ORASECOM Report No. 016/2011

A SCOPING STUDY ON URBAN POLLUTION IN THE ORANGE-SENQU RIVER SYSTEM

June 2011

ORASECOM

A SCOPING REPORT ON URBAN POLLUTION IN THE ORANGE SENQU RIVER SYSTEM

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Chapter 1: Introduction.

1.1 Background

The European Union (EU) provided support to strengthening the Orange-Senqu River Commission (ORASECOM) as part of its African Transboundary River Basin Support Programme. The overall objective of this support derives directly from the vision of the Revised SADC Protocol on Shared Watercourses, and is specified as follows;

> *To reduce poverty and food insecurity through improved management and environmental protection in the Orange - Senqu River basin.*

The intention of the overall project is to contribute to this objective by delivering on the following purpose;

> *To support institutional strengthening and to build the capacity of institutions for the implementation of priority projects and development of water conservation and environmental strategies and policies in the Orange-Senqu River basin.*

This assignment provides a scoping study of the extent of the urban pollution problem in the Orange-Senqu River System. It is aimed at helping the ORASECOM Contracting Parties develop a common understanding of the scope of urban pollution in the basin, the applicable legislation and current efforts to address the problem.

1.2 A brief description of the Orange-Senqu Basin[1]

The Orange-Senqu River originates in the Lesotho Highlands, from where it flows westwards to its mouth at Alexander Bay/Oranjemund on the Atlantic West Coast of Africa. The river basin is the third largest in southern Africa, after the Zambezi and the Congo, covering a total area of 1,000,000 km^2 of which almost 60% is inside the Republic of South Africa. Four countries – Botswana, Lesotho, Namibia and South Africa, share the Basin, and the river forms the border between South Africa and Namibia in its lower reaches (Figure 1.1).

Lesotho, the most upstream country falls entirely within the basin and contributes over 40% of the stream flow from only 5% of the total basin area, but Lesotho is one of the smallest users of water from the basin. However, the Lesotho lowlands is one of the more densely populated parts of the basin. South Africa is by far the biggest user of water from the Orange-Senqu River system, and this use drives the economic heartland of the region. South Africa is also the home to the majority of the population of the basin, and has the largest urban centres. In South Africa, the basin receives inter-basin transfers from the Inkomati and Usutu systems, shared with Mozambique and Swaziland, and from the Tugela system. Water is also transferred out of the basin to the Limpopo system as urban return flows from the Gauteng and Rustenburg regions. The footprint of the basin is therefore much wider than its geographical extent.

The part of the Basin in Botswana is entirely covered by the Kalahari Desert with very little surface runoff and this region is very sparsely populated. Groundwater contributes to the water demands in this portion of the basin. However, pollution of this water resource through sanitation facilities and cattle kraals is a cause for concern.

The water requirements in the lower reaches of the river are driven primarily by irrigation demands from both Namibia and South Africa, as well as the need to maintain environmental flows to the estuary. The middle and lower reaches of the river are subject to periodic and often devastating floods.

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[1] This section only provides a brief description of the basin, more detailed information on the basin is available from http://www.orangesenqurak.com/. South Africa's Internal Strategic Perspectives also provide a wealth of detailed water resources information for the South African portion of the basin.

The Orange River estuary is ranked as one of the most important wetland systems in southern Africa. Developments in and around this wetland system as well as reduced freshwater inflows have, nevertheless, resulted in environmental degradation. This wetland system was recently re-designated as a Ramsar Site and placed on Montreux Record. However, altered freshwater inflow patterns and destruction of estuarine habitats may be affecting wetland functioning.

Figure 1.1 A map of the Orange-Senqu Basin showing the main Urban Centres.

1.3 Defining urban pollution

Urban pollution is usually regarded as the impacts of contaminated water from the following waste streams:

- Sewage from wastewater treatment plants or on site sanitation,
- Sullage (grey water),
- Storm water drainage,
- Solid waste leachates and litter.

Contamination from these sources may include a range of pollutants, chiefly; nutrients (nitrogen and phosphorus), microbiological components (faecal bacteria), and metals from storm water washed of roads. Urban pollution may also affect both surface waters as well as groundwater particularly where on site sanitation systems are used. Effluent from waste water treatment plants may also contain pollutants from industries which discharge their waste to the sewers. We have defined ‘urban pollution’ as the impacts from all 4 of these waste streams.

Urban pollution poses unique challenges for water quality management (Table 1.1). Urban water pollution derived from household waste results from vital human needs for water and sanitation. The management of this waste usually falls to Para-state or state organisations, and the costs of these services is usually recovered in services payments. However, often the poor struggle to pay for appropriate levels of services, and the cost of urban pollution management has to be recovered through cross subsidisation in the local and/or national taxation system. Simple application of polluter pays principles is therefore more challenging particularly in developing countries, were sustainable economic growth is a priority.

Table 1.1 Differences between ‘Urban’ and ‘Non-Urban’ Pollution

‘Urban Pollution’	‘Non-Urban’ Pollution Issues
Often originates from activities regarded as basic human needs. The users of these services have no choice but to use the service, irrespective of income.	Often originates from non-essential activities and consumers can choose not to use the service, or limit their use of the product.
Waste management services are provided by a sole provider, and users can not exercise a ‘greener’ choice of service provider.	The consumer has the option of purchasing competitive products with less impact on the environment and can exert ‘greener’ purchasing powers.
Normally provided and administered by para-state or state organisations, which can only act according to the provisions of the legislation.	Normally administered privately. Private organisations can act in any manner, provided it is within the law.
Regulated through intra-government relations. e.g. National Governments regulate Local Government.	Regulated externally by state actors imposing pollution control through legislation and enforcement
These services are regarded as a fundamental human right and must be provided irrespective of the ability to pay.	Results from producing commercial products, and the costs of waste management can be passed onto the consumer.

This unique character of ‘urban pollution’ raises significant challenges in all of the Member States.

1.3 The Scope of this Study

This study is primarily defined by its scoping nature. It was recognised that this assignment could, within the resources made available, take several forms; from a broad scoping study on the extent of urban pollution in the basin and an assessment of the legislation and measures being taken to address the problem, to a detailed assessment of particular urban pollution problems that may be of transboundary concern. The ORASECOM Council expressed a specific need for an overview study that contributes to the common understanding of the basin, rather than a detailed assessment of any of the potential problem areas.

This scoping study therefore included;

1) A review of available reports and data focusing on urban water pollution in the Orange-Senqu basin.
2) Interviews with specialists from each of the Parties.
3) The identification of the main urban pollution “hot spots” within the river basin through population density data, estimates of the volumes of urban return flows (effluents), as well as water quality data.
4) An assessment of the legislation available in each of the ORASECOM Member States, and current efforts being made by the Parties to tackle the problem. This was done specifically to share practices and experiences.

Preliminary findings of the study were presented to a workshop on 19 May 2011, and participants from each of the basin States provided feedback and additional information in support of the work. This report was compiled from all these contributions.

Chapter 2: The Geographical Scope of the Problem.

2.1 Introduction

One of the key components of this scoping study was to assess the geographical scope of the problem. This aimed at determining which areas of the basin may be prone to pollution from urban areas, as well as to provide some indication of possible transboundary problems caused by urban pollution. This was not an exhaustive analysis of all the areas where urban pollution problems may be noted, but rather an assessment of where urban pollution may have regional impacts. This was done through;

- Population density data – identifying densely populated areas of the basin where urban pollution may be a problem.
- Assessing the relative proportions of urban return flows in different parts of the basin.
- An analysis of the water quality data.

This chapter provides an assessment of the geographical scope of the problem using all three of these methods, identifying possible urban pollution 'hot spots' and the potential transboundary nature of these 'hot spots'.

2.2 Assessments using population density data

Any human settlement will produce waste. However, in sparsely populated areas the impacts of this waste are often small. Pollutants are assimilated before reaching the surface or groundwater, and dilution means that the regional impacts are limited. However, in densely populated areas the volume of waste produced may exceed the assimilative capacity of the water resource and regional water quality impacts may be noted in the surface and groundwater. Densely populated areas may also be associated with industrial use of water, and potentially the discharge of industrial waste to sewers. These areas have more hard surfaces creating more storm water runoff, and may generate larger volumes of solid waste requiring formal disposal systems. Waste production is also associated with the relative wealth of the population, with wealthier areas producing more waste water while densely populated poorer areas with on-site sanitation systems like pit latrines may impact on groundwater quality.

Population density and other demographic data therefore provides a good indication of the potential for urban pollution. South Africa's National Strategy for Managing the Water Quality Effects of Settlements suggests that areas with a density of over 35 dwellings per hectare may be prone to pollution problems. Using an average of 4 people per household, this translates to some 140 people per hectare. The population of the whole basin is some 15.7 million, making an average population density of < 0.002 people / ha. However, this population is not evenly spread across the basin, with 85% of the population living in the 60% of the basin area that lies in South Africa (Table 2.1).

