Okavango River Basin Transboundary Diagnostic Analysis Technical Report

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Okavango River Basin Technical Diagnostic Analysis: Specialist Report Country: Namibia Discipline: Water Supply and Sanitation

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Environmental protection and sustainable management of the Okavango River Basin

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TABLE OF CONTENTS

TABLE OF TABLES

ASSESSMENT OF WATER SUPPLY AND SANITATION IN THE OKAVANGO RIVER BASIN IN NAMIBIA

1. INTRODUCTION

This chapter presents the findings of the assessment of Water Supply and Sanitation for Okavango River Transboundary Diagnostic Analysis 2009 on the Namibian side. The chapter looks at the existing water supply arrangements formal and informal, and the existing sanitation coverage and type. It further identifies planned programmes to increase water supply to various uses and improves sanitation coverage in Kavango Region. The chapter further assesses the sustainability of the current water use practices, environmental sound of the existing sanitation and proposed alternative sustainable measures.

1.1 BACKGROUND INFORMATION

1.1.1 Water availability

Rising in highlands in Central Angola the Okavango River transverses for over 1000 km (Kgathi et al, 2006) crossing three countries namely Angola, Namibia and Botswana. The entire basin covers an area of approximately 120 000km^2. Most of the 500-600 mm average annual rainfall falls within the water-rich Angola. Namibia and Botswana contribute a very low percentage to the stream flow of the Okavango River. In Table 1 the mean annual runoff are summarised for two points in Namibia.

Table 1: Runoff in Perennial Rivers Bordering Namibia

River	Runoff site	Runoff (MAR) (Mm^3/a)
Okavango	Rundu	5 500
Okavango	Mukwe	10 000

The sub-tropical climate and water-abundant in Angola makes water use from the Okavango River of less important to that country compared to the two water scarce countries, Namibia and Botswana. This riparian river supports abundance of biodiversity and local livelihood through fishing, tourism, irrigation and horticulture, water supply and potentially energy supply. These often competing water uses pose a threat to the environment and associated ecosystems through changed of water quantity and quality.

At the moment water abstraction from the Okavango River is limited throughout the basin. Namibia uses more water from the Okavango River as compared to Angola and Botswana. Whereas Botswana relies more on groundwater sources for various uses in parts of the Kalahari deserts. Although the interconnections between groundwater and surface water are not well understood it is believed that groundwater in that parts of Botswana are fed by the Okavango River given the fact that the Okavango River discharges into the Okavango Delta region. Currently there are very limited major water infrastructure in the entire basin with only small dams such as the Omatako Dam in Omatako River, Namibia and Mopipi Dam in Botswana. Similarly, up until now there has been limited development in the upper reaches of the basin, but with the return of peace to the Angola part of the Basin, it is fair to accept that Angola would want to develop irrigation schemes and possibly hydropower to address social-economic needs and encourage people to move back in the catchment. Possible future developments can have profound consequences on the water availability and quality to the Okavango Delta.

Increased water withdrawal from the river system to meet the growing population and socio-economic development will alter the flow of the river and negatively impact on the environment downstream. Likewise agricultural runoff, improper disposal of sewage and inadequate sanitation facilities can have effects on one of the last pristine river systems in Africa (Green Cross International, 2000).

1.2 WATER SUPPLY AND USES

Water supply can be grouped into three categories:

- commercial bulk water supplied by NamWater to local authorities, regional councils and settlements and Villages;
- rural water supplied by the Directorate of Rural Water Supply (DRWS) to rural communities;
- and direct water drawing from the river or stream by rural communities, tourist lodges and campsite, irrigation and fish farms.

NamWater has nine water abstraction points along the Okavango River and twelve groundwater supply schemes. Most of water supplied by DRWS in Kavango Region is mainly from boreholes as at the moment DRWS does not operate any surface water supply scheme. About 70% of the population in the basin in Namibia live within a 5 km of the river and indirectly dependent on water from the Okavango River (Mendelsohn and el Obeid, 2003).

Of recently large scale irrigation has seen great increase and interest in the Kavango Region (Mendelsohn and el Obeid, 2003). As a result irrigation activities has been on increase along the Namibian side of the river with about seven large irrigation schemes in operation and five more in the pipeline as Namibia government seeks to improve food security. In attempts to increase food security, create employment and generate income at community level, fish farming activities along the Okavango River have also increased of recently. At the moment the Ministry of Fisheries and Marine Resources operates three community-based fish farms at Nkurenkuru, Kangongo and Kaisosi in Kavango Region. The latest addition to the inland fish farming is the construction of the Kamutjonga Inland Fisheries Institute (KIFI) which will be used for research and development of inland and freshwater fish in the whole country is expected to be in full operation by 2015. In addition water from the Okavango River is used by various tourist lodges situated off the banks of the Okavango River many of which abstract water directly from the river.

