CLIMATE TECHNOLOGY CENTRE & NETWORK

Assessment of Water Resources Management

1. Overview

Namibia is the most arid African country south of the Sahara with low and varied precipitation, from a maximum of ± 650mm in the north east to less than 50mm per year along the coast. 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 evapotranspiration (14%). Namibia's rainfall is skewed, with the northeast getting more than the west and south-western parts of the country. Namibia's international boundaries, both northern and southern are marked by the Kunene River in the northwest, the Okavango River in the central north and the Zambezi and Kwando Rivers in the northeast. The Orange River marks Namibia's southern border. It is only in these rivers that perennial surface water resources are found. These rivers are all shared with neighbouring riparian states with an obligation for them to be managed and used in terms of the relevant rules of International Water Law.

2. Climate

It is well known that the distribution of rain over time and space is much more variable in dry climates compared to wetter climates. Rainfall in Namibia commonly falls as intense local showers. This leads to a high spatial and temporal variability of rainfall, both within and between years. Another feature of the dry Namibian climate is the severe impacts drought has on the biological production. The majority of the population is rural and very dependent on the climate for their livelihoods. The urban population depends on good rainfall and runoff in the rivers that feed water supply dams and aquifers to sustain their water needs. 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).

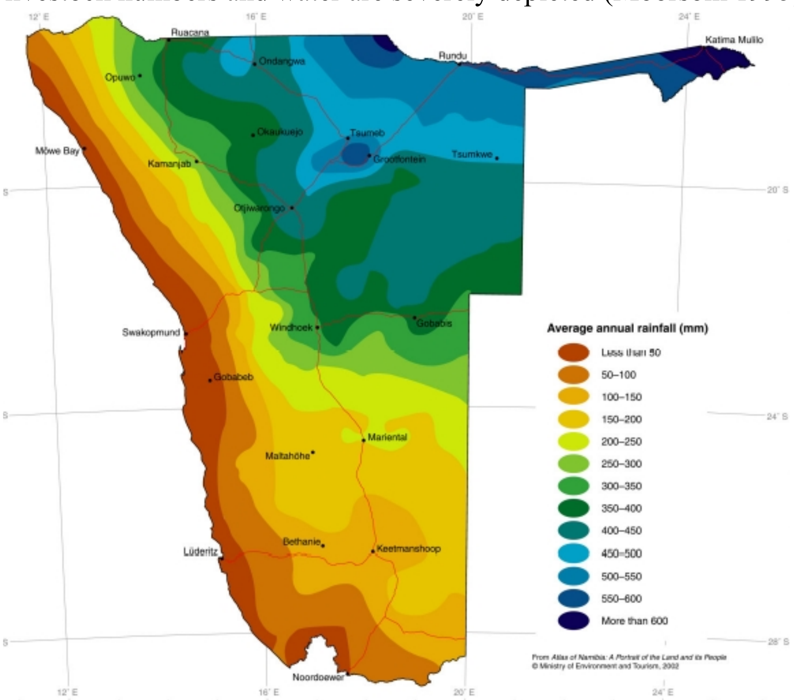

Figure 1. Distribution of annual rainfall in Namibia (IWRM 2010)

The general climate of an area influences the perceptions of 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.

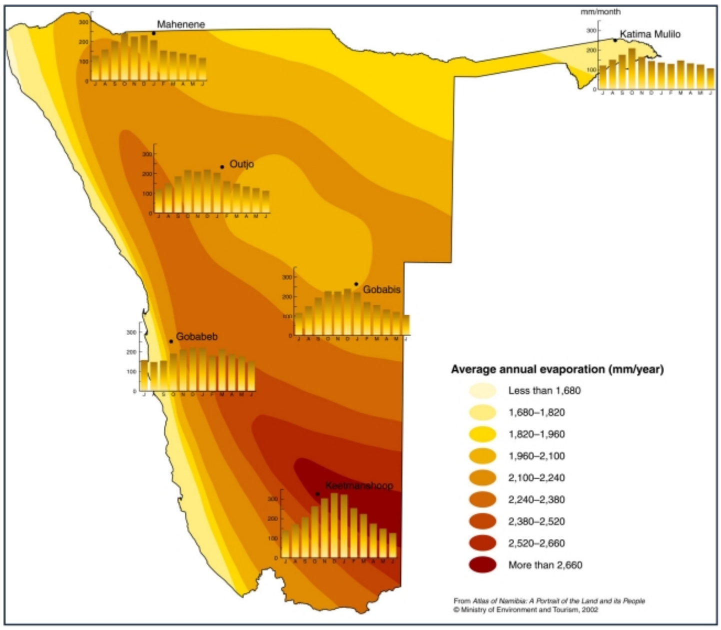

Figure 2. Average Annual Evaporation in Namibia (IWRM 2010)

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 geo-hydrology 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 geological ancient rocks which are inherently impervious. Groundwater is found in secondary structures along joints, bedding planes, shear zones and faults.