Table 2.1 The population distribution in the Orange-Senqu Basin

Country	Total population	Population in basin	National pop in basin	Total basin population
Botswana	1 680 863	47 661	3%	0.30%
Lesotho	2 127 539	2 127 539	100%	13.56%
Namibia	1 830 330	163 093	9%	1.04%
South Africa	44 819 778	13 357 298	30%	85.10%
Total	50 458 510	15 695 591	31%	100.00%

Of the some 15.7 million people living in the basin, 60% are considered to be 'urban'. However, in this sense 'urban' is a relative construct and may exclude densely populated areas designated as 'rural' in the population census. As such the overall population density of the basin may provide a better idea of the potential impacts of 'urban' pollution.

Figure 2.1 highlights those large contiguous areas of the basin with a population density of over 2,500 people per administrative unit. This includes both 'urban' and densely populated rural areas, but may exclude small towns and settlements with densities of over 140 people per hectare. However, while localised impacts from these towns may be noted, they are not expected to have regional impacts.

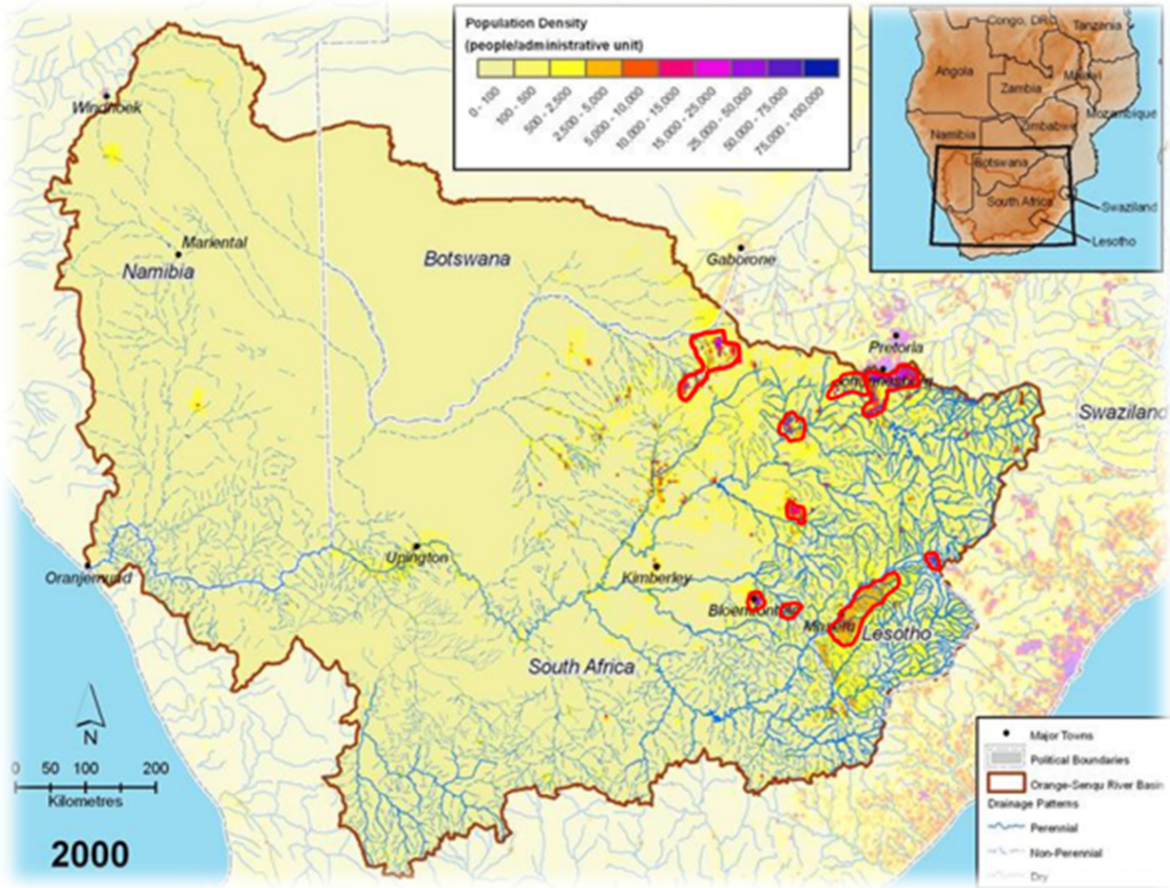


Figure 2.1 A population density map of the Orange-Senqu Basin, highlighting large contiguous areas with a population density over 2,500 people per administrative unit.

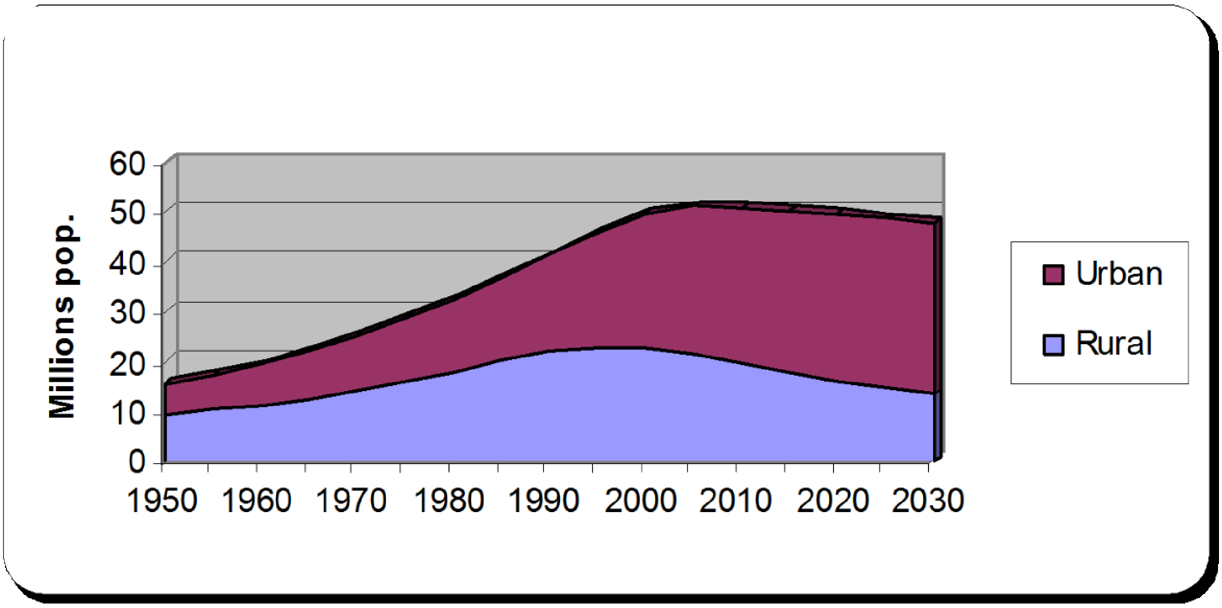
This process has identified the following areas that may be prone to urban pollution problems;

1) The southern Gauteng region, this area is home to an estimated 50% of the total population of the basin. Rivers flow southwards into the Vaal River just upstream of the Vaal Barrage.
2) The West Rand area. This area is characterised large mining towns. Rivers flow southwards into the Mooi River and Schoonspruit which are tributaries to the middle Vaal River.
3) The gold mining areas of the northern Free State around Welkom. The rivers flow westwards into the Bloemhof Dam.
4) The Bloemfontein / Botshebelo region. The Riet and Modder Rivers flow westward, forming a confluence with the Vaal, just upstream of the Vaal / Orange confluence.
5) Phuthadithaba area in the eastern Free State. The rivers flow northwards into the Wilge River and hence into the Vaal Dam.

6) The Lesotho lowlands around Maseru. The rivers drain into the Caledon / Mohakare River which forms the border between South Africa and Lesotho.
7) The Mafikeng area in the North West Province of South Africa. The rivers drain into the Molopo system which forms the border between Botswana and South Africa.

The densely populated areas are consequently mostly found in the upper reaches of the basin, often on small rivers. Most of these areas fall in South Africa, however the Lesotho lowlands also emerges as a potential source of urban pollution problems. Population Densities in Namibia and Botswana are very low. However, the towns of Mariental with a population of 11,977 (2001), and Keetmanshoop with a population of 16,800 may show localised problems. The largest town in the Botswana portion of the basin is Tsabong, with a population of 6,591 may also show some localised impacts.

Estimated population trends suggest that the population of the 4 Member States may decline slightly over the next 20 years (Figure 2.2). However, this is predicted to be associated with an increase in urbanisation, and urban populations are expected to grow.



2.3 Assessments using estimated return flows from urban areas

Comparisons of the total volume of effluent from urban areas returned to the river system provides an indication of the relative impacts of urban pollution on the river systems. Data on the volumes of urban return flows was obtained from the Water Resources Planning Model (WRPM) developed for ORASECOM by the programme coordinated through the German government. This model was not developed for water quality purposes but it does evaluate the net water demands from different parts of the Orange - Senqu Basin. Return flows to the river from urban effluents can then be estimated from these demands. However, due to the volume of return flows from the southern Gauteng area, and the fact that some of the effluent is discharged into the Limpopo Basin to the north, the WRPM includes models this separately.

The while the percentage of water returned to the river as effluent from Waste Water Treatment Works (WWTW) varies according to the type of sanitation system, the relative wealth of the area, rainfall and the type of waste water treatment, previous estimates for the Orange-Senqu Basin (outside of the Gauteng area) suggest that some 38% of the gross urban demand for water is returned as treated effluent. Irrigation return flows have been estimated at 10% of the irrigation demand.