The existing data shows that Namibia uses approximately 22Mm^3 per year from the Okavango River (Mendelsohn and el Obeid, 2003). Of which an estimated of 74% is used for large scale irrigation schemes, 15% rural communities for livestock watering and domestic, and 11% used for urban domestic in Rundu. This information does not include the water that is directly drawn from the river for tourist lodges and campsites along the stretches of the river, schools and clinics, and other urban settlements such as Nkurenkuru.

Propose development include plans to abstract water to feed the National Eastern Water Carrier to supply water to the City of Windhoek and Construction of a hydropower at Popa fall rapids. In 2003 Namibia proposed to construct a hydropower plant at Popa falls to provide reliable power supply to Rundu and Katima Mulilo towns and for rural electrification in surrounding areas. Though hydropower is not a consumptive water use, its development can have an impact in the water quality and environment downstream. There is a perception in Botswana that the construction of hydropower and increased water abstraction from the Okavango River will negatively affect the ecologically sustainability of the Okavango Delta (Kgathi, et al, 2006).

Water demand for the different users varies between seasons. For instance water demand for domestic decreases during the cold winter months and increases during the hot summer months. Readily available water in natural ponds during the rain season reduces water demand from boreholes for livestock and in certain cases for rural domestic as communities would often opt to use the nearest water source. Water demand for tourist increased on average by 50% during the high season and decreases by 70% during low season (Kgathi, et al 2006). Likewise water requirements for livestock fluctuates between seasons, during the hot summer months livestock drinking frequency increases compared to winter months where livestock go to the water points once in two days.

Similarly water demand for irrigation increases during the growing season as the plants need more water to produce grains and decreases as the plants matures and ripen. Though, high water demand for irrigation during growing season in summer months can be supplemented by the rainfall, due to the erratic nature of the rainfall pattern in the country, dry spells are very common, necessitating irrigation throughout the growing season. The fluctuation on water demand for the various uses during dry and wet season can impact on the available water if such increased seasonal demands coincide with low water levels in the river or drought.

1.3 SANITATION COVERAGE AND TYPE

The management and responsibility for provision of sanitation services and facilities falls under the jurisdiction of local authorities, regional council and the Ministry of Health and Social Services. The Ministry of Health is responsible for ensuring that the types of sanitation in place do not pose danger to public health.

The Town Councils of Rundu and Nkurenkuru provide sanitation services and facilities to the urban dwellers. Sanitation in the urban areas consists of flushing toilets, septic tanks and wastewater treatment plants. In informal housing areas in towns such as Nkurenkuru and Rundu (Pamwe and Kaisosi settlement areas) there still a large proportion of population without proper sanitation therefore still making use of bushes.

The majority of rural communities still use bushes for sanitation purposes. The Kavango Regional Council in collaboration with the Directorate of Rural Water Supply and Sanitation Co-ordination are responsible for provision of sanitation facilities to the rural communities consisting mainly of pit latrines and VIPs. Construction of unlined pit latrines or VIP's may pollute the relative shallow groundwater along the Okavango River.

There are also places such as clinics, schools and hospitals located outside urban areas where maintenance of sanitation facilities falls under the jurisdiction of the Ministry of Works and Transport. Existing arrangements for maintenance and servicing of sanitation infrastructures often had left sanitation at many of such institutions in dare needs due to unclear line of responsibilities and budgetary constraints.

Generally access to sanitation is still very low for both urban and rural communities. The information gathered during the National Housing and Population census conducted in 2001 reveals that as high as 82% of the population residing in Kavango Region are without toilet facilities (NPC, 2007). Only 15% of Rundu residents are connected to the sewer system by 2002 (Sinime pers communication, 2008). Some residences in Rundu Town have septic tanks that are pumped out or soak away which may pollute the shallow groundwater near the river. Most of Rundu residences particularly those that are living in what is called informal areas make use of pit-latrines or green toilets (bushes). However a new wastewater treatment plant is under construction to be completed in 2009 to increase the number of residents to the sewer network.

Table 2: Access to sanitation in Kavango Region

Type of toilet used	% of the population served
Private flush toilets	5
Shared flush toilets	2
Ventilated Improved Pit latrine (VIP)	1
Pit latrine (long drop)	9
Bucket/pail	1
Bushes	82

[Source: National Planning Commission, 2003]

2. METHODOLOGY

Data collection involved literature review on water supply and sanitation in the Kavango Region. Primary data was obtained through interviews with local authorities, regional councils NamWater, DRWS, MHSS and local communities. Population number and population growth rate were obtained from the National Population and Housing census Report of 2001. While number of livestocks were extracted from Mendelsohn' and el Obeid, 2004.

