50 boreholes with a yield of 20 m^3/h are developed and installed, it would be possible to abstract about 8 Mm^3/a over a 22 hour pumping day.

This groundwater resource will reduce the need to supply the expansion of more piped water schemes with water from the Kunene or from the Okavango to support development in the north-eastern part of the CEB.

The underground water system of the Otavi Mountain land in Grootfontein sub – Tsumeb – Otavi triangle in the Tsumeb sub-basin is known as the Karst Aquifers. A "Karst aquifer" is a dolomite rock formation that is water bearing because rainwater formed solution cavities in the rock. The long term sustainable safe yield from the Karst aquifers in the Tsumeb sub-basin is 18 Mm^3/a. These formations also form the southern and western edge of the Etosha depression. There is a large cave filled with water in the dolomites near Grootfontein, the Dragon's Breath Cave, and this cave is nothing but a huge solution cavity. The lakes at Otjikoto and Guinas near Tsumeb were also such caves, but a sink holes was formed when the roof of an underground cave at each site collapsed.

The present estimate of the quantity of water that is available from groundwater sources in the CEB is about 36 Mm^3/a. This includes the estimated 8 Mm^3/a available from water stored in the new regional sub-artesian aquifer discovered in the north-east of the CEB in Namibia. NamWater operates 6 borehole water schemes in the CEB and supplies about 600 000 m^3/a from 12 production boreholes.

In 2009, there were records for 8 833 boreholes drilled in the CEB. There are 139 monitoring boreholes in use the CEB. Two of them are analogue recorders, 59 digital and 78 manual.

5.3.6 Groundwater quality

In the revised Draft Water Resource Management Bill one of the fundamental principles accepted was that the "equitable access for all people to safe drinking water is an essential, basic human right to support a healthy productive life".

Salinity

Groundwater over the greater part of the central Cuvelai basin contains prohibitively high levels of dissolved salts which make the water unsuitable for human and stock drinking. Suitable groundwater does occur in the eastern and south-eastern areas of the basin.

Water with elevated levels of total dissolved solids can be corrosive and water with elevated levels of calcium and magnesium can cause hard water. Corrosive water or hard water may also cause damage to water supply equipment and needs careful consideration in the design of water supply infrastructure and water treatment works. Water with high levels of chlorides gives the water an unacceptable brackish or salty taste. Chlorides can also cause hypertension in humans.

See **Figure 16** for an indication of the distribution of the salinity in the groundwater in the basin. The boundaries of the four sub – basins in the CEB are indicated in red in the figures.

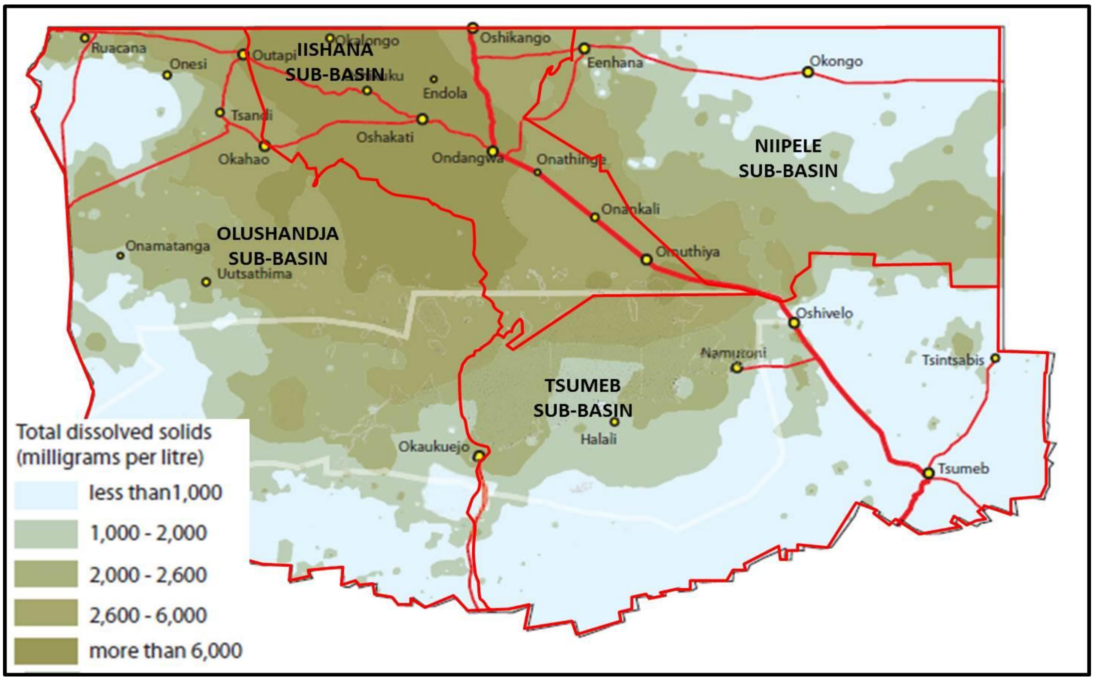

Figure 16: Distribution of the salinity in the groundwater of the CEB. The boundaries of the different sub-basins are shown in red

Figure 16 shows that the groundwater on either side of the road between Oshivello and Ruacana, and further south to the southern edge of the Etosha Pan (Mainly the Iishana Sub-basin) has very high salinity, larger than 6 000 mg/ℓ. The total dissolved solids can be as high as 30 000 mg/ℓ and in some areas the total dissolved solids in the water is about 60 000 mg/ℓ or twice as high as in sea water. The high salinity renders the water unsuitable for human and animal consumption. In the areas to the south of Etosha, in the north east and a small area in the west of the basin, the quality of the water is acceptable for human consumption.Due to the high total dissolved solids in the groundwater in the central parts of the Cuvelai Basin and the occurrence of unacceptably high levels of sulphate, nitrate and fluoride in the boreholes along the perimeter of the central oshana area in the Cuvelai Basin, groundwater has a limited use, but normally enough to sustain stock farming and domestic use in small settlements where the water is not too saline.

In the western, southern and eastern parts of the basin (Olushandja, Tsumeb and Niipele sub-basins) boreholes are used to abstract groundwater with acceptable levels of total dissolved solids, but many have unacceptably elevated levels of fluoride, nitrates and sulphates which make the water unfit for safe human consumption. The boreholes drilled in the area on the eastern side of the basin (Niipele sub-basin) are generally successful with yields in the order of 2 to 5 cubic metres per hour (m^3/h) at depths of 70 to 90 m. The water is potable and the concentration of the total dissolved solids in the water is about 500 milligramms per litre (mg/ℓ).

The yield of the boreholes drilled to mobilize the groundwater resources in the area on the western side of the basin (Olushandja sub-basin) is normally very low and more than 50% of the boreholes yield less than 2 to 5 m³/h at relatively shallow depths of between 10 and 30 m. The salinity of the water varies between 400 mg/ℓ in the northwest and 1 000 mg/ℓ in the southwest, but in the central western area it may be as high as 5 000 mg/ℓ, rendering the water barely useful for stock drinking. Borehole water is therefore insufficient to sustain large scale developments. The total number of boreholes drilled in those areas is about 1000, but only about 500 are in use according to a hydrocensus done in 2009.

Fluoride

High fluoride concentrations, above 3 mg/ℓ, may cause severe dental and skeletal deformation (bone fluorosis) in both humans and livestock, but especially young children. This can be observed when people display brown or mottled teeth. Teeth can be stronger when low levels of fluoride are in the water but mottled teeth can be weaker and wears much quicker. Very high fluoride levels are found in a belt running south-eastwards from Outapi towards Omuthiya and Oshivelo. Fortunately, most people in this area do not use deep groundwater, but high fluoride levels in eastern Oshikoto and western Omusati are of concern to people who drink borehole water in those areas. See **Figure 17.**

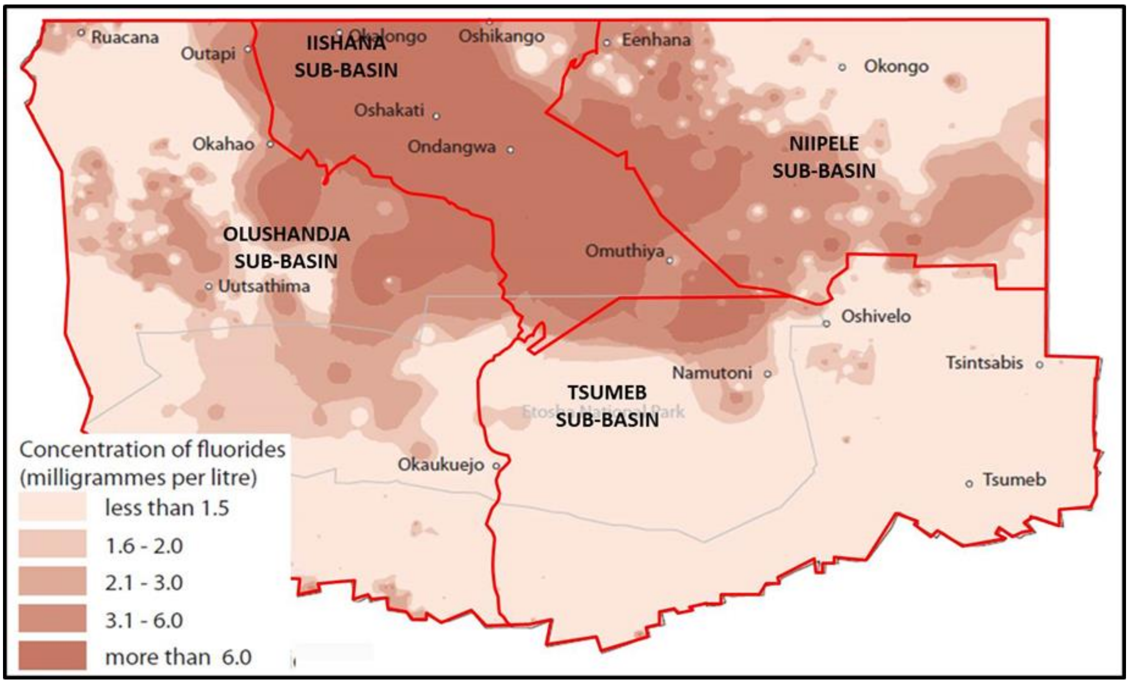

Figure 17: Concentration of fluoride in the groundwater of the CEB. The boundaries of the different sub-basins are shown in red

Nitrate

Consumption of excessive amounts of nitrates can result in a condition known as methaemoglobinemia, which starves the body's tissues of oxygen. The populations most affected by methaemoglobinemia are infants and people older than 45 years. High levels of nitrates can cause the death of babies under the age of one year and even birth defects. Nitrate levels above 10 mg/ℓ are considered harmful as they affect the ability of blood to carry oxygen to the lungs and tissues. Levels far higher than 10 milligrams are found in large parts of the Olushandja sub-basin in the Omusati Region and in localised places in a belt across the southern parts of the CEB (Olushandja and Tsumeb sub-basins). Cattle dung may contribute to groundwater contamination and unsafe levels of nitrates in groundwater. Care should thus be taken to ensure that groundwater sources used by humans are not polluted by livestock. See **Figure 18**on the next page.

Sulphate

Concentrations of sulphates above 500 mg/ℓ, in drinking water can act as a laxative for people that are not accustomed to elevated levels of sulphate. Higher levels of sulphate can cause diarrhoea while people who are accustomed to water with elevated levels of sulphate can suffer from constipation when water with lower levels of sulphate is consumed. Much of the CEB north of Etosha Pan has levels higher than this, but the high concentrations in the central parts of the CEB are of little concern to people who have access to piped water. However, the many people who depend on groundwater in southern and western Omusati may have problems. See **Figure19**.

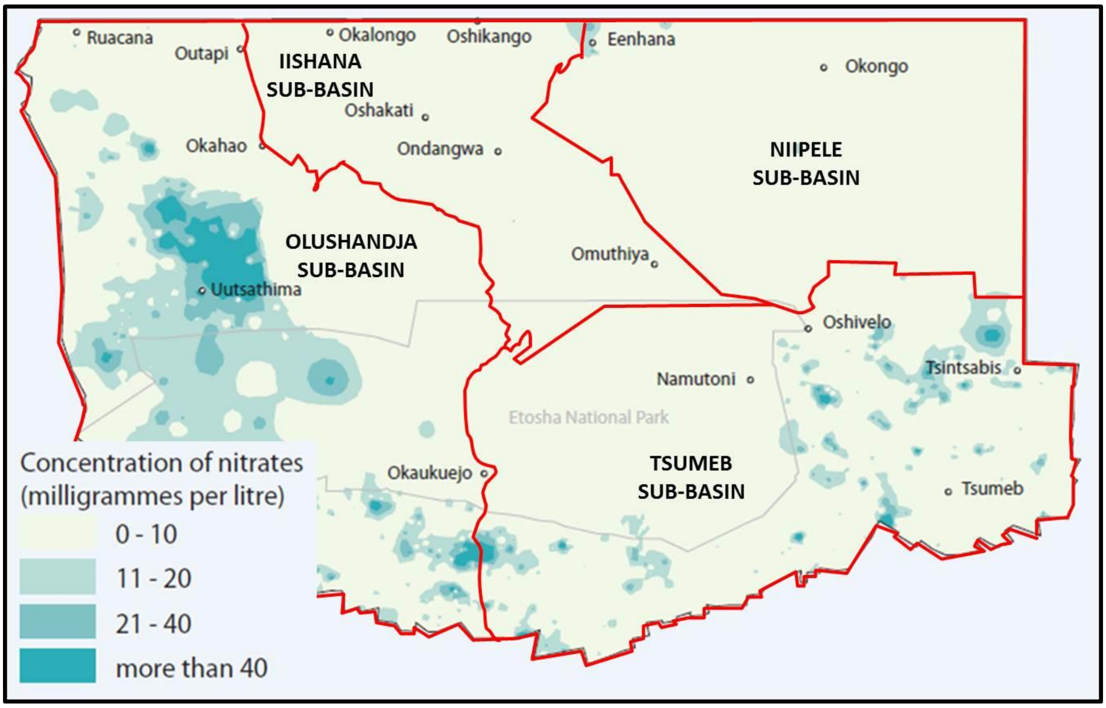

Figure 18: Concentration of nitrates in the groundwater of the CEB. The boundaries of the different sub-basins are shown in red

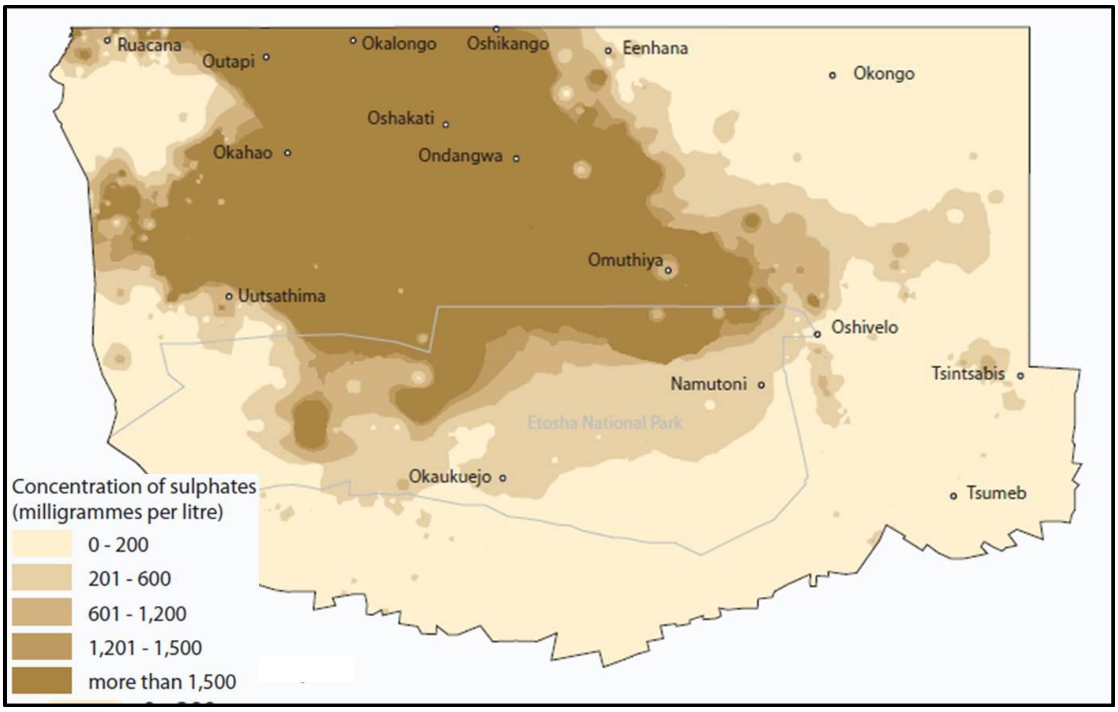

Figure 19: Concentration of sulphates in the groundwater of the CEB. The boundaries of the different sub-basins are shown in red.