Seven sub-basins were identified from the model framework, as follows;
1) Vaal River Basin
2) Riet/Modder River Basin
3) Upper Caledon River Basin
4) Upper Orange River Basin
5) Gariep River Basin
6) Lower Orange River Basin South Africa,
7) Lower Orange River Basin Namibia.

The return flow from the model data is shown in Table 2.1 and displayed in map form in Figure 2.3.

Table 2.2. Estimated return flows from the Water Resources Yield & Planning Models

Modelled Return Flows for 2010				
Sub-basin	**Source**	**Volume (M m^3/annum)**	**% of Sub-Basin Total**	**% of Basin Total**
Vaal	Domestic/Urban	476.53	57.25	36.67
	Irrigation	143.14	17.2	11.02
	Mine dewatering	109.5	13.15	8.43
	Storm water	103.24	12.4	7.94
	Total	832.4		64.06
Reit/Modder	Domestic/Urban	68.14	87.19	5.24
	Irrigation	10.01	12.81	0.77
	Total	78.15		6.01
Upper Orange	Domestic/Urban	9.08	26.19	0.70
	Irrigation	25.59	73.81	1.97
	Total	34.67		2.67
Gariep	Domestic/Urban	28.47	30.66	2.19
	Irrigation	64.4	69.34	4.96
	Total	92.87		7.15
Vanderkloof RSA	Domestic/Urban	55.78	30.33	4.29
	Irrigation	128.13	69.67	9.86
Vanderkloof (Namibia)	Domestic/Urban	6.95	36.06	0.53
	Irrigation	12.33	63.94	0.95
	TOTAL	203.19		15.63
TOTAL RETURN FLOWS		1299.49		

This analysis shows that the total return flows to the Orange-Senqu System are dominated by urban return flows in Vaal sub-basin. Effluent from WWTW in this sub-basin makes up some 37% of the total return flows, with a further 8% being contributed by storm water washoff. Domestic effluent in the Riet/Modder sub-basin contributes just over 5% of the total effluent volume in the whole basin, while return flows to the Orange River downstream of Van der Kloof Dam make up just less than 5% of the total effluent volume.

The Vaal sub-basin is consequently dominated by urban return flows, and this effluent makes a significant contribution to downstream water use. The smaller tributaries to the Vaal River are dominated by domestic effluent flows. Irrigation in this sub-basin makes up 11% of the total return flow. A similar pattern is noted in the Riet/Modder system where domestic effluent makes up 87% of the return flows to that river. In this system irrigation return flows mostly impact on the lower reaches of the river, and the Modder River which carries the effluent from Bloemfontein is dominated by urban effluents.

Domestic effluents make up a smaller proportion of the flows in the other sub-basins, with the possible exception of the Caledon / Mohakare River, which receives effluent from small towns on the South African bank, as well as from Maseru from the Lesotho bank.

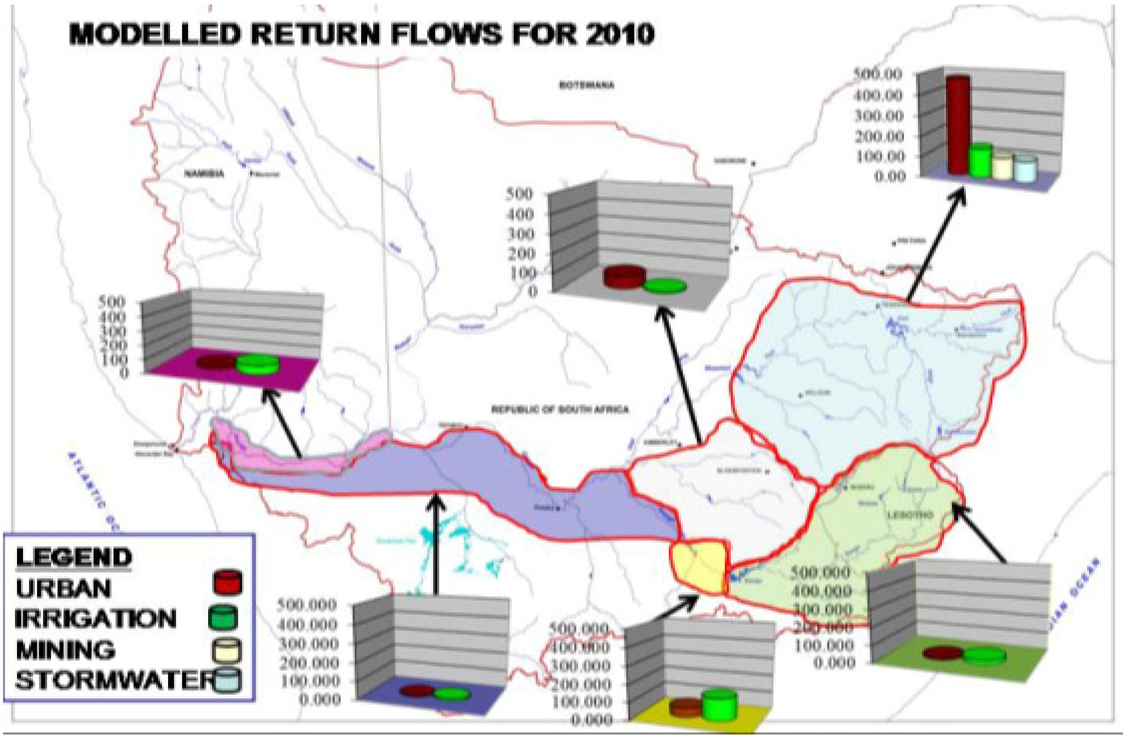


Figure 2.3 A Schematic map showing relative volumes of return flows from the Water Resources Yield and Planning models

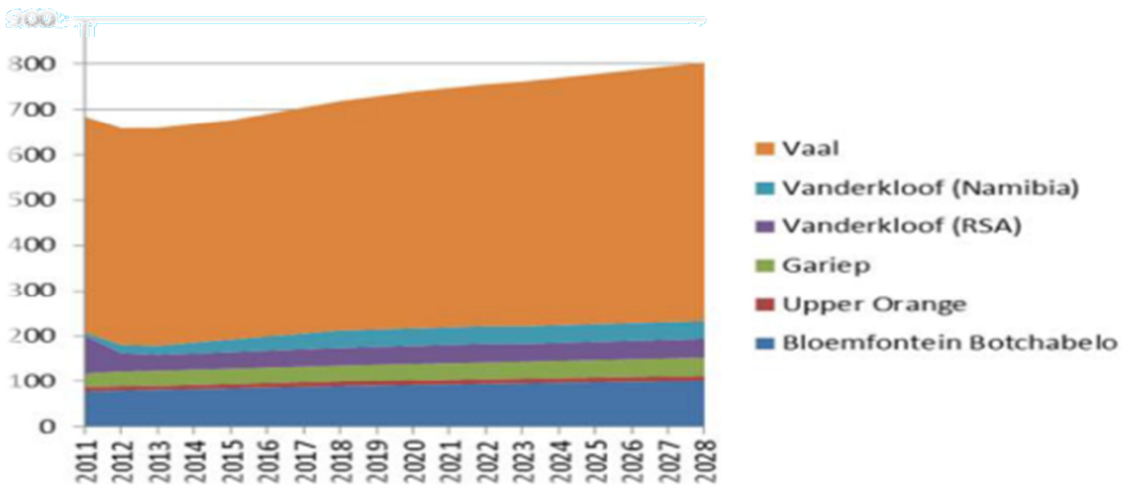


Figure 2.4 Projected return flow volumes in the Orange-Senqu River System

Total return flow volumes to the Orange-Senqu River System are expected to grow by about 15% over the next 20 years, predominantly in the Vaal sub-basin (Figure 2.4). However, in the short term, plans to treat and use acid mine drainage in the southern Gauteng area may reduce total return flows. Importantly, this could remove acid mine drainage water from rivers in this area, increasing the impacts of domestic effluent.

2.4 Assessments using water quality data

While population density and effluent volumes provides an indication of the *potential* for urban pollution problems, effective waste management and effluent treatment could mitigate the impacts of urban pollution. The geographic extent of urban pollution in the Orange-Senqu System was therefore also assessed using selected water quality variables. The following data sources were used for this assessment;

i.) South Africa's Water Management System (WMS).
ii.) The Joint Basin Survey carried out by ORASECOM.
iii.) Namibia and Botswana Groundwater data (from Molopo/Nossop basin)

Data for a number of parameters typically associated with urban pollution were readily available for a number of points in the basin. These parameters could therefore be used to assess the geographical extent of water quality problems typically associated with urban pollution. The following parameters were analysed

i.) Nutrients - Nitrogen and Phosphorus.
ii.) Heavy Metals.
iii.) Nitrates in the groundwater
iv.) Chloride and Sulphate concentrations (specifically in response to assess the impacts of pollution from clothing manufacturing in Maseru).

2.4.1 Nutrients

Nutrients such as phosphates and nitrates derive from a number of point and non-point sources including:

i.) Inefficient and failing Waste Water Treatment Works (WWTW);
ii.) Sullage drainage in poorly serviced densely populated settlements;
iii.) Failing sewerage and other sanitation systems[2];
iv.) Storm Water Drainage;
v.) Solid waste leachates; and
vi.) Chemical plants including fertiliser and explosives factories.