Apart from the metered water abstraction by NamWater, all other water users directly drawing water from the river including large-scale irrigation schemes, fish farm and tourist establishments either do not have water meters to measure their water abstraction, or have water meters that are not functional or not read. This implied that water supply for many uses had to be estimated and extrapolated.

Information on water supply for urban domestic use was extracted from NamWater water accounts data, and cross checked with information obtained from the Town Councils of Rundu and Nkurenkuru. The number and sizes of the irrigation schemes were obtained from the Agricultural Engineer within the Ministry of Agriculture, Water and Forestry. The Directorate of Rural Water Supply does not monitor the water abstracted from boreholes therefore data on water supply to rural communities are not available. Hence water use for rural communities were obtained by multiplying the number of people living in the rural areas by 25 litres per person per day, the World Health Organisation and Directorate of Rural Water Supply recommended water use for daily basin human water needs.

Water for livestock watering was calculated based on 45 litres and 7.5 litres per day per large stock unit and small stock unit respectively. Water use for tourist were based on 3% of the 22Mm^3 total water used from the Okavango river in Namibia, with an average of about 45 500 tourist beds per annum (Anderson, et al, 2006). Water requirement for fish farming was calculated based on the size and depth of the fish ponds. The information sizes, depth and number of fish ponds at each fish farm were obtained from the Directorate of Inland Fisheries in Rundu.

3. FINDINGS

3.1 WATER SUPPLY

Water supply can be grouped into different categories, those that are supplied with water by NamWater, those that have their own small water pumps and the rural communities that get water from boreholes or draw water directly from the river. Water using activities in the Kavango Region include urban and rural domestic, irrigated and rainfed agriculture, fish farming, livestock watering and tourism. Large scale agriculture mostly irrigation accounts for over half of the water used in the Kavango Region. Fish farming activities at the three fully operational fish farms consume approximately 4%. Whilst water for urban and rural domestic accounts for about 13% of the total water use per annum (Table 3).

Table 3: Water requirements for the different water uses

Water Users	Water use Mm^3
Urban Domestic	7
Rural Domestic	2
Livestock watering	3
Irrigated Agriculture	36
Fish Farming	2
Tourism industry	1
Total	**51**

At the moment there are about ten irrigation farms with area under irrigation ranging from 20 ha to the largest of 800 ha at Ndonga Linena. Most of the irrigation schemes irrigate throughout the year between summer and winter crops. Table 4, presents the water required to irrigate the different irrigation farms per year. Using the area under irrigation, crop water demand (table 4) and type of irrigation system in place, the water required to irrigate the existing irrigation farms with a total area of about 2400 ha has been estimated to approximately 36 Mm^3 per annum. In cases where multi-cropping is practiced, it was assumed that vegetables takes 33% of the irrigated field, maize is grown during summer and wheat is grown in winter. If Lucerne and citrus are grown it is assumed each crop occupy 50% of the field. Most of the irrigation schemes use sprinkler and centre pivot and grow mainly maize, wheat, cotton and vegetables. Water use efficiency for sprinkler and centre pivot ranges between 75% and 85%.

Table 4: Water used at different irrigation schemes

Irrigation Farm	Area (ha)	Irrigation system	Crop grown	Water requirement (m^3)/a
Musese-Maguni	200	Centre Pivot	Cotton, Maize	3280000
Vungu-Vungu	225	Centre pivot, Sprinkler	Lucerne, maize, Oats	3474900
Ndonga Linena	800	Centre pivot, micro, drip	Maize, Wheat, vegetables	9989760
Shitemo	400	Centre pivot	Cotton, Maize, Wheat	7280000
Shadikongola	400	Centre pivot	Cotton, Maize, Wheat	7280000
Bangani Research	40	Micro	Fruits	504000
Divundu Prison	110	Centre pivot	Maize, vegetables	1320000
Mashare	140	Centre pivot, Sprinkler	Maize, Wheat, vegetables	1748208
Kaisosi	34	Sprinkler	Cotton, Maize, vegetables	545700
Shankara	20	Sprinker	vegetables	272000
Total	**2369**			**35694568**

Table 5: Crop water demand under in the North and North-east

Crop Type	Net Water Requirement (mm/season)	Irrigation System Water Requirement (m^3/a)			
		Flood -65%	Centre Pivot -85%	Sprinkler -75%	Drip & Micro -95%
Citrus	836	12 880	9840	11 150	8 820
Cotton	887	13 100	10440	11 830	9 340
Lucerne	1 630	25 100	19180	21 730	17 160
Maize	506	7 800	5950	6 750	5 330
Potato	448	6 900	5270	5 970	4 720
Sorghum	492	7 600	5790	6 560	5 180
Vegetables	507	7 800	5 970	6 760	5 340
Wheat	659	10 100	7 750	8 790	6 940