5.3.7 Unconventional water sources

Traditional sources of water are either diminishing beyond the point of being accessible for increased development, or augmentation schemes are very expensive to develop**.** Alternative approaches must therefore be pursued and need to be examined to determine their viability, affordability in terms of capital cost, the degree and sophistication of the technology involved, operation and maintenance implications, the eventual unit cost of the water to the consumer and the environmental consequences.

Water conservation and water demand management can be facilitated by using unconventional water resources to alleviate water supply deficiencies. The use of unconventional water resources and the yield from such resources in comparison to the other water sources is at present negligible in the CEB and has so far only found application on a very limited scale at specific localities.

The types of unconventional water sources are discussed below and may not all have an application in the CEB, but they include the following:

- **Rainwater harvesting**

The possibilities for rainwater harvesting for large scale water supply is very limited due to the low mean annual rainfall and the seasonal nature of the rainfall (only available in the rainy season). Some schools harvest rainwater from the roofs and store the water in tanks to use it later for drinking purposes. Some households, especially in Windhoek where water demand management is encouraged, divert runoff from their roofs to their swimming pools or into water tanks for use in the garden and this can also be done in the CEB.

- **Reclamation of waste water**

Reclamation is when waste water such as domestic sewage effluent is treated to potable water quality standards. This method is used in Windhoek, but has not yet found an application in the CEB.

- **Reuse of waste water**

Reuse is when waste water is treated to some acceptable level that does not yet conform to potable water quality standards, but is disinfected before it is used again to water gardens, parks a golf course or sports fields. This method is used in Windhoek, Swakopmund and Walvis Bay for landscaping and watering sports fields or golf courses, but has not found a broad application in the CEB, except for an attempt at the Onandjokwe hospital in the 1980's to use a dual pipe system conveying effluent to water gardens.

- **Recycling of waste water**

Recycling is when waste water that has been used in an industrial process is re-used in the same process without any purification or treatment to improvement of the quality of the water. This method is mostly used by mines because the cost of water for mining is charged at full cost recovery rates and is therefore expensive. There is thus an incentive to not only save on the operational cost for water, but also to reduce the quantity of water required. This has not found an application in the CEB.

- **Desalination**

Desalination is a process using of energy to separate pure water from brackish or saline feed water. Desalination is an energy-dependent process and the overall efficiency is a function of the concentration of solids in the feed water, the desalination technology (Solar. thermal, electrical, mechanical) employed, and the size and design of the plant. Different energy sources and combinations thereof can be used to drive a desalination process, but the type of energy selected depends on the availability and affordability of power sources such as sunlight, wind, fuel and electricity.

The use of renewable energy sources in general, and specifically the use of wind and solar energy, holds few environmental risks and sunlight is abundantly available throughout rural Namibia. Although solar energy is free, the technologies available are less efficient than those powered otherwise. Presently, in the absence of targeted capital cost subsidies supporting the use of renewable energy technologies for desalination, the high upfront costs of such technologies are the main barrier limiting the large-scale rollout of such plant in rural areas throughout the developing world.

The desalination of brackish or saline groundwater in the Cuvelai Basin is technically possible, as has been establish by research that was done by the Department of Water Affairs and Forestry, but the operation and maintenance of the desalination equipment requires technical skills which are not readily available in the areas where the quality of borehole water could be improved upon. The desalination of saline borehole water has therefore not been seen as practical to implement.

The Cuvewaters Project in the CEB is at present investigating the long term sustainability of using desalination technologies. Several plants have been established and one unit supplies the village of Amarika with 5000 litres of water per day and another system provides water at Akutsima.

- **Aquifer recharge**

This technology is discussed here as background for the benefit of the BMC's, and to rule out the possibility that it may be appropriate for the CEB. There are basically two methods applied in Namibia to recharge aquifers with fresh water that would either have spilled into the sea or would have evaporated from an open water surface in a dam. These technologies are artificial recharge and water banking. The difference between the two is that in the case of artificial recharge the raw river water runoff is recharged into an aquifer through infiltration ponds, but with water banking, treated water from impounded surface runoff is injected directly into an aquifer through recharge boreholes. The high salinity of the groundwater makes it impractical to store fresh water underground.

5.4 WATER AVAILABILITY

There does not appear to be a major problem with the availability of water in the CEB. Namibia may abstract 180 million cubic metres of water per annum (Mm^3/a) from the Kunene River from the Calueque Dam in Angola. The presently installed capacity of the pump station is 74 Mm^3/a. The estimated long term sustainable safe yield of the boreholes in the basin is 35 Mm^3/a. The installed capacity of the borehole water supply infrastructure is 26 Mm^3/a, see **Table 4.** The unreliable availability of ephemeral surface runoff is not taken into account as a secure source of water because most of the local water schemes that used local runoff water have fallen into disuse after the piped water supply network has reached those places.

A major challenge lies in upgrading and maintaining the vast bulk and rural water distribution network, expanding the water services network and ensuring that water quality is maintained.

Table 4: Estimated availability of water

WATER RESOURCE POTENTIAL (Mm^3/a)			INSTALLED SUPPLY CAPACITY (Mm^3/a)	
SURFACE WATER	GROUNDWATER	TOTAL	SURFACE WATER	GROUNDWATER
180	36	240	74	27

6. SOCIO-ECONOMIC CHARACTERISTICS OF THE CUVELAI – ETOSHA BASIN

6.1 POPULATION

The population in the Cuvelai – Etosha basin in Namibia is about 850 000. About 54% or 458 985 of the population is women and 46% or 392 485 are men. The growth rate of the population is 2.2% per annum. The distribution of the population in each region in the basin is shown in **Table 5.**

Table 5: Population of each Region in the CEB in 2011

REGION	AREA	POPULATION			
		Men	Women	Total	Density
Kunene	5 287	2 565	2 275	4 840	0,92
Ohangwena	10 706	112 200	132 900	245 100	22,9
Omusati	26 550	109 900	133 000	242 900	9,1
Oshana	8 647	79 800	95 100	174 900	20,3
Oshikoto	38 685	87 000	94 600	181 600	4,7
Otjozondjupa	2 375	1 020	1 110	2 130	0,90
TOTAL	92 250	392 485	458 985	851 470	9,2

The average density of the population is 9.2 persons per square kilometre (p/km²), but in some areas it is more than 100p/km². The average population density in the CEB is much higher than the average of 2.2p/km² for Namibia. About 16% of the population or 136 200 live in towns while 84% or 715 200 live in the rural environment. However, the rate of urbanization is very high because the land cannot support the large number of people and the many migrate to the towns in the hope to find job opportunities and employment. The distribution of the urban, rural and total population as well as the population density in the four sub-basins in the CEB is shown in **Table 6.** The urban population is 42% of the total population and the rural population is 52% of the total population. From **Table 6**, it is clear that the Iishana sub-basin has by far the highest population density.

Table 6: Number of people in the sub-basins in the Cuvelai – Etosha basin in 2011

SUB-BASIN	ITEM				
	Area	Population			Population Density
		Urban	Rural	Total	
Iishana	21 199	254 224	351 070	605 294	28,6
Niipele	9 079	17 143	23 673	40 816	4,5
Olushandja	32 613	54 700	75 540	130 240	4,0
Tsumeb	29 357	31 550	43 570	75 120	2,6

TOTAL	92 250	357 617	493 853	851 470	9,2

6.2 LAND USE

6.2.1 General

About 75% of the land area of the basin is used for commercial and communal stock farming, predominantly on communal land where most people have customary rights to their homes and fields, as well as the surrounding commonage. About 1 600 ha is under irrigation. The Etosha National Park makes up much of the remaining 25% which is thus used for conservation and tourism. The three quarantine farms at Omatambo Maowe, Mangetti and Omauni, and the Ogongo Agricultural College make up most of the land used by the government.

Communal land is intended to be a safety net for the poor so that they may have free access to land. This land is, however, also free for people who are not poor. As a result, many wealthy, influential people have acquired large farms, most covering thousands of hectares, which they occupy exclusively. There are approximately 170 of these large farms which were mostly obtained with the agreement of traditional authorities. The majority of these farms are in eastern Oshikoto and north of the Etosha National Park.

6.2.2 Land tenure

Land tenure in the Basin is broadly divided in three systems. The southern zone comprises freehold, privately-owned farms, the northern and much bigger area of state-owned land, and urban land. All communal land, the resettlement farms and the Etosha National Park formally belong to the state. The vast majority of residents in rural communal areas have traditional rights to the use of the land, portions of which are allocated to individuals by local traditional authorities. Legally, these are called customary rights which permit residents to use the land and its resources but they do not confer ownership or the right to trade their land rights. As a result, most people have no capital value in their land, their land may not be used as security, and incentives to invest in land as a tradable asset are absent.

Urban local authorities are divided into municipalities (Tsumeb), towns (Eenhana, Helao-Nafidi, Okahao, Omuthiya, Ondangwa, Ongwediva, Oshakati, Oshikuku, Outapi and Ruacana) and settlements (Eheke, Ogongo, Okalongo, Okongo, Omungwelume, Onawa, Onayena, Onesi, Onethindi, Ongenga, Oniipa, Onyuulaye, Oshigambo, Oshivelo, Tsandi and Uukwangula).

The vast majority of people live on small farms to which they have customary user rights, but do not own. There are perhaps as many as 100,000 of these holdings, most of which cover less than 10 hectares. *Mahangu*(pearl millet) is grown on most of these farms, along with some vegetables and sorghum.

6.2.3 Dry land crop farming

The vast majority of crops are produced on dry-land or rain-fed fields where the plants depend entirely on moisture from rain. Of all the crops, mahangu (pearl millet) is by far the most common and widespread. Smaller areas of sorghum, maize and various vegetables are grown as well, but mahangu is the favoured staple cereal.

6.2.4 Stock farming

Roughly half of the families in the rural areas have some cattle, goats and donkeys. The number of cattle in the Basin varied between about 300000 and 500 000 between the 1960's and late 1990's, the numbers being limited by shortages of rain and grazing, and by and disease. In recent times, however, numbers have increased dramatically and stood at about 800,000 in 2006 when the last livestock census was conducted. Much of the increase was due to the good rains and improved disease control. Numbers have probably continued to increase since 2006, which means that the number of cattle is now more than double the population in 1994/1995 when the Basin last experienced a significant drought. Since then, pasture areas have declined significantly – perhaps by as much as 20% – as a result of the appropriation of large farms and increasing settlement in areas that were open for grazing.

On average, only about 7% of cattle are sold each year in the Basin, which is several times lower than the off-take rate of most commercial producers in Namibia, and half the off-take by pastoralist communal farmers in Kunene north of the veterinary cordon fence. Most meat sold in the Basin is therefore not from local animals but comes rather from livestock in the communal areas of Kunene or on freehold farms south of the Basin. Of those cattle and goats that are indeed harvested and sold in the Basin, most are sold by households who own small herds. Paradoxically, large livestock owners generally seldom sell cattle. This is probably because cattle, and to a lesser degree goats, serve largely as savings and capital assets that are only sold when their owners have a particular need for cash.

6.2.5 Irrigation

The largest single irrigation scheme in the CEB is the 300 ha Government – owned Etunda Agricultural Project. A number of small irrigation farms have been established in the basin of the Olushandja Dam (about 50 ha) at Mahenene (12 ha) and along the Etaka Canal downstream of the Olushandja Dam. There are no permanent and sufficient sources of non-saline surface or groundwater available in northern Namibia and all irrigation is done with water imported from the Calueque Dam on the Kunene. Irrigation is also done in the Tsumeb area and the water is obtained from groundwater sources. Maize, sunflowers, wheat and some fruit and vegetables are the main products of these irrigation schemes and about 1 300 ha is under irrigation.

6.3 SOCIO-ECONOMIC ACTIVITIES IN THE CEB

Water demand is the result of socio-economic activities and the growth in water demand is a function of economic growth, an increase in the standard of living of the population and population growth due to natural causes or urbanization. Most people in the CEB are engaged in farming activities, but their livelihoods depend largely on incomes derived from employment or businesses away from the rural homesteads in local towns, schools, health facilities or other urban areas elsewhere Namibia or in the industrial, fishing, agricultural or mining environment.

Pensions, social welfare grants and remittances from migrant family members working outside the basin are also important incomes for most rural households. This is one fundamental, but widely misunderstood characteristic of most rural households in the basin.

Another important feature is the high degree of variation between the wealth of households. Around 20-25% of all families in the basin are really poor, and these families are typically headed by women. Most have only two or three family members who are either too old or too young to work. These families have few if any livestock, very small fields (typically less than one hectare) which are often in low lying flood-prone places and where the soils have poor fertility. Pensions are often their only external incomes.

The wealthiest families are many times better off than the poorest ones. Wealth is closely linked to household size, with the biggest homes generally having more income, a greater variety and number of incomes, more livestock and larger fields than poor families. Many wealthy, influential people have acquired large farms, most covering thousands of hectares, which they occupy exclusively. There are approximately 170 of these large farms which were mostly obtained with the agreement of traditional authorities. The majority of these farms are in eastern Oshikoto and north of the Etosha National Park.

Historically, tourism in the basin has been concentrated entirely on the Etosha National Park and its wildlife attractions. In recent years new tourism enterprises have developed in other parts of the Basin, including tourist accommodation and attractions such as cultural, historical and craft-based enterprises in the conservancies, community forests and elsewhere.

Many of the tourism facilities south and east of Etosha capitalise on the proximity of the Park, attracting visitors who make use of accommodation outside the Park and visit Etosha as day visitors.

Mining activities in the CEB is limited to the base metals and copper mines in the Oshikoto Region near Tsumeb, the copper smelter at Tsumeb and the mining of dolomite to produce cement at the Ohorongo cement factory, on the farm Sargberg, about 35 km from Tsumeb. Salt has also been mined in the past at the Otjovalunda salt pans to the north-west of the Etosha Pan.

6.4 WATER DEMAND IN THE CEB

6.4.1 General

The water demand is mainly generated by four user groups. Those are domestic, mining, stock and irrigation water users. The domestic demand is divided in urban, rural and tourism domestic demand. It is expected that the major increase in the future demand will be as a result of domestic use, including small scale service industries in the urban environment. Please refer to **Table 7** on page 43.