High nutrient concentrations can cause significant problems in water bodies by stimulating algal blooms. Algal blooms may be toxic and have been known to cause livestock deaths in several parts of the Orange-Senqu Basin. Algal blooms also increase the cost of water treatment, can cause taste and odour problems in the treated water and produce carcinogens on chlorination. Nutrients also stimulate the growth of macrophytes such as water hyacinth creating a variety of problems in river systems.

Figure 2.5 shows relative concentrations of Total Nitrogen and Total Phosphorus across the basin from samples analysed as part of the Joint Basin Survey.

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[2] Pit latrines and other on-site sanitation systems pose a problem for groundwaters. However, overflowing or blocked on site systems or blocked sewerage systems can cause problems in surface waters.

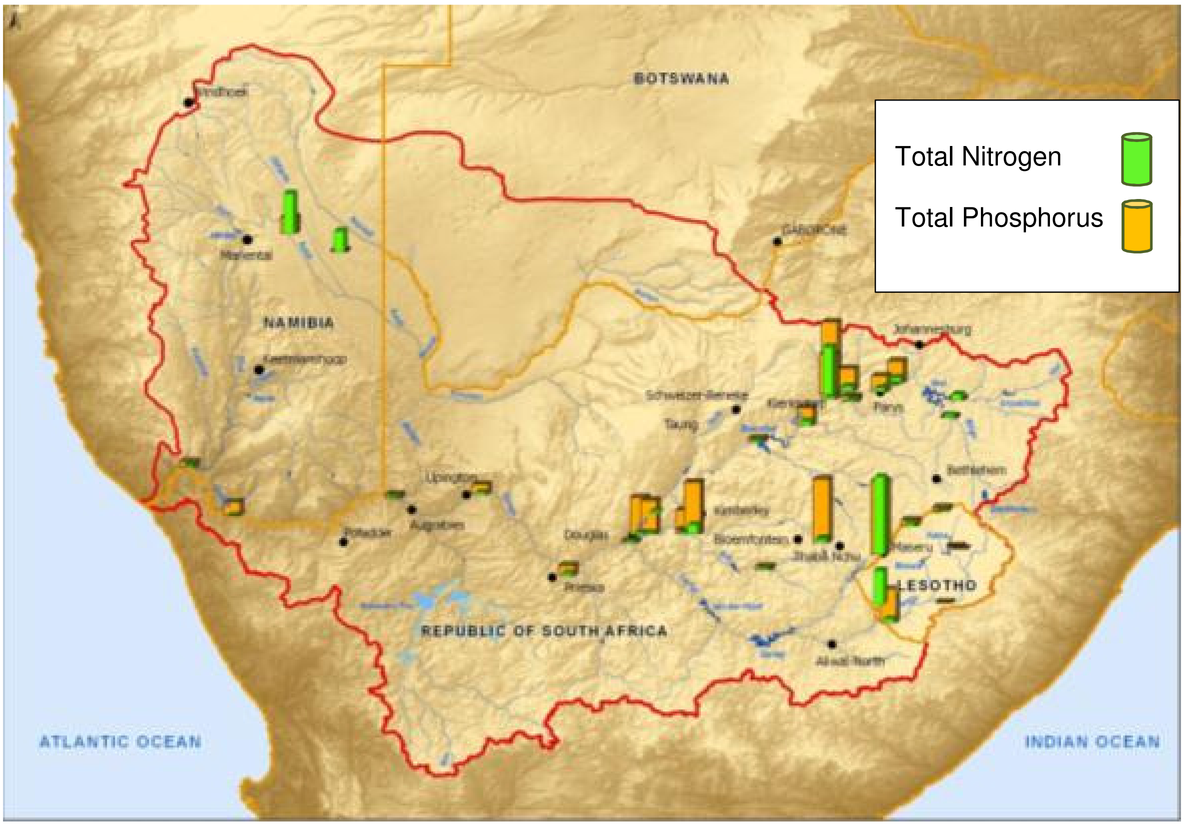

Figure 2.5. Relative Total Nitrogen and Total Phosphorus concentrations in the Orange-Senqu River System. (Note these are relative concentrations only, and are not set to scale.

A closer analysis of the date shows that nutrient concentrations throughout most of the Basin are sufficiently high to cause algal blooms. However, concentrations in the middle reaches of the Vaal River (from Vaal Barrage to Bloemhof Dam) and the lower reaches of the Riet / Modder River Systems in the Bloemfontein / Thaba Nchu area and downstream of Maseru are noticeably higher than those typical of the rest of the basin. Total phosphorus concentrations along this stretch of river range from 1.0 to 5.0 mg/L, concentrations typical of effluent from urban WWTW. Major algal blooms have been noted along this entire stretch, resulting in substantial problems with the treatment of water.

Nutrient concentrations further upstream in the Vaal and Wilge River inflows to the Vaal Dam are lower at 0.1 mg/L total phosphate. Concentrations in the Orange River are generally below 0.5 mg/L total phosphate. High nitrogen concentrations are found in the groundwater in Namibia. Total phosphorus concentrations in rivers in the Lesotho Highlands are typically below 0.03mg/L, while those in the Senqu River just before it flows into South Africa were 1.7 mg/L due to the high sediment loads at the time of sampling. Nutrient concentrations in the Caledon / Mohakare River increase downstream of Maseru. This may, however, also be partly associated with a rainfall event just before sampling.

An assessment of the total nitrogen (TN) to total phosphate (TP) ratio also provides some indication of the origin of the higher nutrient concentrations. Irrigation return flows are typically associated with higher TN:TP ratios as the phosphorus in the fertilisers binds to the soil matrix, whereas the nitrogen is much more water soluble and is washed out of the soil. TN:TP ratios in urban effluent is however often lower due the phosphates used in detergents. In the Orange-Senqu River System TN:TP ratios along the middle Vaal River are typically below 10, whereas in the Orange River concentrations are typically above 10. This suggests that the higher nutrient concentrations at places in the Orange River system may be of agricultural origin.

Orthophosphate trends were also analysed results for selected sites from 1979 to 2009 (Figure 2.6). This analysis has shown that orthophosphate concentrations in the Orange River tend to be stable and do not show significant trends. However, orthophosphate in the middle Vaal River does show significant upward trend since the mid 1990's. This may be associated with the increased loads of effluent as a result of South Africa's efforts in providing higher levels of sanitation to poorer areas. This will not only increase effluent volumes but will also overload WWTW making it difficult to maintain effluent standards[3]. This lends further support to the possible urban origin of increased nutrient concentrations along the middle Vaal River.

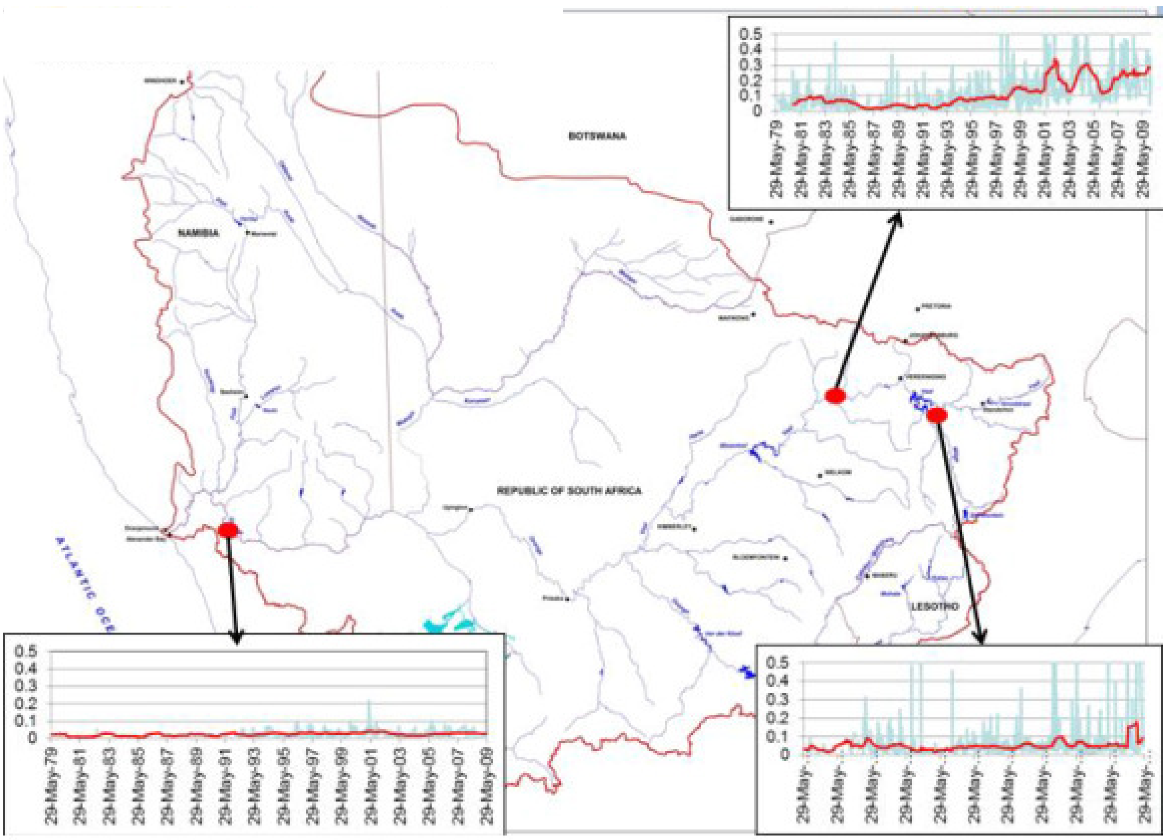

Figure 2.6 Orthophosphate trends at selected points in the Orange-Senqu River System. Trends are shown from May 1979 to May 2009.