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

- ✓ Increased maximum temperatures
- ✓ A longer dry season
- ✓ Increased humidity and convection, and
- ✓ More intense rainfall.

3. Water Resources Potential

88% of Namibia's water potential lies in its perennial rivers on its northern and southern borders 80+% of its land area relies solely on groundwater. Figure 3. presents the water potential of each Water Basin, split into surface water and groundwater potential.

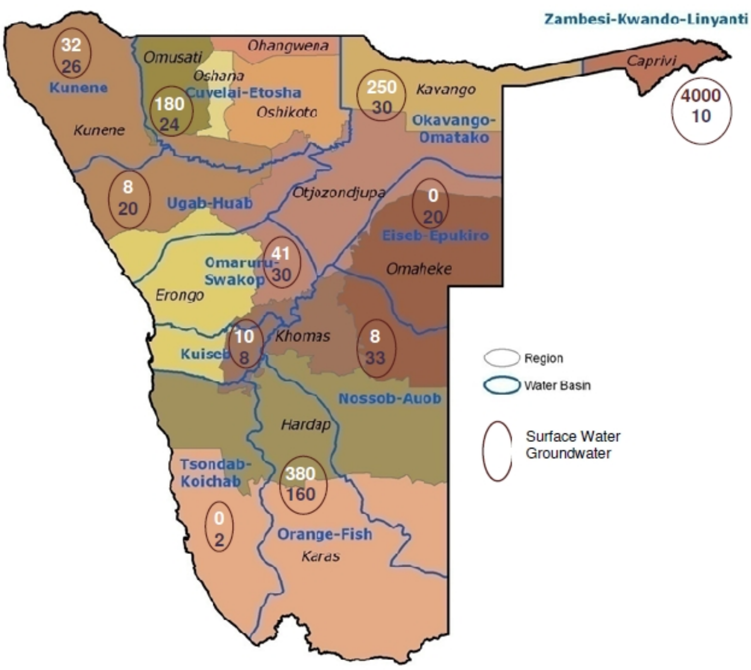

Figure 3. Water Potential of Namibia's Water Basin (IWRM, 2010)

Table 1. Water Potential of Namibia's Water Basin

Basin	Water Resources Potential (Mm^3/a)		
	Surface	**Ground**	**Total**
Cuvelai-Etosha	180.0	24.0	204.0
Eiseb-Epukiro	0	20.0	20.0
Kuiseb	9.8	8.0	16.8
Kunene	31.5	26.2	57.7
Nossob-Auob	8.0	32.5	40.5
Okavango-Omatako	250.0	29.6	279.6
Omaruru-Swakop	41.0	29.5	70.5
Orange-Fish	379.9	160.0	539.9
Tsondab-Koichab	0	1.8	1.8
Ugab-Huab	7.5	19.8	27.3
Zambezi-Kwando- Linyanti	4,000	10.0	4,010.0
TOTAL			

4. Assessment of water resources management

A. Water resources

Namibia is primarily a large desert and semi-desert plateau. Namibia's climate is hot and dry with erratic rainfall during two rainy seasons in summer. Within Africa its climate is second in aridity only to the Sahara. Namibia shares several large rivers, such as the Orange River in the South, shared with South Africa, as well as the Zambezi and Okavango Rivers in the North, shared with Angola, Zambia and Botswana.

But these rivers are far away from the population centres and the cost of tapping them for drinking water supply is prohibitive. Only the Cunene River, which is shared with Angola, provides drinking water for four Northern regions of Namibia. 88% of Namibia's water potential lies in its perennial rivers on its northern and southern borders 80+% of its land area relies solely on groundwater.