6.4.2 Bulk water supply

In 2013 NamWater supplied approximately 13,3 Mm^3 (treated surface water and groundwater) to the urban, rural, livestock and irrigation sectors as well as other minor consumers. NamWater also supplied water to a number of government institutions such as border posts, police stations, schools, hostels and clinics. Most of the government institutions use excessive amounts of water which is mainly a result of non-maintenance of plumbing systems in buildings.

The overall objective for NamWater is to improve service delivery by ensuring efficient and effective bulk supply services at a high level of security of supply, with the necessary capacity (legislative, human and financial) to provide socially accepted services. These objectives must be met while not compromising the environment or the ability of NamWater to be financially self-sustaining.

6.4.3 Urban water use

The urban water sector, which includes industries in urban areas, consumed approximately 11, 35 Mm^3 in 2013, which represents 17% of the total water requirement. In Vision 2030, the urban sector is earmarked to accommodate the majority of the population (75%) and significant industrialisation is foreseen. As a result the expected water demand will increase to 22, 01 Mm³. This represents only 25, 7% of the total expected water requirements in 2030.

The overall objective for the urban water sector is to improve service delivery by ensuring that the service providers are efficient and effective and have the necessary capacity (legislative, human and financial) to provide financially viable and socially acceptable services.

6.4.4 Rural Domestic water use

The rural domestic water sector consumed approximately 6, 34 Mm³ which represented 9, 5 % of the total water requirement. In Vision 2030, it is not expected that the rural domestic sector will grow significantly. The expected water demand will increase to only 6, 84 Mm³ and will comprise only 8% of the total expected water requirements in 2030. The median per capita daily water consumption is 9.9 ℓ/capita/day, which is well below the acceptable minimum water consumption required for good health of 25 ℓ/capita/day (WHO).

The overall objective for the rural domestic water sector is to improve service delivery by ensuring that the water point committees and water point associations are efficient and effective and have the necessary capacity (legislative, human and financial) to deliver affordable services with a high level of supply security provided that the environment and the long-term target of the committees/associations to become financially self-sustaining are not compromised.

6.4.5 Irrigation water use

The total area under irrigation in the CEB in 2013 is 1 660 hectares (ha) and this may increase substantially due to the Green Scheme Project. The irrigation water sector consumed approximately 19,8 Mm³in 2013 which represents 30% of the total water requirement. In Vision 2030, the irrigation sector is earmarked for major development and the expected water demand will increase to 26, 6 Mm³ which represents 31% of the total expected water requirements in 2030.

The overall objective for the irrigation sector is to improve water use efficiency, crop production (more crop per drop) and value addition to enhance economic growth, increase food security and exports from Namibia provided that the environment and water resources are not compromised.

6.4.6 Livestock water use

The demand for stock drinking is variable because it is determined by the number of cattle and the number of cattle is determined by the availability of grazing and that is in turn determined by the variability of the rainfall. This means that although stock numbers may vary between 300 000 and 500 000, no substantial increase in stock numbers is expected.

The livestock sector used approximately 25, 2 Mm³ in 2013 which represents 37, 6% of the total water requirement. The water requirement of the livestock sector is expected to remain constant, butin 2030 it will represent 29, 2% of the total water demand in the CEB.

The overall objective in the livestock sector is to improve water use efficiency and protein production to enhance economic growth in Namibia though increased exports and food security, provided that the range land environment and water resources are not compromised.

6.4.7 Mining water use

The water demand as a result of mining activities in the CEB is limited to the geological formations around Tsumeb where copper, base metals and other rare earth elements are mined. The demand for mining water is small in comparison to the demand water for domestic use and agriculture.

The mining sector used approximately 3 Mm³in 2013 which represents 4, 5% of the total water requirement. The expected water requirement will remain more or less the same because of the limited mining potential in the CEB. Mining demand will represent only 3, 5% of the total expected water requirements in 2030. The figure of 20.3 Mm³ excludes water provided from unconventional water sources such as brackish water, sea-water and desalination.

The overall objective for the mining sector is to improve water use efficiency and to enhance economic growth in Namibia through local processing and exports provided that the environment and water resources are not compromised.

6.4.8 Tourism water use

The tourism sector used approximately 1, 36 Mm³in 2013 which represents 2% of the total water consumption. The tourism sector was identified as a high growth sector in Vision 2030 and the expected water requirement is expected to increase to 2, 12 Mm³ in 2013 and that represents 2, 5% of the total expected water requirements by 2030.

The overall objective for the tourism sector is to improve water use efficiency and to enhance economic growth in Namibia through increased tourism, provided that the integrity of the ecosystems on which tourism depends are protected and that water resources are not compromised.

See **Table 7** for the estimated water demand in the CEB. From **Table 7,** the estimated water demand in 2013 was about 67.0 Mm³/a. and the estimated future demand in 2030 is about 85.7 Mm³/a.

Table 7: Estimated water demand in the CEB

CONSUMER GROUP	ANNUAL WATER DEMAND (m³)				
	2013	2015	2020	2025	2030
Domestic Urban	11 346 452	12 384 273	15 075 741	18 290 676	22 046 462
Domestic Rural	6 338 486	6 395 452	6 540 115	6 688 050	6 839 332
Domestic Tourism	1 363 047	1 502 760	1 742 110	1 923 430	2 123 623
Livestock	25 204 477	25 204 477	25 204 477	25 204 477	25 204 477
Mining	2 896 636	2 896 636	2 896 636	2 896 636	2 896 636
Irrigation	19 831 059	23 431 100	26 553 600	26 553 600	26 553 600
TOTAL	**66 980 157**	**71 814 698**	**78 012 679**	**81 556 869**	**85 664 130**

Table 8: The 2013 Water demand in the Sub-basins in the CEB (rounded figures)

CONSUMER GROUP	THE 2013 CEB SUB-BASIN WATER DEMAND (m³)				
	IISHANA	NIIPELE	OLUSHANDJA	TSUMEB	TOTAL

Domestic Urban	8 066 200	543 500	1 736 000	1 000 100	11 345 800
Domestic Rural	4 506 500	303 600	969 800	559 000	6 338 900
Domestic Tourism	985 300	16 300	224 900	136 500	1 363 000
Livestock	5 792 000	2 480 100	8 909 800	8 020 100	25 202 000
Mining	-	-		2 896 600-	2 896 600
Irrigation	-	-	7 344 000	12 487 100-	19 831 100
TOTAL	**19 350 200**	**3 343 500**	**19 184 500**	**25 099 400**	**66 977 400**

6.5 WATER BALANCE

All in this section have been rounded for easy reference. Refer to **Table 9** to **Table 13** for an overview of the water balance in the CEB as a whole and for each individual Sub-basin separately.

Table 9: Water supply and demand water balance in the CEB

WATER RESOURCE POTENTIAL (Mm^3/a)			**DEMAND (Mm^3/a)**		**SURPLUS (Mm^3/a)**		**INSTALLED INFRASTRUCTURE CAPACITY (Mm^3/a)**	
SURFACE	**GROUND**	**TOTAL**	**2013**	**2030**	**2013**	**2030**	**SURFACE**	**GROUND**
180	36	216	67.0	85.7	149.0	130.3	74.0	27.0

Table 10: Water supply and demand water balance in the Olushandja Sub-basin

WATER RESOURCE POTENTIAL (Mm^3/a)			**DEMAND (Mm^3/a)**		**SURPLUS (Mm^3/a)**		**INSTALLED INFRASTRUCTURE CAPACITY (Mm^3/a)**	
SURFACE	**GROUND**	**TOTAL**	**2013**	**2030**	**2013**	**2030**	**SURFACE**	**GROUND**
180	1	181	18,5	23.5	162,5	157,5	74	1

Table 11: Water supply and demand water balance in the Iishana Sub-basin

WATER RESOURCE POTENTIAL (Mm^3/a)			**DEMAND (Mm^3/a)**		**SURPLUS (Mm^3/a)**		**INSTALLED INFRASTRUCTURE CAPACITY (Mm^3/a)**	
SURFACE	**GROUND**	**TOTAL**	**2013**	**2030**	**2013**	**2030**	**SURFACE**	**GROUND**
162,5	0	162,5	19,5	25	143	137,5	74	0

Table 12: Water supply and demand water balance in the Niipele Sub-basin

WATER RESOURCE POTENTIAL (Mm³/a)			DEMAND (Mm³/a)		SURPLUS (Mm³/a)		INSTALLED INFRASTRUCTURE CAPACITY (Mm³/a)	
SURFACE	GROUND	TOTAL	2013	2030	2013	2030	SURFACE	GROUND
143	8	151	3,5	4,5	147,5	146,5	74	1

Table 13: Water supply and demand water balance in the Tsumeb Sub-basin

WATER RESOURCE POTENTIAL (Mm³/a)			DEMAND (Mm³/a)		SURPLUS (Mm³/a)		INSTALLED INFRASTRUCTURE CAPACITY (Mm³/a)	
SURFACE	GROUND	TOTAL	2013	2030	2013	2030	SURFACE	GROUND
0	27	27	25	27	2	0	0	25

7. WATER SUPPLY INFRASTRUCTURE

7.1 WATER SECTOR RESPONSIBILITIES

The following institutions are responsible for effective water resources management, water supply and waste water treatment in the water sector:

7.1.1 Ministry of Agriculture, Water and Forestry (MAWF):

Overall water resource inventory, monitoring, control, regulation and management

7.1.2 Namibia Water Corporation (NamWater):

Water is abstracted from primary sources (e.g. Rivers, dams or aquifers) and supplied to local and regional authorities or other end-users directly by NamWater, the bulk water supplier.

7.1.3 Self-providers

They are commercial farmers, tourist operators, mines and nature conservation parks who supply their own water

7.1.4 Directorate of Water Supply and Sanitation Coordination in the MAWF

Coordinate water supply and sanitation services to rural areas

7.1.5 Local Authorities and Regional Councils

They buy water in bulk from NamWater and distribute or reticulate the water to consumers in urban areas (cities, towns, villages) and rural areas. They are also responsible for the treatment of domestic sewage.

7.2 WATER SUPPLY INFRASTRUCTURE DEVELOPMENT IN THE CEB

7.2.1 Historical perspective

When the people who permanently settled in the Cuvelai Basin in the early seventeenth century arrived there after their long journey from the Great Lakes in Central Africa, they most probably decided to stay because they found a large, well grassed flat plain with a relative abundance of water, especially during the rainy season. Grazing was available for their cattle and there was enough water for both human and animal consumption.

During the middle of the nineteenth century European missionaries, hunters and traders moved into the area and over time more permanent infrastructure such as churches, schools hospitals and shops were established at those places where it was perceived that enough local water would be available from the runoff in the oshanas and the shallow wells. By the middle of the twentieth century population pressure and socio-economic development caused such a high increase in the water demand that the security of the water supplies were severely compromised. Prolonged droughts and crop failure brought further hardship to the communities and restricted development. More ingenuity and technical innovation and were required to meet the future demands. This necessitated the need for eventual access to more reliable water resources and the principle that Namibia has the right to the use of the perennial water resources of the Kunene River was accepted in 1926 when the First Water Use Agreement was signed between the Governments of the Colonial Powers, Portugal and South Africa, who respectively controlled Angola and Namibia at that time.

Between 1926 and 1954 the development of water supply schemes in the Cuvelai Basin was very rudimentary, but in 1954 an intensive development program was launched to improve local surface water schemes, water storage works, water treatment facilities and groundwater schemes. In the early fifties the initial policy was to develop local water resources first, before moving to other water resources further away. A water scheme that used a local water source was referred as a “local water scheme” and when the local water supply scheme became connected to a more distant water resource, it was called a “regional water scheme.” When a regional water scheme was linked to an internationally shared water source like the Kunene River it was referred to as a “National Water Carrier”

7.2.2 The Use of Ephemeral Surface Water

The first step was therefore to develop improved local water schemes and that entailed the construction excavation dams in or next to an oshana to collect the ephemeral surface runoff during the rainy season. Due to the high saline water table, these dams could not be made more than 2,5 to 3,0 m deep and the intention was that the quantity of water to be stored should be sufficient to bridge at least two rainy seasons in order to allow for a rainy season that did not produce any runoff in the oshana. See **Figure 20.**

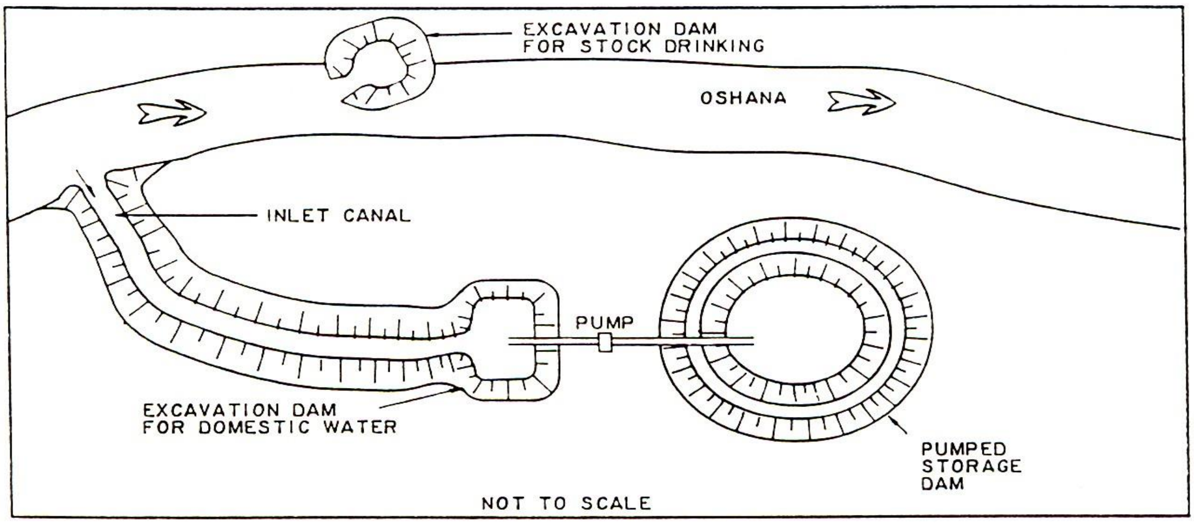

Figure 20: Typical layout of an excavation dam and a pumped storage scheme

As the population and the social-economic activities increased the water storage capacity was further increased by adding a pumped storage dam. Water from the excavation dam was then pumped into the storage dam and at the end of the runoff season water was available from both the excavation dam and the storage dam. The storage dams had the advantage that they could be made deeper and therefore more efficient against evaporation by using the excavated material to construct an embankment and such a dam could therefore be up to ten metres deep. See **Figure 21.**