2.4.2 Heavy Metals

Heavy metals are typically associated with industrial and mining activities, as well as in storm water wash off of roads from the oils and fuels used. Heavy metals were analysed by the UNDP-GEF programme as part of the Joint Basin Survey. Concentrations in sediments taken from over 60 sites across the basin were analysed for a range of different metals and a Metals Pollution Index[4] was calculated (Figure 2.7). This shows that the highest MPI score of 33.94 was found in the Molopo Eye near Mafikeng. However, the Molopo Eye is upstream of the urban areas, and the source of the elevated metals concentrations at this point still has to be identified. High MPI scores (22.22) were also found in the Riet / Modder River System downstream of the Bloemfontein / Thaba Nchu area in the western Free State.

[3] This is discussed in more detail in the following chapter.
[4] The Metal Pollution Index is the geographic mean of the concentrations of the 42 metals elements analysed. This provides an indication of the total metals concentration but not the potential impacts on the water resource or the origin of the metals.

Generally MPI scores of over 10 were found in the urban areas identified in the population density assessment. This includes the middle and lower Vaal, Caledon / Mohakare, Vaal, Riet and Modder Rivers. However, elevated MPI scores were also found in the Lesotho Highlands downstream of mining activities. As such the MPI scores highlight both urban and as well as mining pollution throughout the system.

These metals do not seem to be transported through the system and MPI scores in the lower Orange River are below 10.

Figure 2.7 Metal Pollution Index scores for the Orange-Senqu River System.

2.4.3 Nitrates in groundwater

On site sanitation systems like septic tanks or pit latrines in densely populated areas can pose a risk to groundwater quality. The Technical Task Team requested that the potential for groundwater contamination be investigated in this light. However, the scoping nature of this study precluded the collation and detailed analysis of all the groundwater data for the River System. This section is therefore limited to an analysis of the French GEF study on the Molopo / Nossop shared aquifer (see Figure 2.8).

Nitrate concentrations in this aquifer range from less than 45mg/l – (50 mg/l is the WHO Guideline Value for drinking water) to over 90mg/l in smaller pockets (Figure 2.8). Elevated concentrations (over 45 mg/L) occur in pockets along the length of the Auob, Olifants and Nossop river valleys in Namibia, and in isolated areas of Botswana. Pockets of higher nitrate concentrations in Namibia are not associated with urban settlements, and are most likely to be caused by agricultural fertilisers used in irrigation areas. While there appears to be a rough correlation between settlements in Botswana, and elevated nitrates, groundwater experts from that country suggested that these were primarily caused by cattle watering (Setloboko, pers.

comm). However, this does not necessarily exclude local groundwater contamination in either Namibia or Botswana due to nearby on site sanitation.

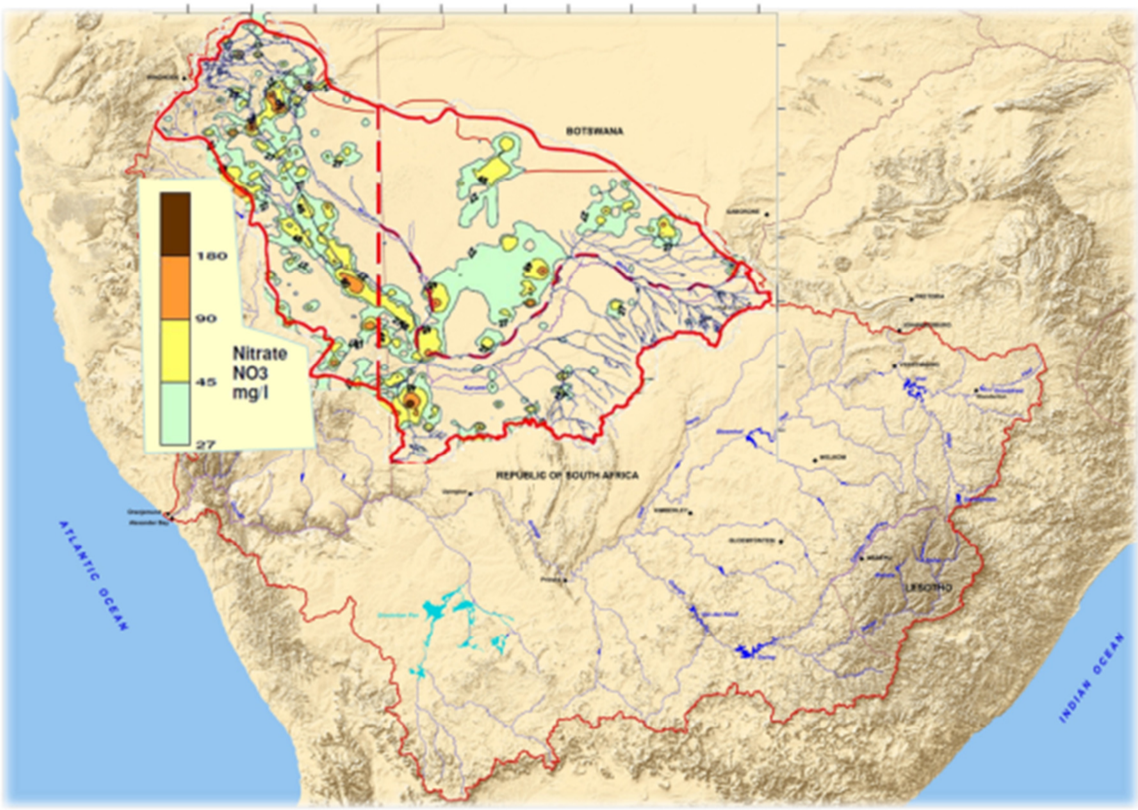

Figure 2.8 Nitrate concentrations in the Molopo / Nossop aquifer. (From A Groundwater Review of the Molopo Nossop Basin. http://www.orasecom.org/_system/writable/DMSStorage/551Final%20Report.pdf)

2.4.4 The impact of effluents from clothing manufacturing in Maseru

The ORASECOM Technical Task Team also requested that the assignment investigates the pollution emanating from clothing manufacturing in Maseru. Preferential trade agreements between Lesotho and the USA have led to the establishment of several foreign owned clothing manufacturing plants in Maseru. These plants wash the dyes from the clothing and have been known to discharge the effluent directly to rivers in Maseru and hence to the Caledon / Mohakare River. The exposure of this practice in the international media prompted further investigation and action. The result of this has been that the clothing factories now mostly pre-treat their effluent and discharge it to sewer. While this would remove the dyes it does not remove the salts and some impacts in the final treated effluent are still likely.

It is known that chlorides and sulphates are associated with the textile/clothing industry as these are derived from salts that are used to fix the dyes during the washing process. The concentrations of these parameters for sites upstream and downstream of Maseru were therefore investigated as part of this study. Sulphate concentrations at Mabine (D2H012) upstream of Maseru range are generally below 30 mg/L and do not show seasonality (Figure 2.9). Chloride concentrations similarly remain below 10 and do not show seasonality. Similar patterns are noted at Ficksburg (aslo upstream of Maseru). However, concentrations of both these parameters are much higher at Wilgedraai, downstream of Maseru and show strong seasonality. Since 2005 chloride concentrations toward the end of winter frequently exceed the

40 mg/L ‘trigger value’ established as part of ORASECOM’s Transboundary Water Quality Monitoring Programme. Concentrations of Chloride and Sulphate at Wilgedraai increase as flow in the river decreases in winter (Figure 2.10). This may indicate that as natural runoff decreases, so the effluent from Maseru has a greater effect on water quality further downstream. As such, there seems to be at least some evidence of pollution from clothing manufacturing on water quality in the Caledon / Mohakare River.