[Source MAWF, 2006]

Image of the Shadikongola irrigation scheme [source: Kgathi et al, 2006)

Fish farming is deemed to become an important source of protein for the world's growing population. Currently Government has developed the three community based fish farms in Kavango Region. The primary fish species bred is Tilapia (*Oreochromis andersonii*), with trials for Catfish (*Clarias gariepinus*) currently underway (MFMR, 2006). Each Fish Farm is approximately 1.8 hectares large with 14 earthen-based ponds (4 Breeding Ponds, 4 Nursery Ponds and 6 Production Ponds). The fish farms integrate freshwater aquaculture with small-scale agriculture to produce vegetable and fruits as cash crops. Water supply for the fish farms is drawn from the river to fill the ponds. Ponds are cleaned and filling every two months. Wastewater from the fish ponds drains into the evaporation ponds and part is used for limited irrigation. At the moment KIFI had two boreholes to supply water to staff houses and office block, but once the construction is completed, the institute will abstract water from the river.

Images of an integrated fish farming with horticulture at Karovo fish farm. [Source, MFMR, 2005)

Water supply for domestic is supplied by NamWater, DRWS or direct water drawing from the stream or river. NamWater operates about twenty water abstraction points of which nine are surface water and eleven are groundwater (table 7) supplying water to urban centres of Rundu and Nkurenkuru, settlements, hospitals and schools. In 2008 NamWater sold about 3.4Mm^3 to the various customers of which 92% comes from the surface water. This figure does not include 10% of water losses from the water treatment plants for surface water abstraction schemes. Of the water abstracted by NamWater in 2008, 2.5Mm^3 was supplied to Rundu Purification Plant to supply water to the Town of Rundu.

Table 6: Water Abstraction from Surface and Ground water sources by NamWater in 2008

Surface Water Schemes	Water sold (m^3)/annum	Groundwater Schemes	Water sold (m^3)/annum
Kandjimi-Murangi	124339	Bangani	404
Kapako	72418	Nyangana	36 939
Rundu	2532303	Sambyu	31 891
Mashare	86185	Kayengona	103 971
Ndiyona	36361	Mupini	3 458
Linus Shashipapo	34945	Bunja	4 371
Andara	28901	Tondoro	7 207
Mamono	138174	Kahenge	39 534
M'kata	15139	Nkurenkuru	32 312
Rupara	6585	Mpunguvlei	25 017
Total water sold (m^3)	**3 075 350**		**285 104**
+ system losses (10%)	307 535	+ system losses (0%)	**0**
Total Water abstracted (m^3)	**3 382 885**		**285 104**

Most rural communities still rely on the river and stream for their water supply. Water supply in rural areas involves carrying water from the communal water point or river on head a chore that is mainly done by women and children. In areas further inland, these communities rely on water provided by DRWS at water points and often the communities have to travel long distances to get to the water point. The labour intensity involved in collecting water by rural communities discourage water wastage, hence limits the water used at household level. On average 2 Mm^3 per annum is water use for rural domestic this figure excluding water for home-based garden and livestock watering.

Image of young girls carrying water from the river at Katere Village

Water use for rural communities exclude rainfed agriculture as it has limited impacts on surface or groundwater quantity. Most rural communities grow rainfed crops such as maize, mahangu (pearl millet), beans, melons and pumpkins. Few communities have murapo gardens that are fed by the flood waters. However nutrients in form of livestock manure from the crop fields can pollute both surface and shallow groundwater boreholes.

Water demand for most uses fluctuates during the dry and wet seasons and during high and low season for tourists. For example water supply to Nkurenkuru Town Council shows a clear distinct between hot months (October –January) and cooler months (April – August). However water abstracted by NamWater from the system remains more or less the same throughout the year.

3.1.1 Water Quality

Most water uses requires good water quality throughout the year. Fish farming requires good water quality with no pollutants and toxic substances as these can be detrimental to the fishes. At the moment the water quality in the river is considered by many interviewees as generally good with the exception of brownish water during the rain season when the inflow in the river increases. At the moment water pollution is not a problem to many of the Kavango Region residents, but increasing fishing and crop farming along the Okavango River could lead to increased nutrients and pesticides being washed into the river. Hence changing the water quality particularly during the months with low river flow to dilute the load concentration. Major irrigation schemes both in Angola and Namibia will decrease the quality and drainage water should not be allowed to enter the river system again.