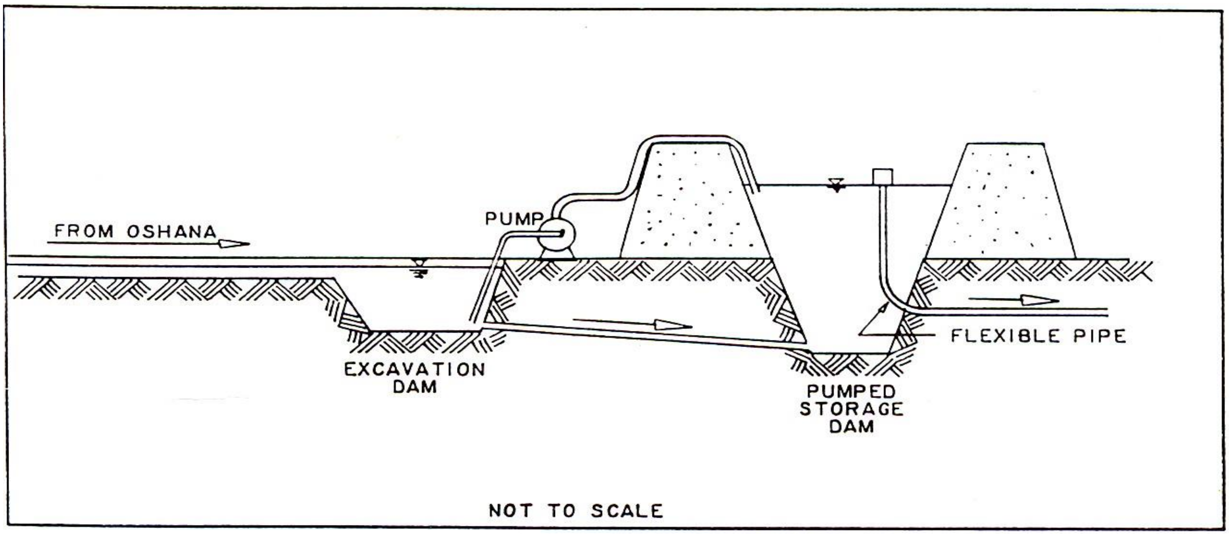

Figure 21: Typical pumped storage facility

It was also realized that the existing wells did not provide safe water. Clear water was needed for supply to the larger centres and for that purposes clear water wells were incorporated in the schemes and simple water treatment plants were designed to supply potable water from the excavation dams and pumped storage dams to the community, the villages and towns within reach of those installations. **See Figure 22.**

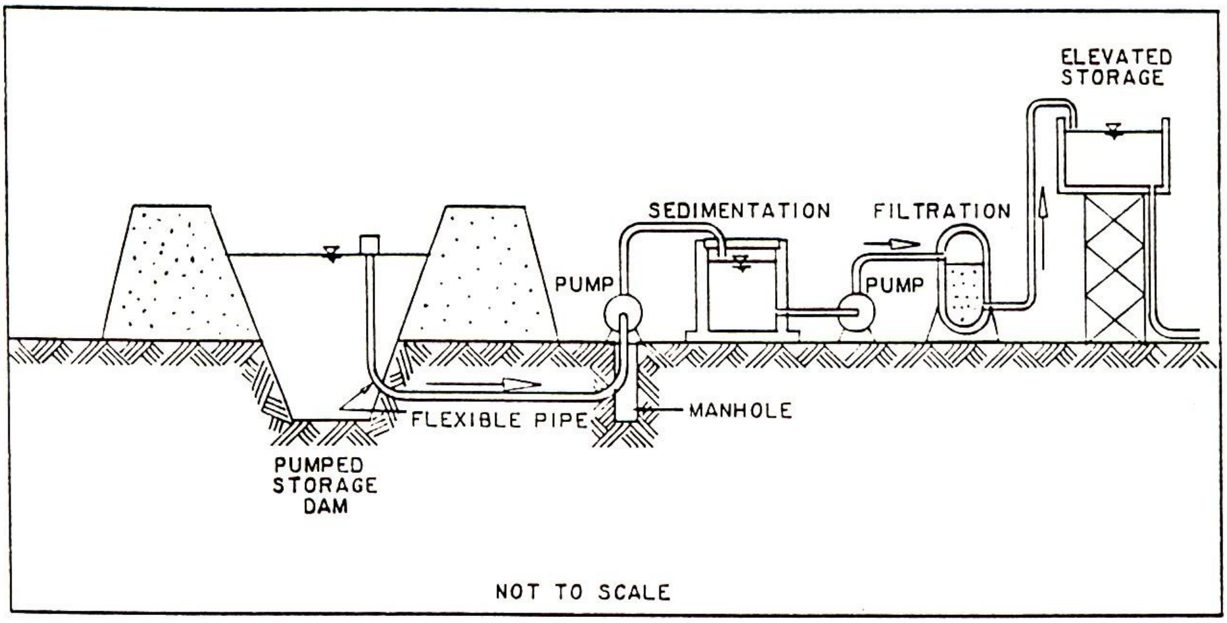

Figure 22: Typical small scale water treatment plant

The construction of excavation and pumped storage dams started in the in 1954 and lasted until the late sixties. In fact, between 1954 and 1968 about 300 dams were constructed, including 87 excavation dams, 86 pumped storage dams and 17 pumped storage dams with water treatment plants that had capacities in excess of 6 000 cubic metres (m^3). All these dams had a total capacity of more than 7.0 Mm^3.

The excavation dams and pumped storage dams supplied water to many communities spread all over the basin, but as the water demand increased the potential of the ephemeral runoff in the oshanas and the inherent inefficiency of the water storage facilities became insufficient to meet the demand on a reliable basis. This situation in the central parts of the basin was compounded by a severe drought after the 1957/58 rainy season and prompted the development of the first regional water scheme in the north. In 1959 the construction of an earth canal between Oshakati and Ombalantu was started. The purpose of this northwest to southeast orientated canal was to intercept the surface runoff in the oshanas that were running from north to south in the area between the two settlements. The water would then be diverted and collected in the storage dams located at the larger centres along the way. This made the supply of water to Ombalantu, (Outapi), Ogongo. Oshakati and Ondangwa and the centres connected to the system more reliable, but by 1970 the regional water scheme had to be extended to a more reliable perennial water source.

7.2.3 The use of perennial surface water

The further construction of storage dams in the Cuvelai Basin were replaced by the importation of water from the perennial Cunene River. This national water carrier was established in terms of the Second and Third Water Use Agreements, respectively signed in 1964 and 1969 between Portugal and South Africa. The project to extend the water supply to the Kunene Basin started in 1970 with the construction of a concrete lined canal from Ombalantu to the Kunene River at the proposed Calueque Dam. This water carrier would secure the supply of surface water into northern Namibia because it provided access to a perennial river.

The Third Water Use Agreement made provision for the transfer of 6m³/s from the Kunene at the Calueque Dam to the Cuvelai Basin in northern Namibia. This international inter-basin water transfer scheme was the first of its kind in Southern Africa and the pump station has a capacity of 3, 2 m³/s.

The construction of the dam started in 1972, but the work was never completed, except for the ten sluice gates and the pump station. The water at the dam must be elevated 18 m to cross the watershed and is pumped from the dam through a 2.4 km long, 1 659 mm diameter steel pumping main into a 21 km long concrete lined canal that goes to the Olushandja Dam in Namibia. The nominal design capacity of the canal is 10m³/s, but at a bifurcation, about 2 km south of the border between Angola and Namibia, the canal has a capacity of 6m³/s to the Olushandja Dam.

The purpose of the Olushandja Dam is to store surplus water that has been transferred from the Kunene. The full supply capacity of the dam provide water security is 42,5 Mm³, and the dam has also been constructed across the watershed between the Oshana Olushandja and the Oshana Etaka to allow water from the Kunene to be conveyed to the Oshana Etaka via a canal through the watershed and the water stored in the dam. The dam has an embankment in each of the two oshanas and the two embankments are 19 km apart. The surface area of the dam is 19 km³, but due to the flat topography the dam is only 4.0 m deep. It is therefore clear that the evaporation losses are prohibitively high and the dam has never been operated at its full supply level. The dam can only serve its purpose for short periods of time when it is not possible to supply water from Calueque.

If there is an interruption in the supply of water from Calueque, for example as a result of a major technical issue or even political reasons, remedial measures can be put in place to supply water from Ruacana until the issues at hand are respectively resolved through technical or diplomatic means.

As part of the 1968 water master plan for the Cuvelai Basin, it was decided to construct water treatment plants at Eunda, Ogongo and Oshakati. (The plant at Eunda would to supply water down to Tsandi, the plant at Ogongo would serve the central part of the basin up to Oshakati and the plant at Oshakati supply water to Ondangwa, north in the direction of Oshikango and south-eastwards in the direction of Oshivello.

Over the years since 1970 many improvements were made to the water supply infrastructure. In 1975 a pipeline was laid between Ogongo and Oshakati to supply purified water from a centralized treatment plant established at Ogongo. The water treatment plants at Oshakati and Ondangwa was upgraded and pipelines were built from Ondangwa to the southwest in the direction of Oshivello, as well as to the north in the direction of Oshikango on the Angolan border. Pipelines were also built from this south to north pipeline to Eenhana in the east and Engela in the west.

After the independence of Namibia an extensive network of additional primary, secondary and tertiary pipelines were constructed to supply water to local communities over a wide area in the Cuvelai Basin. See **Figure 23**. Due to the development of a large number of boreholes and a network of canals, pipelines and water treatment works, about 82% of the population live within 2.5 km of a water point and a safe supply of water. There are about 4 000 km of pipelines which radiate out from water treatment plants at Olushandja, Outapi, Ogongo and Oshakati.

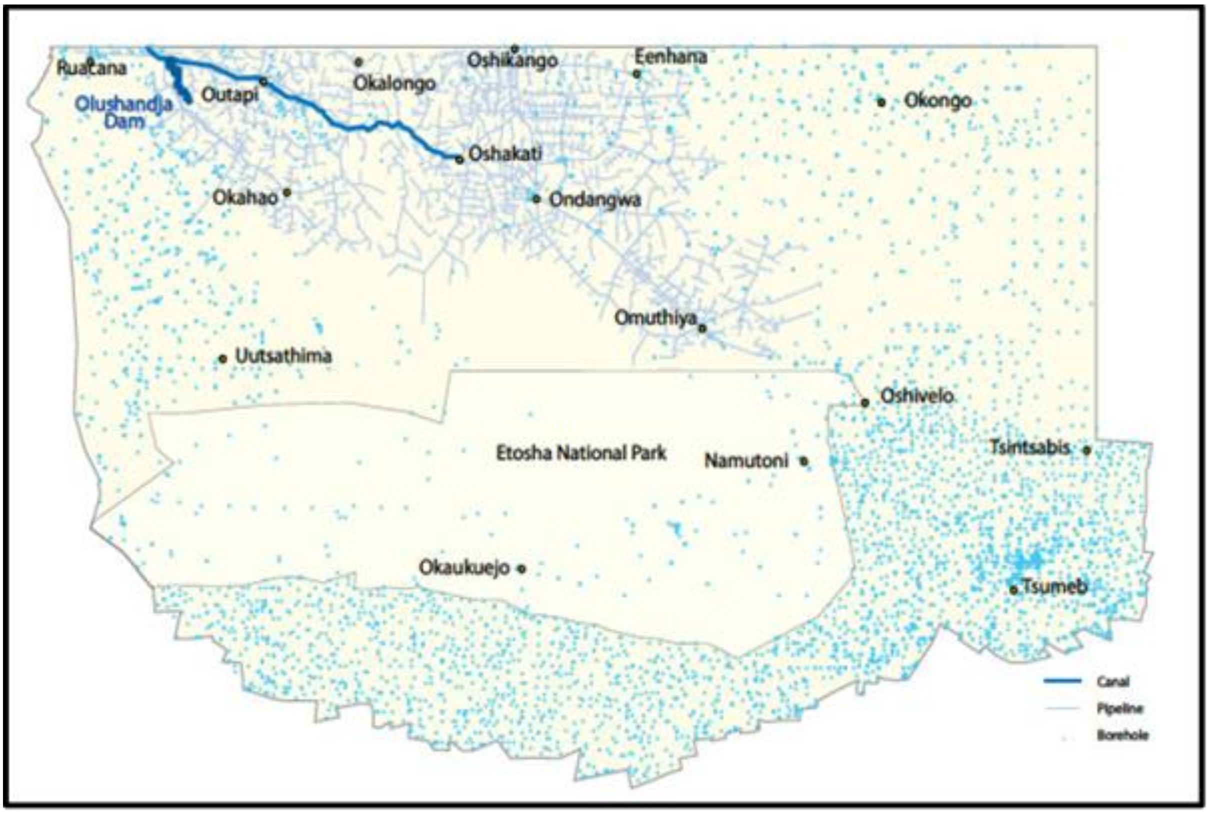

Figure 23: Borehole and pipeline infrastructure in the CEB

See **Figure 24** below for an overview of the canals, pipelines and raw water treatment plants in each sub-basin in the CEB. The potable water is mostly used for domestic purposes and stock drinking while raw water is used for irrigation.

7.2.4 Security of supply

The origin of the water transfer scheme from the Calueque Dam is vested in three water use agreements between the colonial powers, Portugal and South Africa, and those agreements have been endorsed and re-affirmed in 1990 by the independent states of Angola and Namibia. The main rationale behind the agreement that Namibia may abstract its share of the waters of the Kunene River from the Kunene at Calueque and transfer the water across Angolan territory into Namibia, is the fact that it is very uneconomical to abstract the water from the Kunene River at a point downstream of the Ruacana Falls where the river forms the common border between the States and where Namibia has direct access to water. In exchanges for the economic advantage, the South African and Portuguese authorities agreed to fix the southern boundary of the "Neutral Zone" declared by the German and Portuguese authorities, at the top of the Ruacana Falls and therefore Namibia relinquished its claim to access to the Kunene upstream of Ruacana by the assurance given in the water use agreement that Namibia may abstract the water at Calueque in Angolan territory.

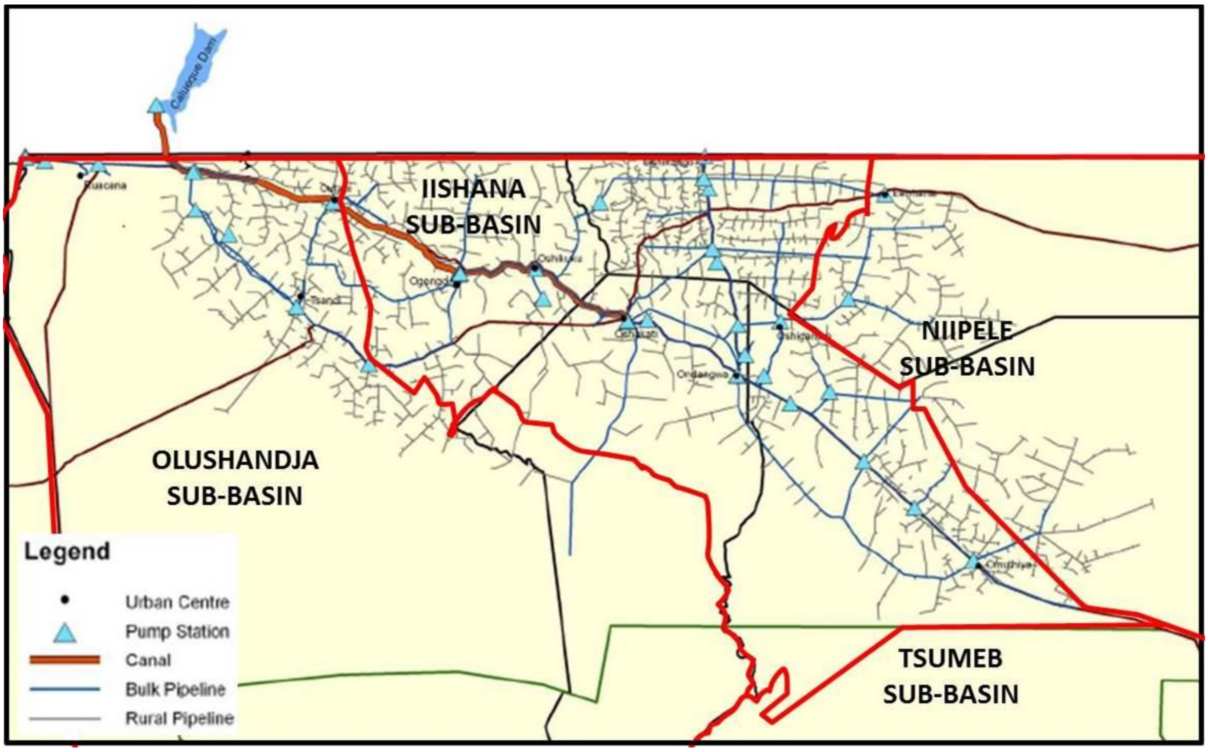

Figure 24: Pipeline network and water treatment plants

The main purpose of the Olushandja Dam is store a quantity of water that has been pumped from the Calueque Dam. This water is supposed to serve as a security of supply which can be used if there is a temporary interruption in the supply from Calueque. The quantity of water to be stored will of course depend on the demand and the expected duration of the interruption of supply. The decision about the quantity of water to be stored needs to be assessed on a continuous basis by the Namibian authorities and will not only depend on the possible physical causes of an interruption, but also the geo-political situation at any given time and the existing level of good neighbourliness between Angola and Namibia.