The description of each water basin is shown in the table below;

Table 2. Water basins of Namibia

Name of Basin	Description
Cuvelai-Etosha	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.
Eiseb-Epukiro	The deep Kalahari sands and the flat terrain means that surface water potential is limited to small dams and the collection of run-off in seasonal pans. There is no potential for bulk water supply from surface water sources
Kuiseb	The major resource of the basin is the alluvial aquifers that lie in the lower Kuiseb (Dorop, Rooibank and Swartbank). Water abstracted from these reserves is used to supply Walvis Bay and the Central Namib Area.
Kunene Water	The surface water potential of the basin should not be seen as a major source of water due to the practical and financial implications of harnessing and distributing it.
Nossob-Auob	The only significant surface water resources of the basin are the Black and White Nossob Rivers and the Oanob Dam in the upper reaches of the Auob River.
Okavango-Omatako	The major water resources of the basin are the Okavango River and the Grootfontein Karst aquifer. Vast areas of the basin rely on groundwater that occurs in secondary fractured aquifers which makes water difficult to find.
Omaruru-Swakop	Windhoek, which is also the biggest industrial and financial centre in Namibia relies mainly on three major dams, the Von Bach and Swakoppoort dams on the Swakop River and the Omatako Dam for its water supply.
Orange-Fish	The Orange-Fish Basin covers a huge area in which agriculture is the main consumer, and in particular irrigation along the Lower Orange River. Livestock demand is also significant.
Tsondab-Koichab	The Tsondab-Koichab Basin is covered by large tracts of desert with livestock and urban demand being the major consumers. There is little or no capacity for further developing the water resources.
Ugab-Huab	The major consumers in the basin are urban as it includes the towns of Otjiwarongo, Outjo, Otavi and Khorixas as well as agriculture, split between livestock and irrigation. Currently all water is supplied from groundwater sources
Zambezi-Kwando- Linyanti	The basin is dominated by the Zambezi and Kwando river system. Although groundwater is found throughout the basin, borehole yields are not sufficient to sustain large demand centres.

Source: Integrated water resources management plan for Namibia (2010)

B. Groundwater

Groundwater is distributed unevenly over the territory of Namibia, thus making the construction of pipelines necessary to tap their potential. In particular, the coastal area is nearly devoid of groundwater. Recharge in these areas is low and unreliable, groundwater lies at great depths and sometimes is of poor quality. Other areas are favorable, sitting on high-yielding, very productive aquifers that contain more water than farmers and communities presently need. Numerous small springs throughout the country sustain wildlife, man and livestock. Over the past century, more than 100 000 boreholes have been drilled in Namibia. Half of these are still in operation. In 2012 German hydro-geologists discovered a huge aquifer in Northern Namibia that could supply the area, where 40% of the population of the country lives, for 400 years. The aquifer, called Ohangwena II, contains about 5 billion cubic meters of water which is up to 10,000 years old. The aquifer is about 300 meters deep and is under pressure, so that its water could be pumped up at a relatively low cost. However, a saline aquifer sits on top of the freshwater aquifer, so that drilling must be done carefully in order to avoid saline intrusion. The aquifer receives some recharge from Angola in the North. Experts recommend that, during normal climatic conditions, water abstraction should be limited to the inflow from the North in order to manage the aquifer on a sustainable basis. However, during extended droughts induced by climate change, the aquifer can be drawn down and serve as an important buffer against drought.

In some areas, groundwater is slightly saline (brackish). In the Omusati Region in Northern Namibia, four small brackish water desalination plants were installed in 2010 as part of the German-Namibian research project CuveWaters. The plants are powered by solar energy and provide between 0.5 and 3.3 m^3 of safe drinking water per day, enough to satisfy the basic needs of between 10 and 66 people. At 15 Euro/m3 the cost of desalinating brackish water in these small plants is very high.

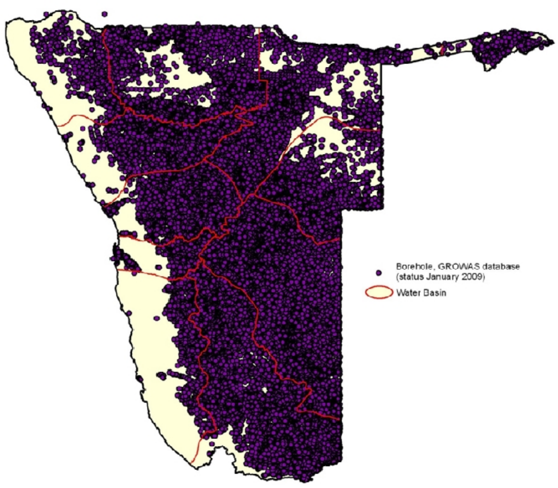

Figure 4. Distribution of boreholes in Namibia (IWRM, 2010)

C. Surface water

The reservoir of the Hardap Dam on the ephemeral Fish River in Southern Namibia is the largest in the country. Many of the ephemeral (=seasonally flowing) rivers of the Namibian interior are dammed and, according to the FAO, provide a 95%-assured yield of 96 million m3/year, based on historical rainfall data. These dams have low safe yields in comparison to their total volume, because of uneven flows over time and high evaporation losses. Thus only about half the water from ephemeral rivers is usable. There is surplus water in some dams, e.g. in the Oanob Dam, the Hardap Dam, the Naute Dam and the Friedenau Dam. This surplus water cannot be used because of the remote location of these dams and the comparatively limited local demand.