Unplanned sanitation systems (such as unlined pit latrines and unlined VIP's) cattle kraals (Nitrate pollution), unlined aquaculture ponds, as well as drainage water from irrigation schemes may pollute the groundwater along the Okavango River. Bank filtration where boreholes drilled along the river to filtrate water through alluvial sands may be an important source of potable water in the future. It is important that pollution should be controlled and minimised to protect both the Okavango River and aquifers.

3.1.2 Planned and Projected Water Supply Schemes

There are number of new development proposals in the pipeline mainly related to irrigated agriculture as Namibia seek to boost national food security. Namibia plans to increase the area farmed under irrigation in the Kavango Region by four folds from the current the 2 400 ha to nearly 9 000 ha projected for the next ten years. The implementation of the planned irrigation schemes will require additionally 140 Mm^3 (table 7) increasing the water abstracted from the Okavango River by Namibia for irrigation from 36Mm^3 to approximately 180 Mm^3 per year, assuming that planned irrigation will adopted the currently commonly used sprinkler and centre pivot for irrigation and grow mainly maize, wheat, vegetables. The water abstraction for irrigation will remain relatively low amounting to less than 5% of the Mean Annual Runoff (Liebenberg, pers. comm). However water demand for future irrigation developments can be reduced to approximately 100 Mm^3 if the planned irrigation schemes implement drip and micro irrigation systems as these irrigation practices low the crop water demand (table 8).

Table 7: Future water demand for irrigation under sprinkler irrigation

Planned irrigation farms	Area (ha)	Consumption (m^3/ha/annum)	Required water m^3/annum
New Projects	7 500	15 540	116 550 000
Musese&maguni	200	15 540	3 108 000
Simanya	200	15 540	3 108 000
Mashare	670	15 540	10 411 800
Sihete	400	15 540	6 216 000
Total	**8970**		**139 393 800**

Table 8: Future water demand for irrigation under drip and micro irrigation

Planned irrigation farms	Area (ha)	Consumption (m^3/ha/annum)	Required water m^3/annum
New Projects	7 500	11 660	87 450 000
Musese&maguni	200	11 660	2 332 000
Simanya	200	11 660	2 332 000
Mashare	670	11 660	7 812 200
Sihete	400	11 660	4 664 000
Total	**8970**		**104 590 200**

Additional water supply schemes for rural areas are planned during the National Development Plan 3 but mainly boreholes. However population growth and development of new urban centres in the region such as the upgrading of Divundu settlement is expected to increase the water abstracted for domestic both urban and rural. The water supply for urban and rural domestic, and livestock watering are also expected to increase to 11Mm^3 and 7Mm^3 respectively proportionally to the population increase and improvement of living standards.

Table 9: Current and projected water demand for the different water uses

Water Uses	2008	2015	2020
Urban, settlements & institutions	7	8	9
Rural domestic	2	3	3
Livestock	3	4	7
Irrigation	36	175	175
Tourism	1	1	1
Fish farming	2	2	2
Total	**51**	**193**	**197**

One of the proposed developments is the Eastern National Water Carrier to supply water to the Central Area of Namibia estimated to abstract approximately 33 million cubic metres per annum by 2030. The implementation of the water banking by the City of Windhoek through Artificial Aquifer Recharge Scheme may reduce requirements for supply augmentation significantly. In a recent study funded by NamWater (2004) it was found that abstraction from the Okavango River for supply augmentation in combination with the water banking in the Windhoek Aquifer abstraction from the Okavango River can be downsized from 14 Mm^3/a to only 2 Mm^3/a for water supply requirements until 2020.

The above figure (33 Mm^3/annum) was determined when the canal which for part of the ENWC was constructed. However Water Demand Management measures applied in Windhoek, Okahandja & Navachab mine have decreased the figure to less than 50% and that water banking through artificial aquifer recharge in Windhoek may reduce it further. In addition City of Windhoek reclaim about 7.6 Mm^3/a for recycling and a further 1.2 Mm^3/a from unconventional water resources from the dual pipe for re-use for irrigation of parks, sport fields and landscaping which further reduces the demand from conventional water resources such as surface and groundwater.

Nonetheless future developments in the Kavango Region will increase the water abstracted from the Okavango River in Namibia to about 200 Mm^3. Although the increased water abstraction will remain low, the increased water demand for domestic and irrigated agriculture during the hot months and growing season in early summer when water level in the river is at lowest will reduce the available water significantly.