If the Namibian access to the pump station at the Calueque Dam and the abstraction of water from Angolan territory is compromised on a permanent basis, Namibia will have to abstract water from the Kunene at the head bay of the Ruacana hydropower station or at river level. In the past such a situation actually existed and it is possible to re-instate such a water transfer scheme because a 500 mm diameter steel pipeline has been constructed from the Kunene River at the Ruacana Falls to Ruacana Town and from there a 400 mm diameter fibre-cement gravity pipeline to the Calueque – Olushandja – Oshakati canal.

The capacity of the pipeline is 0,6 m³/s was with the pumping configuration in place at that time and the pumping head is between 350 and 480 m, depending on whether the water is drawn at the river level (at the tail-race of the power plant) or from the head bay at the penstocks of the Ruacana power station. The annual water transfer was about 18 Mm³/a in comparison to the 74 Mm³/a from Calueque,

It is clear that due to the difference in pumping head, the cost to supply water from Ruacana is much more expensive than to supply the water from Calueque, but the water supply scheme from Ruacana still remains today as a means to supply a portion of the water requirements in the Cuvelai Basin during any interruption of the water supply from the Calueque Dam.

7.2.5 Resource Protection

Bush encroachment influences surface runoff and groundwater recharge in Namibia. According to studies by the Department of Agriculture, approximately 27 million ha of grazing in Namibia are affected by bush encroachment. In a pilot study in the Otjiwarongo Marble Aquifer, it was estimated that the groundwater recharge of a de-bushed location was approximately 8%, while it was less than 1% at bush-invaded locations. This implies that if 100 farms of 5000 ha are affected by bush encroachment, the reduction in recharge is equivalent to the water requirement of all the cattle in Namibia.

Similar information for surface run-off is not available but there is consensus amongst scientists that bush encroachment reduces both run-off and groundwater recharge. Service providers such as NamWater and local authorities who abstract water for urban use can play an important role as facilitators to identify areas with water stress where bush encroachment influences surface runoff and groundwater recharge. Pilot projects such as in the Von Bach Catchment and the Otjiwarongo Marble, or Platveld Aquifers may be beneficial to quantify benefits over time and to improve security of supply.

The following issues are important for resource protection:

- Prevent over abstraction;
- Sensitize users on pollution;
- Check water quality free of charge;
- Prevent pollution through human/animal activities (Large number of boreholes are polluted);
- Integrate management of land and water (surface and groundwater recharge);
- Important role of BMCs to collect information and give input in licensing.

7.2.6 Summary

Very little potable water occurs naturally in the Cuvelai – Etosha Basin. Surface run-off is unreliable and the flat nature of the terrain presents no opportunities for major surface water impoundments. Groundwater over the greater part of the central basin contains prohibitive levels of salts which makes it unsuitable for human and stock drinking. Suitable groundwater does, however, occur in the east and south-east areas of the basin. Recent groundwater studies have indicated that fresh groundwater may occur at greater depths, below the saline water.

Most of the water is imported from the Kunene River in Angola and distributed throughout the basin. The current capacity of the transfer system from the Calueque Dam is approximately 74 Mm^3/a. The demand in 2013 and the estimated demand in 2030 are 63.7 and 85.6 Mm^3/a respectively. It is foreseen that major increase in the future demand will be as a result of further irrigation development.

There does not appear to be a major problem with the availability of water in the basin. The major challenge lies in upgrading and maintaining the vast distribution network, expanding the water services network and ensuring that water quality is maintained.

Further developments are expected in groundwater abstraction. This will reduce the need for the expansion of more piped water schemes.

8. WATER DEMAND MANAGEMENT

Water Demand Management (WDM) is a fundamental part of an integrated approach to sustainable management of the water sector, especially in an arid country such as Namibia. "WDM involves measures that improve efficiency by reducing water use or altering patterns of water use after abstraction" (Beecher, 1995). Within the Namibian context, the WDM strategy attempts to improve cost recovery, the management and maintenance of infrastructure and the reduction of inefficient consumer demand to reduce the pressure and reliance on conventional water resources and infrastructure. By reducing demand, through a variety of approaches, WDM provides an equivalent outcome to supply augmentation. This, in turn, results in a net financial benefit to the supplier as well as its customers and benefits to the environment. The various approached include making the public aware of better water use behaviour that can reduce consumption and wastage, the implementation of appropriate water pricing and block tariffs, and the repair of leaking water supply or reticulation infrastructure.

The Water Act, which is still applicable in Namibia, supported the provision of cheap access to water leading to the perception that it is the government's duty to provide water as a cheap and abundant commodity. Lack of recognition of the true value of water in an arid country such as Namibia resulted in an inefficient and unsustainable water demand.

WDM was included in the Namibian Water Policy in August 2000 for the first time. Although included in the Water Resource Management Bill, there are no legal mechanisms yet in place to enforce WDM within the water sector, but this concept has been widely used since the early 1980's by the Municipality of Windhoek and other local authorities. Most of the results reflected in this report are based on individual efforts by service providers and water users.

The Water Resource Management Bill makes provision, inter alia, for a Water Regulator to harmonise and integrate the expectations of consumers and decision makers regarding the price of water supply and wastewater discharge services without compromising the financial viability of the service providers. The regulator will also address the development of water service plans and water conservation and water demand management strategies.

8.1 STATUS OF WDM IN THE CEB

8.1.1 Bulk water supply

The main challenges for the bulk water supplier, NamWater, regarding water WDM in the CEB is to recover debt, reduce production losses on some schemes, improve maintenance, and secure funding for much needed capital replacement as well as funding for new bulk infrastructure projects. NamWater prepared a master plan for the upgrading extension and improving the bulk water supply systems in the CEB. The BMCs in the CEB has a duty to monitor the implementation of these activities by NamWater to ensure the security of bulk supply linked to the condition of infrastructure and resources. The cost of breakdowns in water supply to the economy of the CEB can be substantial if estimates for the Central Coast (N$ 17.1 million/day) and for the Central Area of Namibia (N$ 22.5 million/day) are used as a measure.

8.1.2 Urban water use

The biggest long-term benefit from WDM in the CEB is keeping the annual growth in water consumption within acceptable limits (lower than 3% per annum) despite high economic growth rates. The ability of population in the CEB to improve water efficiency is critical to respond to the threat of droughts as evidenced by the most recent failure of adequate precipitation during the 2012/13 rainy season. WDM can also be a highly cost-effective means of extending the period of time a water supply scheme would be able to meet the demand because it has been shown in Namibia that it is possible through improved WDM to reduce the demand despite an increase in population and economic activities.

The example of a project that was completed in 2006 at Arandis can be mentioned here to show the BMCs in the CEB what water use efficiency can achieve and why WDM should be actively encouraged by the BMCs. The outcome of the Arandis project showed that many consumers were not recorded on the costing system, major pipe leakages were identified and repaired, a pressure reduction system was installed and a main pipeline was replaced. The result was that non-revenue water was reduced from 50% to 15%, the bulk water demand decreased with 24% from 2006 to 2009 and the net effect was reduced bulk water supply cost to the local authority and the increased sales of saved water amounted to N$ 1.24 million per annum based on 2010 tariffs.

The inability of local authorities to recover costs through appropriate tariffs, or due to poor credit control, high non-revenue water and the lack in management skills, makes the delivery of proper services with proper maintenance and capital replacement of infrastructure impossible in certain urban areas. The high cost of non-revenue water makes it almost impossible for local authorities to improve their financial position in order to improve service delivery.

In most villages high water consumption can be attributed to one or more factors such as high losses at government buildings and institutions, inappropriate water tariffs, inefficient administration (infrequent meter reading, poor billing and credit control), low levels of infrastructure maintenance, no replacement of old infrastructure and inaccurate metering.

The intervention of the BMCs can make a huge contribution (Improvements from 4% to 85%) to potential water saving through WDM interventions in urban centres.

8.1.3 Rural domestic water use

The main challenges for WDM by water point committees/associations are to improve their financial and technical management, cost recovery and ability to pay NamWater or for the operation and maintenance of the water points. Persons serving on water point committees/associations leave the rural areas and that compromises the continuity of the committees while there is no subsidy scheme in place to assist the rural poor to recover costs due to technical breakdowns such as pipe bursts in the branch lines.

WDM can improve the reliability of water supply schemes and water security in the CEB through the proper maintenance of the water supply infrastructure to reduce interruptions.

The role of the BMCs would be to ensure that WDM is practiced in the CEB and that water consumers and water point committees in the rural areas are sensitised to prevent the pollution of water sources. This can be achieved during discussions with stakeholders, requesting assistance from Directorate of Water Supply and Sanitation Coordination (DWSSC) or the Directorate of Resource Management in the DWAF and more regular visits to encourage the rural consumers.

8.1.4 Irrigation water use

WDM is also important in the irrigation sector in the CEB. The irrigation schemes in the Iishana, Olushandja and Tsumeb sub-basins of the CEB accounts for a relatively large percentage (30%) of the water used in CEB should be monitored by the BMCs. Areas of concern are the poor submission of irrigation water use returns to determine the actual volumes of water abstracted and used in order to assess the over or underutilisation of resources, the unknown extent of pollution resulting from irrigation practices, inadequate irrigation scheduling and the fact that the tariffs applied for irrigation do not provide incentives for water use efficiency. The maintenance of both canals and on-farm irrigation systems is also inadequate.

Studies elsewhere in Namibia it has been shown that the implementation of WDM initiatives can achieve potential savings of between 15 and 25% in the irrigation sector.

8.1.5 Livestock water use

About 37,6% of the water used in the CEB is used by livestock and one of the reasons for this high use is the estimated 50% losses due to wastage. This means that the demand can be halved if better control over wastage is achieved. Apart from water wastage, the other main challenges facing WDM in the livestock sector in the CEB are the payment for water, groundwater depletion and groundwater pollution as a result of livestock farming.

The Water Point Committees are inconsistent with the charges for water because some are charging a fee per head of livestock while others charge a flat rate irrespective of the number of livestock.

Groundwater depletion and or pollution in areas where communities do not have access to piped water will have detrimental social-economic and health effects while the wastage of water at cattle troughs occurs mainly as a result of poor maintenance. The BMCs can take these issues up with the respective responsible entities to improve WDM.

Bush encroachment also has a negative effect on the availability of fodder and influences both surface run-off and groundwater recharge negatively. Controlled de-bushing is a proven method of increasing the availability of groundwater and surface run-off and thereby enhancing economic growth. It is suggested that the BMCs in the CEB should encourage service providers and farmers (both commercial and communal) combine efforts to address bush encroachment on a basin-wide basis.

8.1.6 Mining water use

The mining industry is relatively small in the CEB because only 4%of the water used in the CEB is used for mining. However, the mining industry pays the full cost of water supplied and is therefore fairly diligent when it comes to the management of water demand and waste water discharge. The main challenges for the BMCs to monitor the implementation of WDM in the mining sector are the development of water management plans for each mine and to encourage the mines to recycle water to reduce the demand for fresh water and to keep an eye on the possible pollution of ground and surface water.

8.1.7 Tourism water use

The tourism sector in the CEB uses only 2% of the water consumed and very little information is available on the potential of water savings in the tourism sector. However, there is high level of water awareness about water saving and the maintenance of water infrastructure in the sector because it has an impact on the profitability of the sector. The BMCs can monitor this situation, because the WDM issues also relate the over-abstraction of water source, the lack of maintenance and waste water disposal.

8.2 WATER DEMAND MANAGEMENT STRATEGIES

The strategies for the different water use groups in Namibia to implement WDM have been developed in consultation with the water service providers, focus groups and water users in rural areas, irrigation and livestock farmers, and the tourism and mining industries in all 13 regions of Namibia. The WDM strategies include legal, institutional, capacity building, financial and technical requirements as well as customer care. To ensure the success of WDM, greater emphasis should be placed on ensuring broad participation and engagement of all stakeholders in water related activities.

The BMCs in the CEB can take the initiative to improve WDM by the following strategy in all water use sectors:

1. Carry out a situation assessment which covers:
   - Water use and conservation planning goals, historic water consumption, water use efficiency, infrastructure characteristics, non-revenue water, customer profiles, management practices and pollution potential of the water use;
   - Prepare a demand forecast without water savings to estimate the extent of supply augmentation required to satisfy the water demand including the estimated capital and operational costs;
   - Identify WDM initiatives, expected water savings and price them based on Unit Reference Values (URV);
   - Determine required capital and human resources for implementation;
   - Evaluate effect of savings on both the service provider and consumer; and
   - The effect of sanitation provision in areas of jurisdiction.
2. Develop an implementation and monitoring programme for the performance indicators to measure the improved efficiency over time in relation to the target set in the implementation programme.

8.3 WATER DEMAND MANAGEMENT AND CONSERVATION

8.3.1 General discussion

Water resources in Namibia are scarce and it is important that water must not be wasted or contaminated by water users. The BMCs can play a vital role in educating all stakeholders and water users aware about the various ways to use water wisely and these include:

- Making water consumers aware of the cost to supply water,
- Expecting from consumers to pay for the water to enable them to understand the value of water,
- Managing water demand by teaching consumers how to save water,
- Conserving and protecting water resources from pollution

WDM aims to improve water use efficiency by reducing water losses or changing the wasteful way people use water. WDM is implemented by making people aware about the need to save water, providing information about the technical measures that can be taken to save water and educating the water users about the economic and financial principles used to manage the water demand such as water pricing and tariff policies (e.g. rising block tariffs) and the ability of Local Authorities to enforce credit control measures to influence water consumption.

During the development of the National IWRM Plan for Namibia it was estimated that about 26% saving in water demand can be achieved in the urban areas in the CEB through water demand management. This amounted to a saving of about 2.0 Mm^3/a on the 2008 water demand.

8.3.2 Understanding the cost of water

Water supply services follow a cycle from the origin of the water at its source to the point where used water is disposed of. See **Figure 25**.