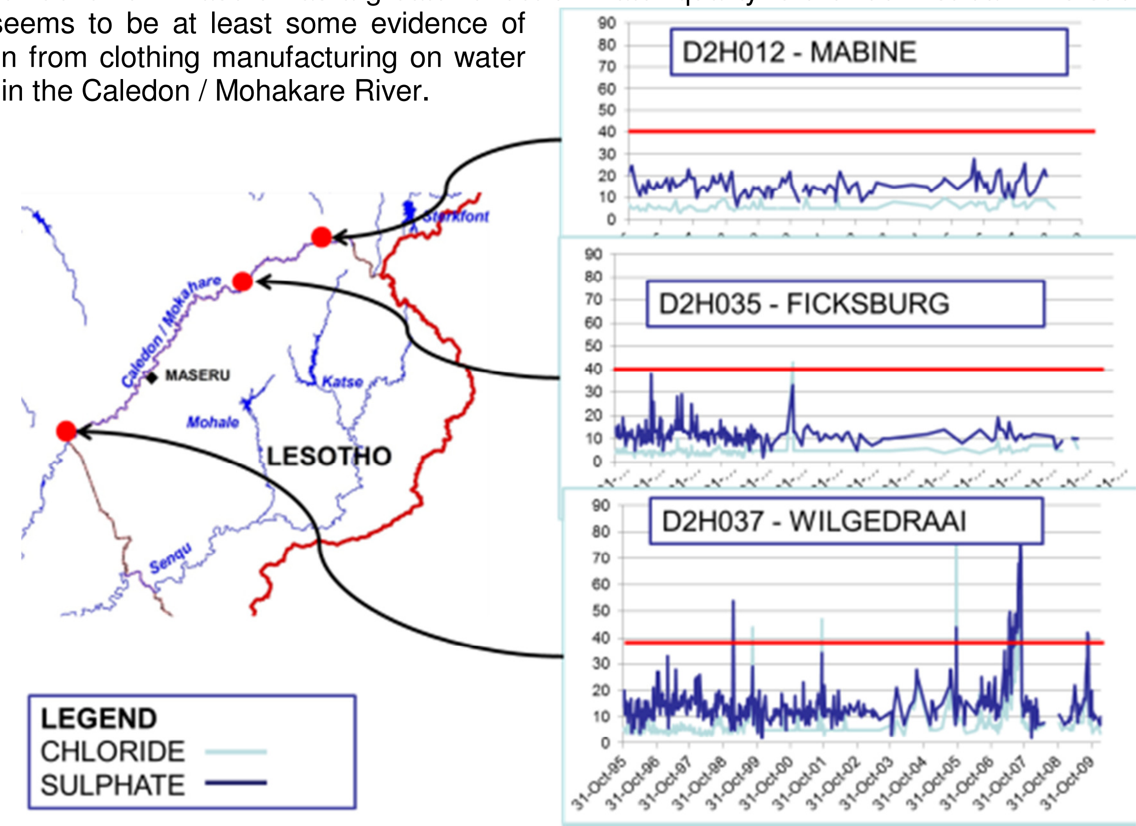

Figure 2.9 Times series graphs of chloride and sulphate at three sites in the Caledon / Mohakare River – showing the higher concentrations and seasonality typical of the site downstream of Maseru.

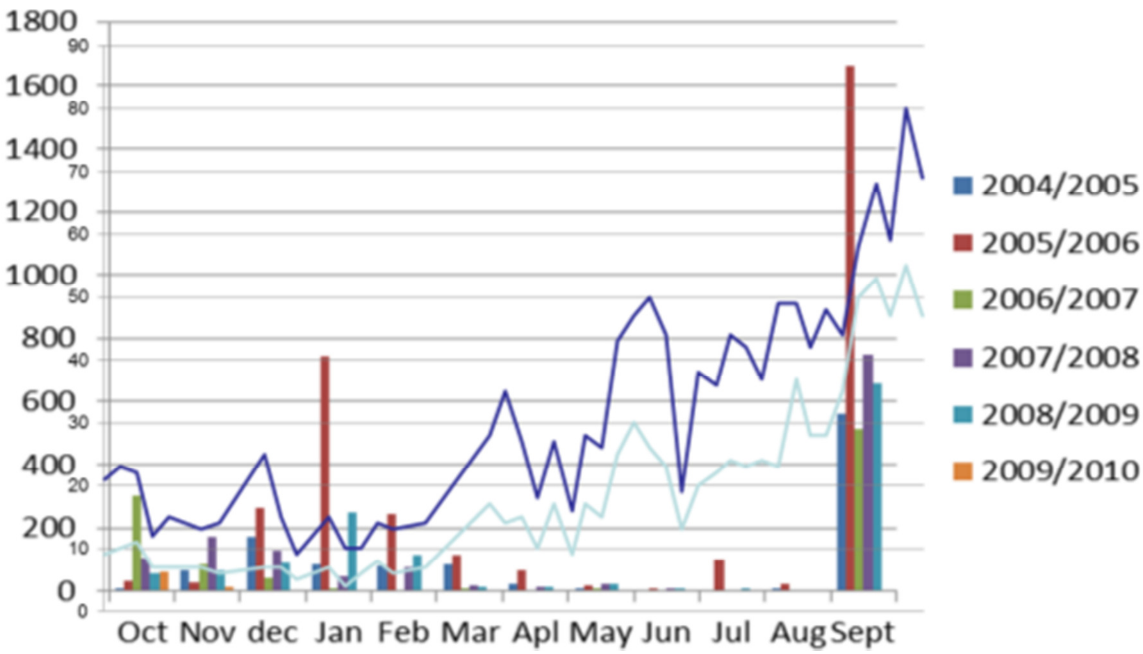

Figure 2.10 Total monthly flows for the 2004-2010 hydrological years (large type in Million m^3), set against the chloride and sulphate concentrations for the October 2006 – September 2007. This shows that sulphate and chloride concentrations tend to increase as flows decrease.

2.5 Conclusions

This provided a scoping analysis of the possible geographic extent of possible urban pollution problems in the Orange-Senqu River System, using population density, modelled effluent return flows and available water quality data. While this does not provide an exhaustive assessment of all the potential areas where urban pollution problems may occur in the basin, the study has identified regions of the basin where the quality of the water may be affected by urban pollution.

Population density maps of the basin show 7 areas where population densities and numbers of people are high enough to pose potential threats to regional water quality;

1) The southern Gauteng region.
2) The West Rand region (west of Johannesburg).
3) The gold mining areas of the northern Free State around Welkom.
4) The Bloemfontein / Botshebelo region.
5) Phuthadithaba area in the eastern Free State.
6) The Lesotho lowlands around Maseru.
7) The Mafikeng area in the North West Province of South Africa.

Of these the *southern Gauteng and West Rand regions* to hold the biggest threat to regional water quality *downstream of the Vaal Barrage*. Total effluent return flows into the whole of the Vaal sub-basin make up some 37% of the total effluent volume for the basin while storm water runoff and other non-point sources of pollution in this area would also pose a threat to water quality.

The *Bloemfontein / Botshebelo / Thaba Nchu* area also shows up as a large densely populated area, potentially *affecting the Riet / Modder sub-basin*, and also with over 5% of the effluent volume of the basin. The population density data for the *Lesotho lowlands as well as the Mafikeng area also suggests that urban pollution may be a concern for these parts of the basin*. However, population densities in Namibia and Botswana are too low to be concern for regional water quality. Although localised impacts may occur near some of the towns.

This broad picture based on population density and urban return flow data is supported by the analysis of the water quality data. The whole of the Vaal River downstream of the Vaal Barrage, and the Riet / Modder Rivers show water quality impacts typical of urban pollution. Similarly, the Caledon / Mohakare River downstream of Maseru shows evidence of urban pollution, including the impacts of the effluents from the clothing manufacturing plants in Maseru. Land degradation in the Lesotho lowlands also contributes to higher sediment loads and the associated elevated nutrient concentrations. This also poses the only clearly identified transboundary water quality threat in the basin.

While metal and dioxin concentrations are elevated in the Molopo River Eye near Mafikeng, this is not clearly linked to urban pollution.

Chapter 3: Legislation, challenges and experiences

3.1 Introduction

One of the key objectives of this scoping study was to provide an analysis of the legislation applicable to managing urban pollution in each of the ORASECOM Member States. This assignment has included an analysis of the key challenges faced by the Parties in managing urban pollution. This is intended to provide a basis for building a better understanding of the problem, and to share experiences between the Member States.

3.2 South Africa

3.2.1 Background

The previous chapter has shown that urban pollution in South Africa poses the biggest threats to regional water quality across the Orange-Senqu River System. However, South Africa's recent political history has also had a profound impact on this problem. The fall of apartheid in 1994 left the new government with enormous backlogs in services provision. Huge pressures to provide water and sanitation services, and in urban areas often higher levels of sanitation services, to the poor created cost recovery problems for local government.

On-going pressure to provide these and other services is dominating the political landscape of the country, and is making implementation of the legislation particularly difficult. National government, in the form of the Department of Water Affairs is responsible for managing the quality of the country's water resources. However, local government has been charged with providing water and sanitation services, and providing adequate support to local government to enable this is increasingly seen as one of the highest priorities of central government. Within this milieu local government is focussing its resources on providing services rather than on managing the water impacts of these additional services. National government is finding it increasingly difficult to apply command and control approaches to address the problem. A dichotomy of approaches from exercising greater controls over local government based on what is required to achieve instream water quality objectives, versus establishing economically and technically appropriate waste management practices for local government is hampering the development of clear policies for urban pollution management. This is exacerbated by a significant urbanisation problem; the rapid growth of informal settlements with little or no waste management facilities is a growing problem for many of the larger cities in South Africa.

3.2.2 Legislation to manage urban pollution in South Africa

South Africa's National Water Act (Act No. 36 of 1998) 'the NWA' has been widely hailed as one of the more innovative pieces of water legislation. This Act provides a number of tools to address pollution from urban areas.