3.1.3 Sustainable Water usage

Most of water users in Rundu are metered and the Local Authority has an increasing block tariff system to discourage water wastage. Nevertheless the per capita water use in Rundu is unacceptable high amounting to 340 litres per person per day. A more realistic water demand for Rundu is 120 litres per person per day. There is a potential to reduce the water requirements of Rundu with more than 50% if WDM is implemented. A large percentage of water users in Rundu do not pay their accounts which contributes to the higher usage of water.

NamWater sold 2.34 Mm^3 in 2008 to Rundu while only 1.49 Mm^3 was sold to consumers. Non-revenue water amounted to 0.83 Mm^3/a (36%) which is unacceptable. The per capita water demand based on production is more than double that of Windhoek with a recommended per capita per day of 150 litres. Rundu requires major improvement in their water management with their local authority area.

Only 20% of the residents in Nkurenkuru are connected to the Town Council water supply network and use on average 30 litres per person per day. The non revenue water in Nkurenkuru was 30% of the water bought from NamWater. But there were months when the Town Council of Nkurenkuru had a 100% of non revenue water (UAfW). It is difficult to ascertain how much of the non-revenue water is attributed to reticulation network leakage and which part of non-revenue water can be attributed to inaccurate water meters, unauthorised use of water, administrative losses, inaccurate meter reading and poor billing. Most of the non-revenue water at Nkurenkuru were attributed to aging water reticulation system and absence of town layout plans which in many cases has led to pipes been gusted when people are digging trenches for new developments (Shihinga, pers comm, 2009).

With the exception of NamWater measuring water abstraction and domestic water use in Rundu, metering has not been effectively implemented amongst the users including government irrigation and fish farms. Those irrigation farms that had water meters complained about their inefficiency in measuring the water abstracted and they break within few months requiring regular replacement. Similarly water meters for raw water abstraction by NamWater are not properly measured because water meters are not well serviced. Likewise Divundu Rehabilitation Centre has water meters in place but these meters are not read because the staff at the centre does not know how to read the water meters. Hence most of the water abstracted the Okavango River is not measured nor recorded.

Most of the irrigation schemes use a combination of sprinkler and centre pivot irrigation system. Overhead sprinkler irrigation increases evapotranspiration due to water intercepted by the foliage which immediately evaporated without ever entering either the soil or the plant. Thus increasing the water input with little or no contribution to crop output.

Exacerbating the situation is the fact that all irrigation schemes both small and large farms do not pay for their water usage. Hence they might have little incentive to change crop patterns to adopt high value crops or adopt better water management practices to increase water use efficiency for irrigation. At the moment crops such as maize, wheat are commonly grown. There is a huge potential to lower irrigation water use through improve irrigation systems and proper scheduling by supplying the correct crop water requirement when needed by the plant.

Equally tourist facilities do not measure nor do they pay for the water abstracted per se but rather for pay for the fuel used to pump water, rendering them less enticement to encourage visitor to save water. Hence water wastage devices are still common in some tourist camps.

3.1.4 Conclusion and Recommendations

Water abstracted from the river is not sufficiently measured. Various uses along the river have private water pumps and often do not have water meters. Irrigation water meters are not very reliable which contribute to the non-measurement of irrigation water. Most of the water abstracted is utilised for irrigation, while the water abstracted by NamWater is mainly used for urban domestic purposes in Rundu. Most rural communities depend on informal water supply drawing water directly from the river for basic household consumption and limited home based gardening. Water usage per capita is extremely high in Rundu, the biggest town centre in the Kavango Region. If the existing situation is a true reflection of domestic usage as urban centres develop and mature, water use for urban domestic will raise tremendously as new urban centres are developed in the Region.

Future water demand increase is likely to come from irrigation and fish farming, as development of hydropower and basin transfer schemes require consultation and prior notification of other basin states in accordance with the UN Convention on the non-navigational uses of international watercourses to which the three riparian states are parties.

Water used for irrigation is still relatively low, but planned irrigation schemes will increase water demand for irrigation particularly during the growing season and will reduce water availability during low river water level. All irrigation schemes use either sprinkler or a combination of sprinkler and centre pivot irrigation system. Low value crops, dominated mainly by wheat and maize and vegetables are commonly grown.

The irrigation sector uses an estimated 70% of the consumptive demand excluding river requirements and environmental requirements in the Okavango River.

The irrigation sector is not highly regarded in water management circles (van der Merwe, et al, 2005). There are perceptions, amongst others, that:

- the majority of farmers do not “schedule”;
- water supplies are not well managed;
- distribution losses are high;
- existing systems, both on-scheme and on-farm, are not well maintained;
- few farmers are concerned about actual crop irrigation requirements;
- water wastage is excessive;
- water management has a low priority; and
- irrigation should be reserved mainly for “high value” crops.