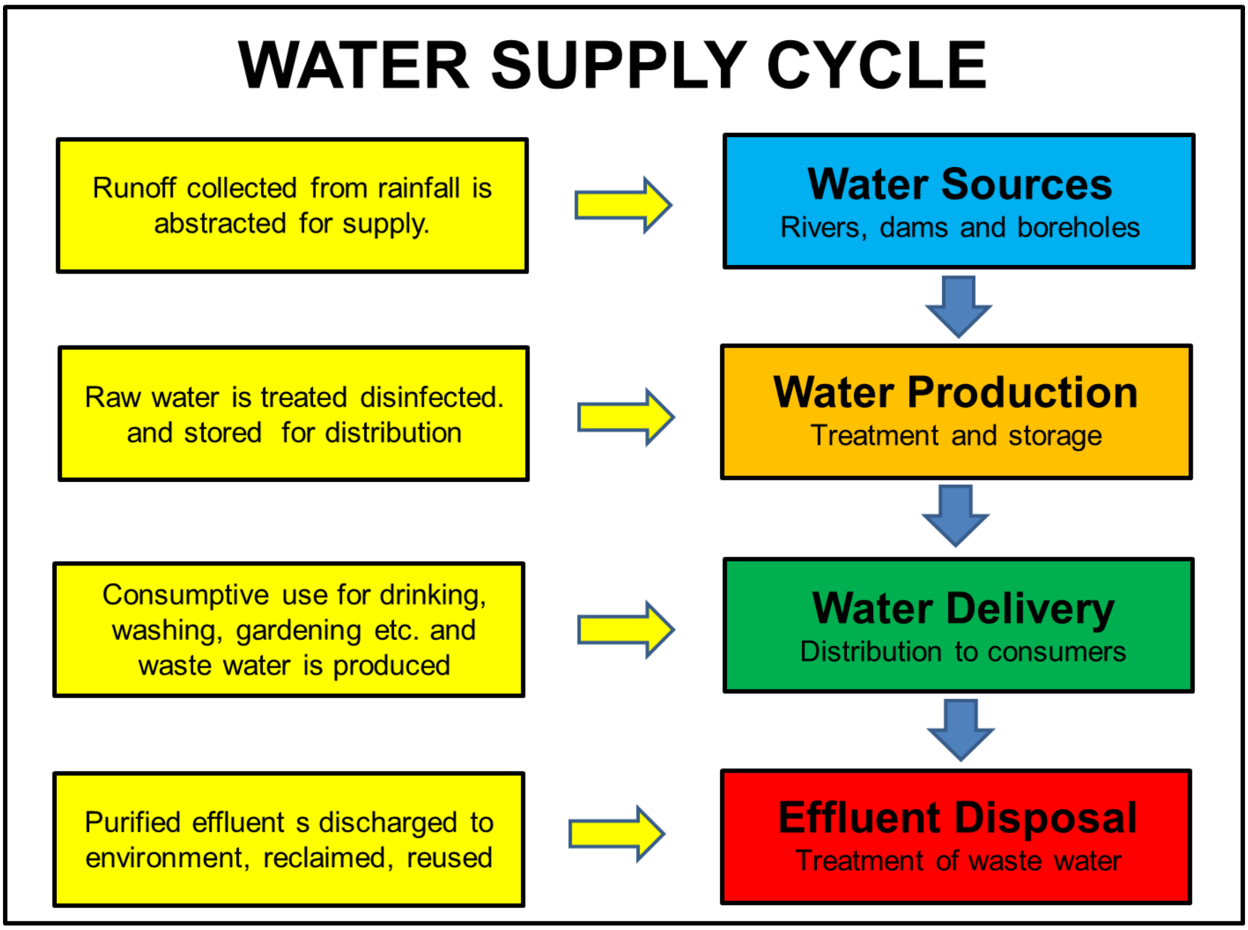

Figure 25: Water supply cycle

The price of water supply services are determined by the cost to develop a water source, the cost of a pipeline or canal to transport the water, the distance the water has to be transported the cost to pump the water, the elevation from the water source to the supply point, the cost to treat the water, the cost of the reservoirs to store the treated before distributing it to the consumers. The consumer base and technology, that is affordable to various income groups (i.e. a communal standpipe or a tap in a household, or a pre-paid meter etc., also have an effect on the cost of water.

The water that we receive from direct rainfall or that is flowing in a river or from a spring is basically recognized as a free commodity or “a gift from God”. However, not everybody lives next to one of these free water sources and such resources may also be contaminated or polluted and unsafe for human consumption.

This requires the development and operation of water supply infrastructure to transport water from source to consumer and to make the water potable or safe for human consumption. It is clear that such developments will cost money and requires the investment of capital funds to build the water scheme and to operate the water scheme over time.

The capital investment required is normally borrowed from a banking institution and both the amount that is borrowed and the interest to be paid on the loan must be recovered over a period of time. This cost is called the capital cost and is usually a fixed amount to be repaid over a period of time. The water scheme must also be operated to pump the water and the water may have to be treated and disinfected to make it safe for human consumption.

This requires the use of energy and chemicals which cost money. The people who must operate the water scheme have to receive some form of remuneration and this also costs money. Any water scheme requires proper maintenance to make sure that it remains operational and broken equipment must be repaired, for example a broken pump set or leaking valve or leaking water tank. These costs are called operating costs and is variable over time.

All the capital and operating costs must be recovered from the consumer or subsidised in some way because the supply of water is not free and costs money. This cost of the water is referred to as the actual cost to supply the water.

When water is supplied, there is normally a water supplier who must recover his costs and that cost of the water is called the water tariff. Water that is supplied to a community must be reticulated or distributed to the consumers and the consumer must pay for the recovery of the capital and operating cost for the distribution network This additional cost increases the water tariff and this increased cost to supply the water to the consumer is called the water price.

There is therefore a difference between free water, the actual cost of water supplied by a water scheme, the tariff for the water and the price of the water which must be paid by the consumer.

Municipal costs to provide a household with water and sanitation services include charges for water collection from a source; water production (treatment of raw water to drinking water standards); water delivery to the consumer and wastewater treatment and disposal. Wastewater collection and treatment contribute to hygienic environments and form part of the water chain to prevent pollution in order to ensure that good water quality and sanitation is achieved. Therefore it is essential that water consumers pay for water services to ensure continued quality and efficient service delivery.

The GINI coefficient for Namibia is 0.604 according to the results of the Namibia Household Income and Expenditure Survey for 2003/2004 (NHIES, 2003/2004). This indicates a high level of inequality in the distribution in income. Although the inequality in the distribution of income decreased from 0.701 in 1993/94 to 0.604 in 2003/2004, it is still among the highest in the world. Implementation of equitable tariffs and improved maintenance of infrastructure to prevent wastage will contribute to skills development, more employment opportunities and poverty alleviation. This is also a clear illustration of the need to introduce an equitable water tariff structure based, not only on the principles of cost recovery, but more importantly, social responsibility.

In rural areas, the community based water management programme under the Directorate of Water Supply and Sanitation Coordination, established mechanisms for users to pay for water services. In addition, mechanisms for transparent and targeted subsidies for those who are unable to pay for water services are being considered.

Local water point committees manage local aspects of water services, preventing issues such as illegal connections and vandalism to pipelines.

8.3.3 The value of water

Water has a value as an economic good. The value of water should not be confused with water charges because they are two different things. Charging for water is applying an economic instrument to affect behavior towards efficient water use and water conservation. The value of water in alternative uses is an important tool for the rational allocation of water as a scarce resource. There is a need to change perceptions and recognize the full value of water. Useful water value and water costing concepts are further elaborated and respectively reflected in Figure 27 and Figure 28 below.

In **Figure 26**, it can be seen that the full economic value of water consists of its economic value and the intrinsic value refers to the actual value of the water, determined through a fundamental analysis, without reference to its market value. The economic value is the value to the users of the water (how much money can be made by using the water for agricultural production or mining), the net benefits from return flows, the net benefits from indirect uses and adjustment for societal objectives such as subsidizing water supply to the poor. Treating water as an economic good may help to balance the supply and demand of water, thereby sustaining the flow of goods and services from this important natural asset.

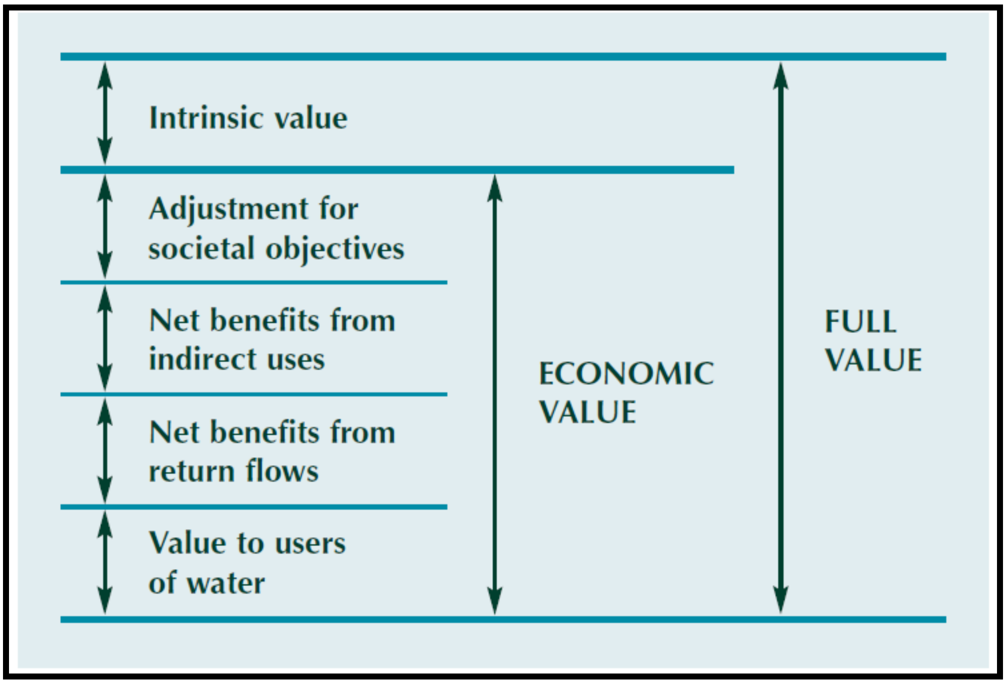

Figure 26: The economic value of water

In **Figure 27**, it can be seen that the full cost of providing water includes the full economic cost and the environmental externalities associated with public health and ecosystem maintenance. The full economic cost of the water comprises the full supply cost, opportunity cost and economic externalities. The full supply cost comprises the recovery of capital investments cost and interest, plus the operation and maintenance cost. The recovery of the full cost should be the goal for all water supplied, unless there are compelling reasons for not doing so.

The relationship between water as an economic good and water as a social good should be well understood. Water as an economic good has to do with the financial self-sufficiency of water supply entities and the money that can be made as a result of the use of water. In order for water resources management agencies and water utilities to be effective, there is a need to ensure that they have adequate resources to be financially independent of general revenues. Thus, as a minimum, the full supply costs should generally be recovered in order to ensure the sustainability of investments.

However, high supply costs and the view that water is a social good, may require direct subsidies to specific disadvantaged groups to address social concerns.

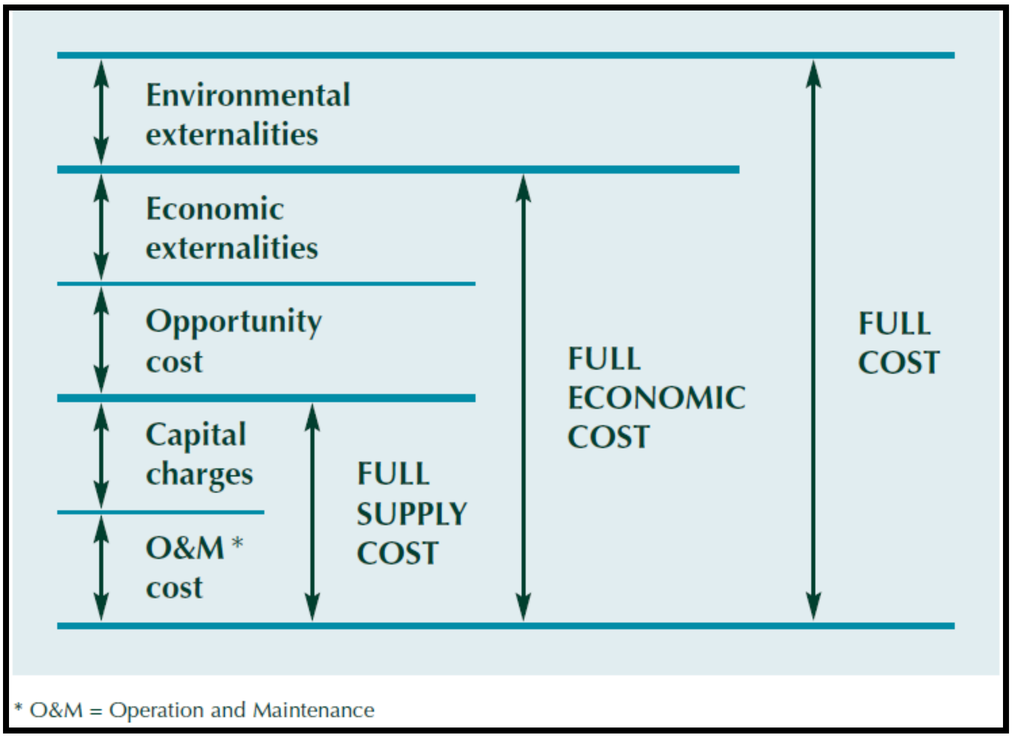

Figure 27: The costing of water

8.3.4 Tariff Setting and Subsidies

A number of principles which underpin the fundamental requirements of tariff structures, affordability and service delivery were defined by NamWater (LCE 2008). Those principles are:

1. A tariff structure can only succeed if the water users accept the tariff policy as fair.
2. The tariff structure should be understandable to water users and decision makers.
3. Tariffs need to convey an economic signal to the users which will support the aspirations of the water supplier to achieve water demand management and conservation. (The tariff should be sufficiently high to influence behaviour and reduce wasteful use).
4. Tariffs should ensure revenue stability, taking variations in water demand into account.
5. The full economic cost of water supplied to mining, industrial and commercial enterprises, including irrigation, should be recovered from the tariffs.
6. When large increases in tariffs are necessary, it should be introduced in small steps over time, so that the increase in cost for commercial consumers can be smoothly absorbed into production costs
7. Social equity in the context of water resources implies that all user groups have fair and reasonable access to water. Equitable tariffs mean that all consumers within the same consumer group, in a particular water supply area linked to the same water supply infrastructure, should pay the same price. An example of this principle would be that all rural consumers obtaining potable water from the pipe line network in the Central North of Namibia should be charged the same tariff.

8. Water service providers should be accountable to the people within their area of supply.
9. The cost of providing water supply services should be open to the public for scrutiny if required. The way in which tariffs are calculated and levied should be transparent and explainable to consumers.
10. Water service providers should provide accurate and user-friendly monthly invoices at a specific date each month to a water consumer.
11. Water service providers should provide proper customer care in a friendly and professional manner within one month after receipt of a query.
12. The security of supply and water quality should be covered in the water supply agreements between NamWater and its customers.

Experience in Namibia has shown that as soon as Local Authorities start addressing their billing and payment systems and increase the efficiency of these systems, and start addressing the integrity of their reticulation networks, water consumption drops dramatically.

As stated in the WSASP (2008): “Mechanisms for transparent subsidies and/or cross-subsidisation by means of rebates for those who are unable to pay for water supply and sanitation services should be pursued.” In the situation assessment for the determination of NamWater tariffs, it was recommended that the following guideline be used as interim measure: “Cross subsidies within a region can handle a poverty component of up to 15%, and rural subsidies are required where the poverty index lies between 15% and 30%. Where the total poverty limit is above 30%, subsidies for both urban and rural areas may be required. Blanket subsidies are not recommended as they mainly benefit the rich. To conserve water, it is important to apply the same tariff principles to all end consumers linked to the same water supply scheme”.

In a study conducted in Rehoboth in 2003 (ref Water Management Assistance for MRLGHRD, funded by SIDA) the relation between income level and water demand (income elasticity - family income versus water consumption) was used as an indicator of the number of poor families. It was established that approximately 27% of the consumers (mostly concentrated in the low income areas) consumed approximately 8% of the water. By introducing appropriate tariffs (rising block tariffs, which include an element of cross-subsidization) the cost of water to the low income group was reduced by more than 50% without industry, business, government and the middle and high income households having to pay much more (5%) for their water. However, this had a significant effect on increasing the disposable income of poor households in Rehoboth.