Namibia suffers from regular droughts, the most recent one hitting the country in 2015/16.

The Cunene River, shown here at the Ruacana Falls at the Namibian-Angolan border, is an important water source for Northern Namibia. The water from perennial (=permanently flowing) rivers used in Namibia corresponds to the small share of Namibia in its border rivers. The actual abstractions as of 1999 (latest available data) were 23 million m3 from the Cunene River at Ruacana, 49 million m^3 from the Orange River at Noordoewer, 22 million m^3 from the Okavango River (that flows through Namibia in the Caprivi Strip) at Rundu, and 7 million m^3 from the Zambezi River. Namibia has agreements in place with Angola and South Africa about the sharing of the Cunene and Orange Rivers respectively. The water allocation from the Cunene River is 180 million m^3 and thus far larger than the amount withdrawn.

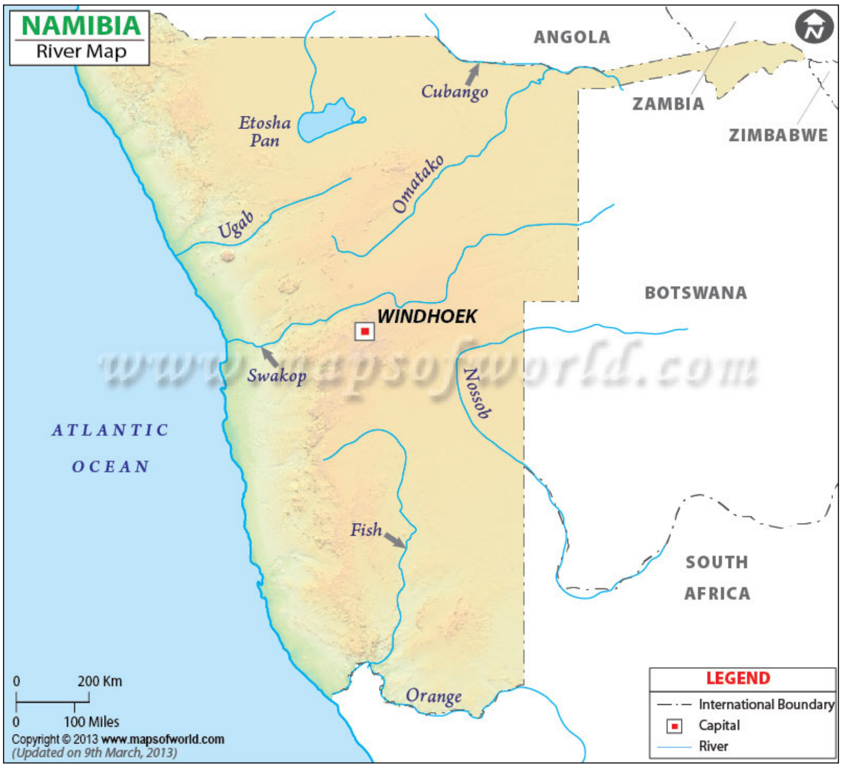

Figure 5. Namibia river map (maps of world)

D. Seawater desalination

The first large desalination plant in Sub-Saharan Africa was inaugurated by Areva on the 16 April 2010. The Erongo plant is located near Wlotzkasbaken, 30 km north of Swakopmund. Its maximum capacity is 20 million m3 per year but it will initially supply 13 million m3. Its primary purpose was to supply the uranium mine at Trekkopje, located 48 kilometres (30 mi) inland. The Trekkopje mine however never opened due to persistent low uranium prices, hence the plant has a contract to sell water to state-owned service provider Namwater and provides some of the water requirements for the town of Swakopmund. During the 2016 drought Areva offered to sell its plant to the Namibian government for $200 million USD.

Desalination has been on the agenda as a possible solution to water shortages in Namibia dhoek for some time and was raised as a possible solution

Figure 6. Arango Desalination plant

5. Conclusion

In general, the amount of water resources in Namibia is sufficient to meet the water demand. However, the demand is focused on the area located in remote areas that are long distances away from sustainable water sources.
Therefore, to utilize the water resources effectively, some challenges should be solved and some challenges are shown below;

- ✓ Upgrading of existing and construction of new infrastructure
- ✓ Capacity building to upgrade maintenance skills of existing infrastructure.
- ✓ Fund raising to construct water related facilities that can covers the long distance of pipe