“These are universal perceptions that are not only confined to Southern Africa, and may or may not be justified. In most developed countries, our competitors in global markets are taking active steps to improve irrigation farming effectiveness and water use efficiency. In most developing countries, including Southern Africa, very little support is given by Central Governments to improve irrigation farming practices and water use efficiency. There are, of course, individual outstanding exceptions, but they remain exceptions." (Crosby, 2001).

Experience elsewhere in the world has demonstrated that WDM in the irrigation sector was only successful if the farmers benefited through improved yields or savings in operation and labour costs. A good example is the "Water for Profit" scheme in Queensland (Australia) where farmers are supported by the Government to improve irrigation systems and farm management to save water and to increase crop production. With an investment of A$ 41 million by the Queensland Government, 180 Mm3/annum of water was saved and the value of crop yield improvement was A$ 280 million/annum, (Robertson, 2003).

To improve understanding of water abstracted from the river through formal water withdrawal, it is recommended that effective water metering and record keep is encouraged amongst all new applicants to abstract water from the Okavango River. At the moment DRWS does not keep record of water drawn from boreholes for rural communities because most rural communities do not pay for the water use. However to monitoring groundwater levels and the installation of water meters at communal water points are recommended.

To reduce non-revenue water in the towns it is recommended that effective water meter reading and proper billing should be enforced by the local authorities coupled with the water users education on the true value of the water. It is commonly perceived that water wastage commonly occurred when users do not pay for their water used or when water tariff are set very low.

Furthermore water abstracted from the river can be reduced if water re-use from the fish farms is effectively implemented. Wastewater from the fish ponds is rich in nutrients and it can be used for irrigation purposes. This implies that plans for aquaculture farms includes irrigation gardens to utilise the wastewater and reduce the pollution potential that can be caused by wastewater from the fish ponds. At the moment wastewater from the ponds are discharged into the evaporation ponds, with a limited amount being used for small-scale gardening. The rest of the wastewater thus evaporates or seep into the ground, which could lead to pollution of groundwater in the long-term.

3.2 SANITATION

3.2.1 Current Sanitation coverage

The adoption of the revised Water Supply and Sanitation Policy (WASSP) in October 2008, brought some management arrangements changes around the provision and supply of water and sanitation. Under the WASSP (2008) water supply and provision of sanitation services to urban areas and settlements is the responsibility of Local Authorities and Regional Councils within their areas of jurisdiction coordinated by the proposed the Directorate of Water Supply and Sanitation Coordination in the Ministry of Agriculture, Water and Forestry. The Ministry of Health and Social Services is responsible for developing, implementing and enforcing health policies and legislation, to promote good sanitation practices. In addition the Ministry of Health and Social Services will establish and develop monitoring indicators for incidents that can be linked to sanitation for example number of cases of cholera. The policy further proposes that the Ministry of Health and Social Services together with the Regional Councils and Local Authorities will be responsible for raising awareness amongst users to enhance public health.

Whilst the responsibility to supply water and provision of sanitation services to the communal rural communities is the responsibility of the Division Rural Services of Regional Councils to be coordinated by the Directorate of Rural Water Supply and Sanitation Coordination. Currently the Directorate of Rural Water Supply is busy drafting a national Sanitation Strategy as a guideline towards improved access and affordable sanitation. On the same move the regional councils have approved two models for rural sanitation, a water-borne system and pit latrine. These models are yet to be implemented but provisional funds are been included in the budgetary allocation.

At the moment sanitation coverage is generally low in the Kavango Region, with as high as 82% (table 2) of the population still make use of bushes. Those that live in the rural areas are the worst well off in terms of access to sanitation facilities. Information gathered from the Ministry of Health and Social Services indicates that construction of toilets in rural areas has been minimal (table 10). Between 2001 and 2007, about 900 latrines were constructed in the Kavango Region by the Ministry of Health and Social Services. People that have access to improved sanitation in rural areas use mainly pit latrines or Ventilated Improved Pit latrines which in many cases are shared between several households. At Popa Village, two pit long drops are shared between more than ten houses.

Table 10: Shows number of constructed toilets in rural areas between 2001 and 2007

Kavango Region	2001	2002	2003	2004	2005	2006	2007	Total
Latrines	241	134	39	111	175	82	81	863

The situation is not much different in informal areas of urban centres. In Rundu the largest urban centre in the Kavango region more than half of the town population of 51 000 inhabitants live in informal settlements of Sauyemwa, Kahemu, Kaisosi all use communal pit long drop, while some uses bushes. As of 2002 only about 15% of residential in Rundu were connected to the central sewer system (Sinime, pers comm, 2008). Other formal residential had septic tanks.