The NWA specifies eleven 'uses' of water, *inter alia*, discharging waste or water containing waste into a water resource as well as 'controlled activities' i.e. specified activities that may have a non-point source impact, and the disposing of waste that may have a detrimental impact on the water resource. As all water 'use' must be authorised, point source discharge of urban waste can be controlled through effluent standards – which may in turn be based on the desired level of protection for that river. However, the NWA can potentially address non-point source pollution from urban areas by designating these as 'controlled activities'. As such any urban activity that potentially affects the quality of the water resource either through storm water runoff or direct impacts on the water can be controlled. However, to date only the irrigation of waste from WWTW is regarded as a 'controlled activity'. The administrative implications of expanding this net make designation of other urban pollution problems as controlled activities unlikely in the short term.

The NWA also provides for the Minister to prepare regulations prescribing waste standards as well as qualifications and registrations of people operating WWT works – providing additional measures of control. However, to ease the administrative burden of the shift to the new legislation, water uses that were lawfully practiced in the 2 years prior to the promulgation of the NWA are regarded as lawful under the new legislation. As such, uniform effluent standards prepared in 1985 are still applicable to most WWTW. There have been attempts to update the 1985 uniform standards, but implementation has been delayed to 2020 to give Local Authorities time to upgrade to the new requirements– probably in recognition of the financial constraints facing local government.

The NWA also prescribes a water resource classification process. All 'significant' water resources can be classified in any one of 3 Classes. Resource Quality Objectives (RQOs) specifying a desired instream quality can be set according to the Class. As such RQOs may be more stringent where higher levels of protection are required. Potentially therefore WWTW may have to apply more stringent effluent standards in some areas. However, stakeholders must participate in the determination of the Class – and so local government can apply pressure to 'lower' the class. In principle, therefore, the uniform effluent standards would apply, except in places were the desired level of protection and / or volume of effluent returned to the river demand higher standards. This will make it difficult for local government to make appropriate investments in pollution management until the classification process is complete. Classification is currently underway in the middle Vaal River, but no other river system in the Orange-Senqu has been classified yet.

While South Africa's NWA provides a raft of options to address urban pollution, and to ensure that instream water quality objectives are maintained, the practical application of these provisions will remain a significant challenge.

3.2.3 Urban Water Pollution Challenges for South Africa

Urban pollution problems in South Africa are dominated by a host of post-apartheid challenges. South Africa has made significant inroads into providing sanitation services to previously disadvantaged communities. Since 1994 the percentage of the urban population with access to improved sanitation services has jumped significantly, and some 93% of the urban population now has access to improved sanitation. This has meant that in the larger urban centres significant numbers of households have been linked to sewerage systems. The volumes of effluent from WWTW have consequently increased significantly since the mid-1990s. However, many local authorities have not upgraded treatment facilities, and the majority of WWTW across the country do not meet the applicable standards.

A national survey of WWTW done from 2008 to 2009 - 'the Green Drop Report'[5] - reviewed the management and operation of WWTW across the country. If the assessment scored well, meeting important criteria, the WWTW would be awarded the Green Drop Certificate. This was a voluntary exercise, and was used to motivate management to improve the operation of the WWTW. The Green Drop Report notes that only 7.4 % of the WWTW achieved a Green Drop standard and only 449 out of about 852 municipal WWTW offered to be assessed. The majority of the WWTW in the country consequently had unsatisfactory performance.

The reasons for this include:

i.) A lack of funding for maintaining and upgrading WWTW as funds are being deflected into other municipal priority areas.
ii.) Poor financial management in local government.
iii.) A serious decline in skilled workers operating the WWTW has led to most works not being operated effectively.
iv.) A hydraulic overload owing to the increasing installation of flush water sanitation systems.

The Green Drop system also reports on performance on a provincial basis. An analysis of the performance of WWTW in the Gauteng, Free State, North West and Northern Cape Provinces provides an estimate of the problem with respect to the Orange-Senqu River System (Figure 3.1). Of

[5] Available at; http://www.dwa.gov.za/dir_ws/GDS/

the 260 WWTW in these 4 provinces that are part of the Green Drop system, 52% were considered to be in a critical state in 2010/2011, and a further 18% were in a very poor state.

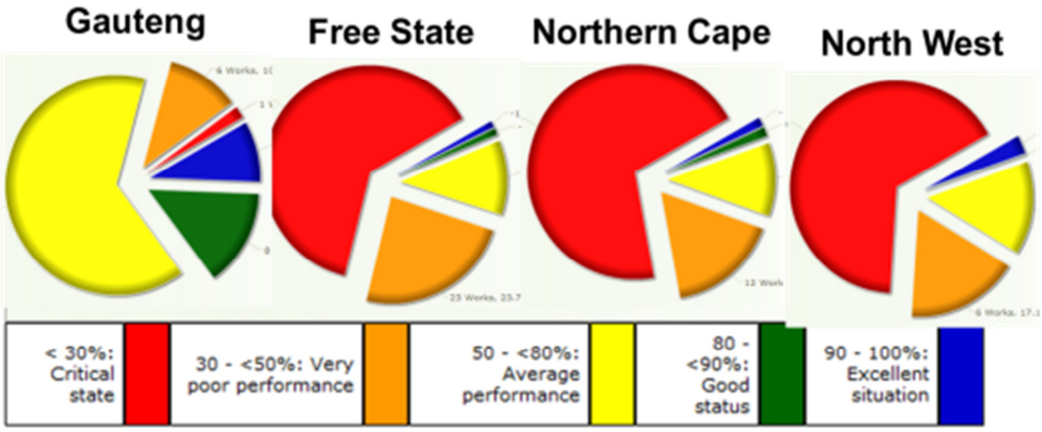

Figure 3.1 The performance of WWTW in the 4 provinces making up part of the Orange-Senqu River System as reported in the Green Drop system.

The poor performance of WWTW is therefore a significant problem not only nationally for South Africa, but also specifically for the Orange-Senqu basin. Indications are that this problem may be worsening. However, addressing this problem is particularly daunting. The recognition of local government as an equal sphere of government and the fact that local government is at the frontline of services provision has posed problems with enforcing compliance to standards. Moreover, both the ability and willingness to pay for services in the poorer areas has created a financing gap, and local government increasingly finds it difficult to ensure effective cost recovery. This has led to a growing operation and maintenance gap and many WWTW are failing, often leading to the discharge of untreated effluent directly to the rivers. Financial problems and the political importance of local government has also underpinned a reluctance to enforce, and the Department of Water Affairs has yet to propose a single clear regulatory policy in this regard. Point source management of urban pollution remains a significant and growing problem.

Non-point source pollution from poorly serviced or un-serviced settlements, however, also poses a significant challenge. In South Africa the demand for new housing grows at a rate faster than houses can be provided by local government. Informal settlements have therefore become a significant and rapidly-expanding component of urban development in South Africa. Approximately 7.7 million people (about 19%) of South Africa’s population live in ‘squatter camps’ and informal settlements around many urban areas. A number of studies have shown that water quality is significantly degraded downstream of these settlements, with high levels of organic pollution, faecal coliform bacteria, nutrients and solid waste. Often this poses a health hazard for those living in these areas.

3.3 Lesotho

3.3.1 Background

The urban pollution landscape of Lesotho is dominated by two issues. Firstly, the majority of the 2.2 million Basotho people live in a relatively small portion of the country - in the lowlands. The Lesotho lowlands are therefore some of the most densely populated areas of the basin, with large numbers of people living in scattered rural villages, in addition to the some 230 thousand people living in Maseru. Secondly, the majority of the people are poor, and Lesotho is the poorest of the 4 ORASECOM Member States. This means that while much of Maseru has been provided with reticulated sewerage, the majority of the population is still serviced by on-site sanitation. Total effluent loads to the surface waters are therefore low. Moreover, Lesotho’s status as one of the ‘least developed’ nations places it in line for preferential trade agreements, attracting certain manufacturing industries. This also poses specific challenges for managing urban pollution.

3.3.2 Legislation to manage urban pollution in Lesotho

Urban pollution management in Lesotho is enabled through the;

i.) The Water Act of 2008.
ii.) The Environmental Act of 2007.

Lesotho's Water Act draws heavily on the South African experience, allowing for the classification of water resources, and the associated quality and quantity objectives for these resources – including an environmental flow reserve. The Act also allows for the definition of 'controlled activities' in a similar manner to South Africa's NWA.

However, the key differences are that local authorities are responsible to manage their catchments through established Catchment Management Plans (CMP). These CMPs must include environmental protection, wetlands, and riparian buffer zones. Furthermore, the Act establishes a shared national responsibility for prevention pollution of water, and where pollution occurs, anyone who owns or occupies land should take measures to prevent the pollution continuing.

Permits to discharge effluent are required under the Environment Act 2007 but the Director of Environment must consult with the Commissioner of Water before issuing them. These permits can specify the permissible quality and quantity of the discharge.