8.3.5 Water saving

There are different ways to save water in urban households, such as:

1. Schedule watering of gardens for early or late in the day (before 10 am and after 4 pm). Also consider gardening with wastewater from showers, bath or rinse water from washing clothes.
2. Avoid the use of hosepipes for cleaning pavements, floors or cars by using a bucket.
3. Retrofit existing equipment by replacing it with equipment specifically designed to reduce water use, such as:
    - Low flush and dual flush toilet cisterns. This can also be achieved by placing a 1 to 2 litre plastic bottle filled with water, or a brick wrapped in plastic, inside the cistern to reduce the quantity of water used for each flush of the toilet. The swimmer arm inside

the cistern can also be bent downwards so that the inflow valve is shut off when the water reaches a lower level than previously.

- Low flow shower heads can be installed to reduce water flow.

4. Any moisture leak should be fixed immediately or reported it to the municipality. Most water leaks occur from toilet cisterns. A single leaking toilet cistern can lose up to 7 000 litres of water per day in a household.
5. Explore rainwater harvesting to collect and store of rain from run-off areas such as roofs,
6. Keep track of water usage by regularly monitoring a household water meters. If all the taps in the house is closed and the water meter is running, it means that there is a leak somewhere. Such a leak should be found and repaired.

8.4 WDM CONCLUSION

The development of end use water tariffs, subsidy or cross subsidisation policies and appropriate credit control policies are overdue, and no water demand management policy or strategy will succeed without it. Moreover, to implement WDM successfully it is important that the revisions of the Water Resource Management Bill and the Regulations be finalised soon in order to enable the promotion of water use efficiency, the prevention of water pollution and the controlling of water quality. The water use efficiency regulations must include the performance indicators required in the different water use sectors. All service providers will also be licensed in terms of the Act.

In conclusion the issues in the water sectors can be summarised as:

- Urban and irrigation sectors present the greatest potential for water savings through WDM and water use efficiency provided that sufficient resources (human and financial) are allocated to realise the benefits;
- The mining sector must develop water management plans to improve water use efficiency and take steps to prevent pollution;
- The rural domestic sector should concentrate on good financial management and maintenance of infrastructure. Further work needs to be done to adapt current policies to best meet the requirements of the sector;
- The important issues for the livestock sector are the maintenance of infrastructure to reduce wastage, pollution control and the reduction/reverse of bush encroachment;
- For tourism the issues are wastage, over abstraction and pollution;
- NamWater needs to recover debt of more than N$270 million, improve the maintenance of water supply infrastructure and to develop a funding strategy for capital replacement and the development of new bulk supply infrastructure.

9. WASTE WATER MANAGEMENT

9.1 WATER QUALITY

The achievement of Vision 2030 will put a major strain on existing water resources and the protection of such resources from pollution by human activity, including industry and mining is a serious issue. Most of the wastewater treatment plants are overloaded and there are major backlogs in sanitation, both in urban and rural areas. The high rate of urbanisation has created a major strain on the capacity to treat wastewater to an acceptable standard and this situation needs to be addressed

Water quality guidelines for drinking water have been adopted by the Department of Water Affairs and Forestry. The quality of water is determined by its aesthetic (colour, smell, and turbidity), the chemical and the bacteriological quality. There is a direct link between water quality and health. It is therefore important to be able to differentiate between safe and unsafe water sources. Water quality is determined by both natural and human-induced contaminants (pollutants) that may have found their way into the water supply.

The chemical quality of the groundwater in the CEB was discussed in Paragraph 6.3 above. Water in nature contains varying concentrations of dissolved oxygen and other gases, microscopic living organisms, tiny particles of dead and decaying organic matter, sediments and inorganic salts. The concentration of salts dissolved in the water affects the taste of the water and its safety for human or stock consumption. These constituents include nitrates, fluorides, sulphates as well as sodium chloride and carbonates. The taste of the water with elevated levels of salinity is salty and is described as brackish or highly saline, depending on how the salt concentration is experienced.

The chemical quality of the water in the central parts of the CEB is very poor but improves further south, east and west - away from the central zone - with the best quality of water found in the Tsumeb (Karst) groundwater area. In general, the quality of groundwater across the basin is poor (saline water), especially in the shallow aquifers in the central areas of the basin extending south from the Angolan border towards the Etosha Pan.

Many people in the CEB basin are exposed to bacteriologically unsafe or “dirty” water from open wells, canals and oshanas, but much has been done since 1994 to give the people access to safe water through modern water services and the coverage is well over 80%. Dirty water can have a colour (yellow, brown or black), but it can also be clear and contain invisible bacteria or chemicals that are harmful to humans and animals. Therefore it is advisable to clean water by boiling it before drinking it. The Omusati and Oshana regions are prone to high sulphate concentrations causing laxative effects on humans. High fluoride concentrations are found in the Ohangwena, Okongo and Outapi-Ondangwa areas and south of Okahao towards the eastern half of Omusati. This can lead to severe dental and skeletal deformation in both humans and livestock.

9.2 WATER QUALITY AS AN INDICATOR OF POTENTIAL PROBLEMS

The evaluation of the water quality gives an indication of potential problems such as:

- Groundwater pollution;
- The presence of unacceptably high concentrations of salinity, sulphate, fluoride and nitrate in some places;
- Possible negative health effects for consumers especially with respect to microbiological hazards which are not monitored in most water distribution systems;

- Important parameters such as arsenic, cyanide and radioactivity which are not measured in areas where such substances may occur as a result of rock or soil type;
- The negative effect that scaling and corrosive water has on the lifetime of infrastructure and the cost of maintenance.

9.3 PREVENTATIVE PRINCIPLES TO BE INCLUDED IN WATER QUALITY REGULATIONS

It is important that the water quality regulations be based on the preventative principle as advocated by the WHO and must stipulate:

- The required testing frequency of water quality, especially to prevent biological hazards;
- Frequency and format of mandatory reporting of water quality;
- The establishment of a national water quality and monitoring data base;
- Development of water safety plans, based on preventative management, to avoid the outbreak of disease; and
- Warning and consultation with consumers if water does not comply with basic health parameters.

In addition, pollution control regulations must include the necessary precautions for the protection of the water resources (surface and groundwater) in Namibia.

9.3.1 Water quality problems currently faced in the CEB

Below are some of the water quality issues that require attention in the CEB through the BMCs:

- In areas with high population densities such as in the CEB, unfenced pond systems expose humans (mostly children) directly to major health risks when they swim in ponds or catch fish. Effluent in or from the pond systems is also not suitable as drinking water for animals.
- Seepage from unlined sewerage ponds creates an immediate pollution threat to groundwater resources.
- Location of solid waste sites around towns may contribute to pollution. Water produced from boreholes in the immediate vicinity may show signs of pollution.
- In rural areas, including tourism facilities, the location of facilities such as kraals, unlined pit latrines, septic tanks and solid waste disposal sites near boreholes can cause pollution of groundwater.
- In a few areas water sources contaminated through mainly animal waste (especially where cattle troughs are close to wells) have been declared as ‘unsafe’ for human consumption due to high concentrations of nitrate.
- The increased development in and around towns create another source of pollution can create major environmental pollution problems which may be detrimental to human health.
- Possible pollution from mining activities – such as the smelter at Tsumeb.

Groundwater monitoring is considered very important, not only to determine the sustainable yield of boreholes, but also to identify the availability of groundwater with acceptable water quality, to understand water quality trends over time and to use the information to predict seasonal water quality fluctuations or identify permanent quality changes.

The quality of drinking-water may be controlled through a combination of protecting the sources of water, appropriate treatment processes, as well as the improved management of the distribution and handling of the water.

The Geo-hydrology Division in the DWAF is responsible for groundwater investigation and monitoring.

9.4 SANITATION AND HYGIENE

Sanitation is vital for human health, generates economic benefits, contributes to dignity and social development, and protects the environment. Sanitation promotion focuses on stimulating the demand for ownership and use of a physical good. Access to basic sanitation refers to access to facilities that hygienically separate human excreta from human, animal, and insect contact.

Hygiene promotion focuses on changing personal behaviour related to the safe management of excreta, such as washing hands and disposing safely of household wastewater. Both are essential to maximize health benefits. A lack of sanitation facilities and poor hygiene can cause water-borne diseases such as diarrhoea, cholera, typhoid and several parasitic infections. Provision has been made for both urban and sanitation management objectives and principles in the Water and Sanitation Sector Policy of 2008. This will contribute towards improved health and quality of life.

Considering that Namibia is a water-scarce country, in most (rural and urban) instances, the most affordable individual household or community sanitation option are ecological or dry sanitation facilities, however where possible it should be left to the individuals to decide on the most appropriate technological and payment options as well as maintenance responsibility allocation. Communities have the right to determine which water and sanitation solutions are acceptable and affordable to them.

9.5 WASTE WATER TREATMENT AND DISPOSAL

Most of the wastewater treatment facilities in Namibia are overloaded and deliver substandard effluent which is not suitable for discharge into the environment. In many cases treatment plants are not well maintained, or the operation of the plants is left to people with insufficient knowledge of the biological processes which influence the effluent water quality. Most of the towns rely on oxidation and maturation ponds which were originally designed not to discharge effluent into the environment. Seepage from lined ponds with leaking linings or unlined ponds creates an immediate threat to water resources. As a result of both organic and hydraulic overloading, sub-standard effluent is also discharged into the environment where open water sources and groundwater can be contaminated. There are signs of borehole pollution in the vicinity of the Okaukuejo oxidation ponds. A typical example of industrial waste water pollution is the discharge of industrial waste from mining activities such as in Tsumeb where the effluent can pollute the in water in Karst aquifers.

In areas with high population densities such as in the CEB, unfenced pond systems expose humans (mostly children) directly to major health risks when they swim in ponds or catch fish. Effluent in or from the pond systems is also not suitable as drinking water for animals.

Floods in the CEB inundates pond systems, bush toilets and unlined pit latrines and can cause major health problems, especially when potable water supply infrastructure is damaged and people revert to drinking untreated surface water. This results in the outbreak waterborne disease such diarrhoea and in worst cases, cholera.

The location of solid waste sites around towns may contribute to groundwater pollution. It is therefore necessary to improve solid waste disposal and sanitation facilities to deal with solid and liquid human waste.

At settlements in rural areas, including tourism facilities, the location of facilities such as kraals, unlined pit latrines, septic tanks and solid waste disposal sites near boreholes can cause pollution of groundwater and must be avoided.

With increased industrialisation as contemplated in Vision 2030 all development in the CEB must be planned in such a way as not to compromise the quality of water resources.

10. STRATEGY FOR IMPLEMENTATION, MONITORING AND EVALUATION

10.1 GENERAL BACKGROUND

MAWF is the custodian of the National IWRM Plan, and therefore will lead the development and implementation of both the National Plan and the CEB IWRM Plan, including monitoring and evaluation. However, the BMCs that have been established in the CEB have certain responsibilities in the sub-basins, but those responsibilities are limited to the extent that technical and financial capacity are available to implement development projects or to give effect to addressing the issues that are identified by the basin stakeholders. This lack of capacity should be addressed in the interest of proper integrated water resources management.

To enable the Cuvelai – Etosha Basin Management Committees to be relevant in the integrated management of water resources, some administrative, technical and financial support will be available from Government sources, but the major role of the BMC will be advisory in nature and to serve as a custodian or guardian on behalf of the stakeholders in the different sub-basins to ensure that those institutions who indeed have executive powers and appropriate capacity, will be doing their work in the interest of the basin. This requires that the BMC should be aware of its capacity constraints, powers and responsibilities as a statutory body to influence or to bring pressure to bear on those institutions which have certain distinct responsibilities in the water sector and may not be performing as expected.

10.2 ESTABLISHMENT OF THE BASIN MANAGEMENT COMMITTEES

A group of representatives of stakeholders who have a common vision to deal with matters relating to the development, management, protection and enhancement of water resources in a river basin, may approach the Minister of Agriculture, Water and Forestry to be recognized as a basin management committee for the purposes of the Water Resources Management Act and in furtherance of the Government's objective to achieve the integrated management of water resources.

The Minister may recognise a group of representatives of stakeholders as a basin management committee only if the Minister is satisfied that interests in the use and management of water resources in the river basin concerned are broadly represented in the membership of the group

A basin management committee may be recognised for any purpose connected with the use protection, development, conservation, management or control of a water resource in a basin, such as an aquifer, shared water supply infrastructure, an area comprising adjacent geographic entities with joint water resource management features, an area defined for common management of water resources or irrigation activities.

The recognition of a basin management committee must be given by notice by the Minister in the prescribed manner in the Government Gazette and must elaborate on such issues as the name of the basin management committee, the purpose of the committee, the boundaries of the water management area in which the committee will operate, and any other matter deemed necessary

The composition of a basin management committee will be governed by a constitution or other founding document or instrument embodying the terms and conditions of association of the group of representatives recognised as the basin management committee.

The Minister may provide direct administrative, financial and technical support to a basin management committee according to the provisions in the Water Resources Management Act (WRMA).

10.3 FUNCTIONS OF THE CUVELAI – ETOSHA BASIN MANAGEMENT COMMITTEES

The functions of a basin management committee regarding its water management area, in this case the Cuvelai – Etosha Basin, are to:

- advise the Minister on matters concerning the protection, development, conservation, management and control of water resources and water resource quality;
- co-ordinate with the regional planning component of the regional council, or a local authority, to ensure that water resources and resource quality are effectively managed and protected in accordance with the Water Resources Management Act;
- promote community participation in the protection, use, development, conservation, management and control of water resources in its water management area;
- promote community self-reliance, including arrangements for the recovery of costs for the operation and maintenance of any waterworks;
- help to resolve conflicts relating to water resources and resource quality;
- report to the Minister the occurrence or threat of serious water or pollution;
- make recommendations to the Minister about the applications amendment, cancellation, or suspension of licences for water resources allocated;
- collect, manage and share data required for the proper management of its water management area in coordination with the Minister;
- prepare an integrated water resources management plan for its water management area;
- conduct, with the concurrence of the Minister, a water research agenda appropriate to the needs of institutions and water users within its water management area;
- monitor and report on the effectiveness of policies and measures in achieving sustainable management of water resources and resource quality;
- give effect to a direction given by the Minister;
- perform such functions as are delegated or assigned by the Minister;
- compile and submit an annual report on its activities to the Minister.

10.4 IMPLEMENTATION STRATEGY OF THE IWRM PLAN FOR THE CEB

The Government adopted a National IWRM Plan for Namibia and in that plan a broad overview was given to elaborate the background against which the plan had been developed, as well as the issues to be addressed in the preparation of a strategy and action plan, including issues of capacity development and funding.

The purpose of the IWRMP for the CEB is to home in on more the specific issues that need to be addressed in the CEB in general and in the four respective sub-basins in more detail. Some of those issues can be addressed by the BMCs, but most will have to be addressed by the respective Government Institutions directly responsible for implementation. In such cases the BMCs will have a specific monitoring and controlling responsibility to ensure that effect is given to the plans to address the identified issues.

10.4.1 Summary of Issues identified

The following is a summary of the issues that have been identified during a consultative process with the sub – basin Committees as part of the development of the IWRM Plan for the CEB that will become the responsibility of each BMC to implement according to the functions of the BMCs as prescribed in terms of the WRMA.