In Nkurenkuru Local Authority as high as 80% of the town's population of 7 000 people use the bushes and only 20% have flushing toilets that are connected to septic tanks. The septic tanks are pumped out for treatment at the centralized treatment plant consisting of evaporation ponds.

Most of the institutions located outside municipal areas such as schools, hospitals, and mission have either pit-latrines or flushing toilets with own localized sewage pumps and system of oxidation and maturation ponds. However due to the aging and dilapidated state of pond systems and other sewage systems cases of sewage flowing into the streams have been reported.

Images of over flowing sewage and sewage treatment pond over growing with weeds and shrubs at Max Makuse Secondary School.

3.2.2 Sustainability of current Sanitation

At the moment only about 8% of the population in the Kavango region has access to flushed toilets. Poor sanitation coverage in populated centres poses pollution risk to water sources especially during inflow and due to increased population. At the same time water-borne sanitation when not handled properly in terms of treatment and sewage overflows can pollute the streams. Conversely dry sanitation such as pit long drop reduces water demand but has a potential to contaminate the groundwater sources in areas with high water table.

3.2.3 Conclusions and Recommendations

Sanitation coverage is generally low in Kavango region. More than 3/4 of the region population does not have proper sanitation. Those in rural areas are worst off. Many of the institutions that are situated outside urban centres many have sewer systems that are not working properly. Though sanitation is crucial to the management of water resources, programmes to improve access to proper sanitation are receiving less attention at the moment with few programmes planned in Rundu' informal settlements.

New towns, settlements and villages can look into the implementation of ecological sanitation. Ecological sanitation offers a new philosophy of reducing waste and wastewater. It prevents disease associated with poor sanitation, it protects the environment because wastewater is not discharged in the environment, and nutrients and organic matters are recovered which can be used as manures to produce food. The concept of ecological sanitation offers an opportunity to conserves water due to its minimal water requirements. However the application and implementation of the technology requires change in attitudes by the users and stakeholder as many perceive ecological sanitation as unhygienic.

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The Okavango River Basin Transboundary Diagnostic Analysis Technical Reports

In 1994, the three riparian countries of the Okavango River Basin – Angola, Botswana and Namibia – agreed to plan for collaborative management of the natural resources of the Okavango, forming the Permanent Okavango River Basin Water Commission (OKACOM). In 2003, with funding from the Global Environment Facility, OKACOM launched the Environmental Protection and Sustainable Management of the Okavango River Basin (EPSMO) Project to coordinate development and to anticipate and address threats to the river and the associated communities and environment. Implemented by the United Nations Development Program and executed by the United Nations Food and Agriculture Organization, the project produced the Transboundary Diagnostic Analysis to establish a base of available scientific evidence to guide future decision making. The study, created from inputs from multi-disciplinary teams in each country, with specialists in hydrology, hydraulics, channel form, water quality, vegetation, aquatic invertebrates, fish, birds, river-dependent terrestrial wildlife, resource economics and socio-cultural issues, was coordinated and managed by a group of specialists from the southern African region in 2008 and 2009.

The following specialist technical reports were produced as part of this process and form substantive background content for the Okavango River Basin Transboundary Diagnostic Analysis.

Final Study Reports	***Reports integrating findings from all country and background reports, and covering the entire basin.***		
		Aylward, B.	*Economic Valuation of Basin Resources: Final Report to EPSMO Project of the UN Food & Agriculture Organization as an Input to the Okavango River Basin Transboundary Diagnostic Analysis*
		Barnes, J. et al.	*Okavango River Basin Transboundary Diagnostic Analysis: Socio-Economic Assessment Final Report*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Project Initiation Report (Report No: 01/2009)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment EFA Process Report (Report No: 02/2009)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Guidelines for Data Collection, Analysis and Scenario Creation (Report No: 03/2009)*
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		Jones, M.J.	*The Groundwater Hydrology of The Okavango Basin (FAO Internal Report, April 2010)*
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		Veríssimo, Luis	*GIS Database for the Environment Protection and Sustainable Management of the Okavango River Basin Project*
		Wolski, P.	*Assessment of hydrological effects of climate change in the Okavango Basin*
Country Reports Biophysical Series	***Angola***	*Andrade e Sousa, Helder André de*	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório do Especialista: País: Angola: Disciplina: Sedimentologia & Geomorfologia*
		Gomes, Amândio	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório do Especialista: País: Angola: Disciplina: Vegetação*
		Gomes, Amândio	*Análise Técnica, Biofísica e Socio-Económica do Lado Angolano da Bacia Hidrográfica do Rio Cubango: Relatório Final:Vegetação da Parte Angolana da Bacia Hidrográfica Do Rio Cubango*
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