The following are the key issues that were identified per sub-basin in the Cuvelai – Etosha Basin:

- **Resource sustainability;**
- **Risk of water pollution ;**
- **Waste disposal ;**
- **Flood and drought disasters;**
- **Land degradation;**
- **Limited knowledge about ground water resources, water, sanitation and hygiene, guidelines on pit latrine construction and maintenance of toilet facilities;**
- **Poor coordination and management among institutions;**
- **Human and wildlife conflict;**
- **Illegal hunting.**

10.4.2 The issues per Sub – Basin

Iishana Sub-basin

1. Resource sustainability

- Water security for CEB – dependence on only the Calueque Dam
- Vandalism of water infrastructure vandalism (surface flow monitoring stations
- Limited information and understanding of quantification (yield) and sustainability
- Poor water quality – saline groundwater
- Uncoordinated use of boreholes (permission required)

2. Risk of water pollution from

- Sanitation facilities that are inappropriately located
- Sewage ponds that are inappropriately managed (e.g. sewer ponds overflow during flooding)
- Solid waste disposal
- People bathing and washing in the canal

3. Waste disposal

- Low sanitation coverage in certain areas
- Sanitation technology

4. Disasters

- Lack of Regional or urban flood management plan
- Current approach to disasters more oriented to mitigation rather than to preventive measures

Niipele Sub-basin

1**. Resource sustainability**

- Understanding groundwater resource base
- Quantification (yield) and sustainability
- Water security - low coverage of water supply
- Shortage of water in some places i.e. Epinga, Ohakafiya, Oshipala, Okongo, Omundaungilo and Epembe, Okankolo and Eengodi

2. Pollution Risk of water and soil pollution from

- Poor waste management
- Sanitation facilities inappropriately located
- Fear of groundwater contamination
- Wells that are not covered

3. Waste disposal

- Lack of sanitation facilities in towns (public toilets) and resettlements
- Low sanitation coverage in certain areas
- Difficulty in implementing total sanitation
- Location of dumping sites (dumpsites not fenced, lack of security guards at dumpsite)
- Inappropriate waste management technologies used in the basin

4. Disasters

- Lack Regional or urban flood management plan
- Current approach to disasters more oriented to mitigation rather than to preventive measures

5. Land degradation

- Overgrazing
- Veld fires
- Bush encroachment
- Deforestation

6. Knowledge

- Limited understanding groundwater resource base
- Inadequate information on water and sanitation among communities
- Limited awareness on where to construct pit latrines according to standards/guidelines (if any)
- Lack of awareness on the usage and maintenance of toilet facilities (including the importance of using toilets)
- Poor maintenance of toilet facilities
- Limited hygiene promotion

7. Management

- Poor coordination among institutions
- Monitoring of water consumption
- Participation of community

Olushandja Sub-basin

1. Resource sustainability

- Understanding groundwater resource base
- Quantification (yield) and sustainability
- Illegal connections to water infrastructure Water security for CEB – dependence on only the Calueque Dam
- Vandalism of water infrastructure (surface flow monitoring stations)
- Shortage of water after the rainy season
- Limited maintenance of water infrastructure e.g. boreholes
- Quality – saline groundwater

2. Pollution

- Poor solid waste management and disposal
- Sanitation facilities inappropriately located
- Sewage ponds that are inappropriately managed (e.g. sewer ponds overflow during flooding)
- People washing clothes and bathing in the canal

3. Waste disposal

- Low sanitation coverage in certain areas
- Location of dumping sites
- Inappropriate waste management technologies used in the basin

4. Disasters

- Heavy floods
- Lack Regional or urban flood management plan
- Current approach to disasters more oriented to mitigation rather than to preventive measures

5. Land degradation

- Bush encroachment
- Weeds growing in the canal
- Overgrazing
- Veld fires

6. Knowledge

- Limited understanding groundwater resource base
- Limited awareness on where to construct sanitation facilities according to standards/guidelines (if any)
- Lack of awareness on the usage and maintenance of toilet facilities (including the importance

7. Management

- Poor coordination among institutions
- Limited funds for implementation of activities in the sub-basin
- Voluntarism by Water Point Committees and Local Water Committees to manage their water infrastructure
- Limited ownership of resources
- Limited cooperation and understanding among stakeholders
- Limited awareness on the importance/need of using toilets instead of the bush
- Non-payment for water services

8. Additional Topics

- Wildlife - Destruction of resources by wild animals
- Illegal hunting

Tsumeb Sub-basin

1. Water resource sustainability

- Limited understanding groundwater resource base
- Limited information on quantification (yield) and sustainability
- Poor water quality (northern and waster areas)
- Over abstraction of groundwater
- Allocation conflicts (permits)/unfair allocation of water between various sectors
- Old water infrastructure (Mangetti farmers)
- Long distances travelled to fetch water

2. Risk/Potential Pollution

- Mining activities
- Farming activities
- Solid waste disposal sanitation
- Sanitation

3. Waste disposal

- Sanitation coverage in certain areas (insufficient sanitation facilities)
- Sanitation technologies used
- Inappropriate dumping sites, sewage ponds

4. Land degradation

- Overgrazing
- Bush encroachment

5. Additional Topics

- Lack of participation from some stakeholders (Farmers, Municipality, etc)
- Lack of coordination among stakeholders
- Incentives for BMC and Forum members

10.5 ALLOCATION OF RESPONSIBILITIES

The concerns, issues, expectation and needs as identified by the Sub –Basin Committees will be the responsibility of each Basin Management Committee. The possible interventions or solutions to address the concerns have been discussed at the consultative meetings with each Committee and the entities responsible for attending to the issues have also been indicated. This strategy to achieve these objectives is reflected in **Annex 1**.

10.6 CAPACITY BUILDING

The key findings related to Capacity Building to implement the IWRM Plan for the CEB have been identified in the course of drafting the Plan and are summarised as follows:

1. Integrated Water Resources Management is for all stakeholders in the water sector, i.e. for all water service providers and related management and governance entities and all water users in Namibia as in the Cuvelai – Etosha Basin.
2. Capacity building and institutional development were found to be the key elements for implementation of IWRM in Namibia as they are for the Cuvelai – Etosha Basin.
3. The key-objective of IWRM capacity building is informed and improved decision-taking, and the responsible implementation of these decisions.
4. IWRM capacity building brings sustainability to all four dimensions: economy, society, environment and technology.
5. IWRM capacity building for human resources and organisations is iterative in nature and is focused on all stakeholders to ensure water resource security. Managerial and technical capacity building is the pivotal goal ensuring that water demand management and integrated water resources management are central
6. The national IWRMP proposes bringing into force, strengthening or establishing the following institutions and water governance structures all of which will influence BMCs:
    - the revised WRM Act and Regulations;
    - a Water Research Council (WRC);
    - the Water (and Sanitation) Advisory Council (WaSAC);
    - Performance Support Teams (PSTs);
    - the Water Regulator (WR);
    - a National Irrigation Water Efficiency Group (NIWEG);
    - Basin Management Committees (BMCs) and
    - Water Point Committees (WPCs).
7. The national IWRMP proposes to engage all stakeholders and the following set of enabling strategies to meet the goals of IWRM and the available policies. This will influence the Cuvelai – Etosha Basin.
    - an ephemeral river catchment and integrated basin management strategy;
    - a clear communal land and water use strategy;
    - a national water demand management strategy;
    - a strategy on national pollution control and effluent discharge quality and appropriate regulations, a groundwater protection strategy and management plan;
    - an effective strategy on tariff setting;
    - an effective strategy on water metering and data monitoring;
    - a strategy on integrated coastal management;
    - an effective strategy on the reduction of bush encroachment to enhance groundwater recharge and surface run-off;
    - a strategy on gender participation and engagement on all levels in IWRM/WDM;
    - a suite of strategic planning and management support mechanisms.

8. IWRM is a highly complex and interconnected system with numerous mutual and simultaneous impacts between critical issues. A broad skills mix is therefore needed to master such an interconnected system.
9. Four elementary capacity levels were identified:
    - The system level addresses key requirements related to policies and the legal framework;
    - The organisational level addresses managerial effectiveness with a specific focus on decision taking and responsibility allocation;
    - For human resources capacity maintenance and building new capacity, the individual level was identified with key-requirements relating to a broad knowledge and skills mix;
    - At the technical level required capacity ranges from integrated resource planning and demand management to maintenance management.
10. A broad skills mix, with aggregated skills levels and the experts involved in IWRM performance, capacity maintenance and capacity building are required. A broad skills mix calls for balanced interdisciplinary cooperation between specialists based on well managed and competent teams which are carefully designed and their capacity maintained.
11. The Polytechnic of Namibia is identified as one key-technical educator and capacity builder. The Polytechnic currently offers twenty-eight IWRM relevant formal study programmes.
12. IWRM anchoring and outreach is an important element of capacity building. The IWRMP process proposes development, re-activation and proactive use of the multiple, existing awareness raising materials to reach Namibian stakeholders in urban and rural areas on all levels
13. The private sector should be actively used for mentoring and capacity building and capacity maintenance, nationally and in the Cuvelai – Etosha Basin.

10.7 FUNDING

The Cuvelai Basin Management Committees are statutory bodies with an advisory role. Funding will be required to support their advisory role and budgetary provision must be made for by the Ministry. Nevertheless, it must be remembered that in the advisory role of the BMCs it must be advocated to the community that water has an economic value regardless of the sector in which it is used and water should be considered as an economic good. In addition, the water sector has many facets of which resource development, supply infrastructure and service delivery is the most important. This implies that there is more to the cost of water than just the cost of infrastructure. All costs should be considered when funding the Water and Sanitation Sector (WSS), including those to support BMCs and their advisory role.

11. CONCLUSIONS

The main objective of integrated water resources management is to achieve sustainable water security that will support socio-economic development, health and prosperity for all;

The implementation of IWRM is a continuous, collective effort facilitated by the Department of Water Affairs and Forestry in the Ministry of Agriculture, Water and Forestry and supported by the activities of Basin Management Committees established at the water basin level by stakeholders and communities;

The BMCs have a responsibility to ensure that all role players in the water sector meet their respective obligations in terms of their mandates, *i.e.* NamWater, Regional and Local Authorities, other Ministries and the communities that benefit from water and sanitation services;

The practical implementation of IWRM Plans will depend on the organizational efficiency of the water institutions, the capacity of the human resources employed and the appropriation of adequate funding through the fiscus and the recovery of the cost to provide water supply and sanitation services;

Effective stakeholder participation at all levels is required to ensure ownership and responsibility regarding the decisions taken to initiate water resource management activities;

The issues that should be monitored by the BMCs relate to efficient water supply and sanitation services, pollution control, water resource protection and conservation, cost recovery, capacity building, awareness raising, institutional development, water demand management and providing advice to the line Ministry about water management issues and the performance of all entities with responsibilities in the water sector.

12. RECOMMENDATIONS

It is recommended that

12.1 The IWRM Plan for the Cuvelai – Etosha Basin is accepted as a guideline document to assist the BMCs in the CEB to direct their activities effectively to assist the Ministry in managing the water resources and service provision in the CEB for the benefit of all the basin stakeholders.

12.2 The IWRM Plan is made available to all other institutional stakeholders to facilitate water management and cooperation between all stakeholders and the BMCs in a holistic way

WINDHOEK

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14. ANNEX 1: KEY ISSUES IDENTIFIED IN THE FOUR SUB BASINS OF THE CUVELAI – ETOSHA BASIN

Iishana Sub-basin

Water related concerns and issues	Are these still concerns, issues, expectations and needs? What is really the issue?	Possible interventions/solutions to address the concerns and issues	By Whom?
1. Resource sustainability • Water security for CEB – dependence on only the Calueque Dam • Vandalism of water infrastructure vandalism (surface flow monitoring stations • Limited information and understanding of quantification (yield) and sustainability • Poor water quality – saline groundwater • Uncoordinated of boreholes (permission required)	• Insufficient infrastructure, only having one pump at Calueque dam. • Depending on only one external water source	• To have more pumps at the Calueque dam • The Etaka canal needs to be rehabilitated, to provide water for livestock at Uuvudhiya side. • A need to have more water harvesting sources, such as earth dams, In times of floods and high rainfall • A dam between Omadhiya Lake and Okuma. • Awareness campaigns need to be raised among communities regarding the impact of vandalism of water infrastructures. • Regulations need to be in place, to prevent vandalism of infrastructures. • Local communities need to be informed on the quantity of water available and the sustainability of this resource.	• NamWater, line ministries and NGOs
2. Risk of water pollution from • Sanitation facilities that are inappropriately located • Sewage ponds that are inappropriately managed (e.g. sewer ponds overflow during flooding) • Solid waste disposal		• The need to construct environmentally friendly toilets at appropriate sites. • Proper Rehabilitation of the existing sewer ponds • Proper management of the existing solid waste disposal sites {landfills with relevant compassion materials} • Advocate reduce, recycle and reuse mechanisms in the sub-basin.	Line Ministries, NamWater, BMC, RC

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• People bathing and washing in the canal		• Awareness campaigns on solid waste management especially in rural areas • Awareness campaign on the implications of bathing and washing in the canal • Enforcement of the Laws and regulations	
3. Waste disposal • Low sanitation coverage in certain areas • Sanitation technology	• It is not known which sanitation technology is favourable for which areas	• The need to construct environmentally friendly toilets at appropriate sites • Speed up/accelerate the development of sanitation standards • Train people on construction of sanitation systems • Conduct feasibility studies • Consider social including cultural beliefs of people during construction of toilet facilities	Line Ministries accountable (MRLGHRD, MAWF), Constructors, BMC
4. Disasters • Lack of Regional or urban flood management plan • Current approach to disasters more oriented to mitigation rather than to preventive measures	• Regional and urban plans are in place however the implementation is delayed due to limited funds • Yes, it is still a concern • Another concern is for those who are already in flood prone areas	• Construct storm water channels to allow rainwater to flow • Mobilise people in flood affected areas • Train people in affected areas to cope with the effects of floods (still mitigation) • TCs and TAs be informed to stop allocating land for settlement in flood prone areas • Allocate land for settlement in high lands/grounds • Re-channelling/deviation of water channels/flows • Permanent structure (concrete wall) to reduce the flooding of towns and the intensity of the floods	
5. Land degradation • Deforestation • Overgrazing • Bush encroachment		• Deforestation - Enforcement of the Forestry laws and regulations (especially Ompale area)	MAWF, TAs, RC, MET

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• Salinization of arable land • Uncontrolled veld fires		• Cutting of trees be regulated • Consider establishment of more community forests • Promote the use of alternative building materials • Reduce livestock numbers • Consider land redistribution (between the poor and the rich) • Crop rotation • Planting of trees to improve the soils • Conservation tillage (modern implements) • Implementation of the fire cut lines • Information mobilisation on the field fire, reporting of fire and regulation enforcement of forest act	
6. Knowledge • Limited information about water consumption (mining, wildlife, agriculture) • Limited monitoring of consumption • Limited understanding on and quality of water resources • Over abstraction of groundwater • Water allocation (permits)		• Protection of water source such as natural spring • Introduction of rain fed trees • Introduction of rain gage at the constituencies offices, community and farmers • Planting of more plants • Information on water treatment such as boiling	
7. Management • Poor coordination among institutions • Poor attendance of representatives from key divisions within the MAWF during forum meetings to		• Decentralization with funds and function of the activities to the region • Proper coordination of the activities by the BMC in collaboration with line ministries	Extension Officers MAWF MWTC MoHSS line ministry farmers MAWF and NamWater

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address emerging issues • Access to safe water supply (long distances) • Monitoring of water consumption • Participation of community		• Incentives (e.g. payment) of the WPC	