The recently formed Para-state the Water and Sanitation Company (WASCO) is responsible for water supply and administering the sanitation systems in the urban areas. The responsibility of the water supply and sanitation in rural areas falls to the Department of Rural Development

3.3.3 Urban pollution challenges for Lesotho

Lesotho is a 'least developed country', and has been given preferential import conditions by the USA, giving exports from Lesotho a competitive advantage. A number of global clothing companies have consequently sub-contracted their manufacturing base to Lesotho to reduce their costs. However, this advantage is relatively tenuous. Other southern African countries also have the same preferential import conditions. These factories are most often foreign owned, and may shift their base if environmental management costs in Lesotho get too high. This would rob Lesotho of much needed foreign income, jobs and GDP. Lesotho has therefore struggled to maintain an appropriate balance between regulatory control of these factories, and retaining the much needed economic benefits.

As we have shown in the previous Chapter, effluents from these clothing manufacturing plants is most likely having an impact on the Caledon / Mohakare River, which is shared with South Africa. However, of more immediate concern was the discharge of dyes directly to streams in Maseru. The Water & Sewage Company (WASCO) has consequently requested that the effluent should be channelled to the City WWTW after pre-treatment. Lesotho has also established two committees to address the problem; an Industrial Committee, which meets weekly and includes: the Ministers and their First Secretaries of Finance, Trade, Environment, Local Government, & Natural Resources and a Waste Management Committee, which meets monthly and includes technical staff and senior managers from Trade, Finance, Trade, Environment, Local Government, Natural Resources, and, also importantly, representatives from the clothing manufacturing industry. These committees manage the problems on an on-going basis. The parent companies have also exerted pressure on the manufacturers. However, these efforts may struggle to address the more intractable problem of the elevated salt concentrations in the effluent.

This problem is exacerbated by the fact that much of Maseru uses on-site sanitation, and the volume of domestic effluent received by the Lesotho WWTW is comparatively low, reducing dilution of the salts. On site sanitation is considered to be a more affordable solution for most households, and even when reticulated sewerage is available most users choose not to connect. Nevertheless, even on-site sanitation systems require some operational costs, and must be emptied when full. However, the influx of people means that the pits and tanks are filling quicker than normal. If the pits are not emptied in time, they may decant into the surrounding areas, possibly contaminating the groundwater or leaching into the rivers. Moreover, when the pit latrines are full many households construct new pit latrines increasing the risk to the groundwater. This issue has been recognised by the local authority and the emptying of the pits has recently improved. Historically the problem was exacerbated by a lack of effective building regulations, and the siting and construction of on-site sanitation was uncontrolled. However, recently new regulations have been put in place to ensure the pits are lined and located away from water sources.

Importantly, however, while on-site sanitation may pose a threat to the groundwater, the impact on the surface water is limited. This means that the hydraulic overloading of the WWTW is primarily due to the industrial effluent. The construction of a new WWTW may partially address this problem. As such, the impact of the heavily populated Lesotho lowlands on the water quality in the Caledon / Mohakare River is limited. Lesotho's mountainous terrain can also cause problems with the sewerage systems, as it is not economically viable to connect settlements to the reticulated system which requires the sewage to be pumped upstream.

Maseru like most other cities suffers from problems with storm water drainage contamination and also from illegal solid waste dumps. However there have not been the large informal settlements noted in the region causing the serious pollution and health problems that South Africa has encountered.

3.4 Namibia

3.4.1 Background

Namibia has the second-lowest population density in the world at 2.5 people per km². The estimated population of 2 108 000 is distributed across an area of 825,418 km². Most of the people live in the north of the country, and population densities in the Namibian portion of the Orange-Senqu basin are low. Urban pollution problems in the basin, while they occur, are therefore limited to small towns and are not expected to have regional implications. Some small settlements (some without formal sanitation, along the banks of the Orange River, like Aussenkeur and Noordoewer, may also have localised impacts

3.4.2 Legislation and Regulation

The Namibia Water Resources Act was passed in 2004, also drawing on South Africa's NWA. Key elements of the Act are;

1. The Act has integrated the protection of Groundwater and surface water
2. There is a common duty of care to prevent pollution with the liability to make good, and a polluter pays principal.
3. The Act recognises Namibia's international obligations with respect to the need to control cross border pollution.
4. The Act provides for the establishment of Basin Management Committees to develop, conserve, manage and control & make recommendations on licences and permits.
5. Permits to discharge effluent must be issued by Minister of Agriculture & Water& Forestry (AWF).
6. All effluent discharges require a permit, however this excludes on-site sanitation.
7. The discharge permit specifies the terms and conditions, which are policed by the MAWF.
8. The siting of WWTW and on-site sanitation with respect to drinking water sources is strictly controlled.
9. Local authorities are responsible for providing water and sanitation.

3.4.3 Urban pollution challenges for Namibia

On-site sanitation systems are normally used in the low density areas. However, as in Lesotho the pits are often not emptied when full, potentially threatening the quality of the groundwater. However, on-site sanitation systems must be located more than 500m from and hydro-geologically downstream of groundwater drinking water sources. Given the low population densities in this minimises the risks of contamination of drinking water sources.

However, as with South Africa the WWTW operated by local authorities have been known to pose a pollution threat to surface water sources. Small towns in the Orange-Senqu Basin mostly have piped sewage to WWTW mostly using oxidation ponds. Some waste water is also treated and reused for irrigation of parks and fields. These WWTW have problems, such as under capacity or poor linings, so there can be leakage into the groundwater or spills to the surface water. The recent decentralisation of the operation of these WWTW from national to local government also means that some of the local municipalities currently do not have trained operators.

The MWAF may revoke a discharge licences, but usually work collaboratively with the local authority to address any non-compliance and pollution problems. The MWAF and the local authority and usually agree a time window to resolve the problems. However, often these are not undertaken owing to lack of resources and funds.

3.5 Botswana

3.5.1 Background

Like Namibia, the population density in the Botswana part of the Orange-Senqu basin is very low. The largest settlement in the area is Tsabong with a population of only 6591. Moreover, this population is very poor, and most use on-site sanitation systems. Urban pollution problems are therefore expected to be limited.

3.5.2 Legislation & Regulation

The Botswana Government has drafted a Water Bill in 2005. While this Bill has not yet been passed by Parliament it is expected that it will soon be, and this Bill is therefore analysed here. The key elements of this Bill are:

1) The progressive introduction and application of appropriate standards and techniques for the investigation, use, control, protection, conservation, management and administration of water resources.
2) An official National Database will be established to include:
    - i.) information on water resource quality,
    - ii.) ground water data,
    - iii.) waste discharge permits, &
    - iv.) the sampling and analysis of any water or waste.

   This database can be applied to define resource quality objectives for different resources.
3) A national water resources strategy will be prepared, which will include the requirements for basic human needs, minimum aquatic ecological needs, and international obligations.
4) Waste discharge permits will be issued by a Water Resources Council. However, they will have to be referred to relevant government departments for approval.
5) Land owners or occupiers must take all reasonable measures to prevent pollution.
6) Aquifer protection zones will be defined to prevent contamination of the groundwater.

3.5.3 Urban pollution challenges for Botswana

The previous Chapter noted pockets of high Nitrate concentrations in the groundwater in Botswana. However, local groundwater experts have suggested that this is due to livestock (mostly cattle) stations. As with Lesotho, Botswana has also recently established a Para-State Water Utilities Corporation. This WUC will be responsible for the water and sanitation in the small villages and towns, and has recently taken over the management of sanitation in Tsabong. As is the case in Lesotho this may also spread the financial burden and provide government with greater capacity to regulate the impacts of urban pollution.

3.6 Shared experiences and conclusions

Legislation around water resources management in all of the ORASECOM Member States has recently been, or is in the process of being, modernised to bring it in line with the current global thinking on managing the impacts of urban pollution on water resources. In all cases the legislation provides for the regulation of urban pollution through the issuing of waste discharge permits that may specify the volume and quality of the discharge permitted. Additional opportunities are provided through concepts like 'controlled activities' which can specify particular controls over non-point sources of pollution. In other cases, the legislation places obligations on land owners to prevent pollution. In all four States the legislation provides (or will provide) the opportunity to establish resource quality objectives in the receiving waters and hence the establishment of specific environmental flow and quality objectives.

However, it is not a lack of appropriate legislation that provides the biggest threat from urban pollution, but rather the capacity to implement this legislation and the particular complexity of regulating other (often under resourced) spheres of government. This is complicated by the issues of cost recovery, particularly for higher levels of sanitation services, from poor communities.

Of all of the ORASECOM Parties, South Africa faces the most significant and growing problems with respect to managing pollution from urban settlements. The previous chapter has shown that the middle and lower Vaal Rivers, and the Riet / Modder River System are most at risk. This chapter has shown that this situation is likely to persist and potentially worsen as local government struggles to provide basic services, as well as providing adequate resources for managing waste services. This problem is however deeply rooted in the post-apartheid landscape of South Africa, and the relationships between National and Local Government. A lack of a clear policy in the Department of Water Affairs with regard to their regulatory control over local authorities with respect to pollution management makes management of urban pollution even more complex. Addressing these issues is clearly a priority, but also vexing issue, for South Africa.

This particular nexus is not as clear in the other Member States, but is to a limited extent relevant to the Namibia experience. Here too management of urban pollution is complicated by a lack of resources in local government, but as the problem is much more limited in scope a greater emphasis on collaborative solutions is possible. Moreover, the very sparsely populated Namibian portion of the basin means that this problem is limited and localised.

The problem of limited resources to address pollution management, and the political complexity of strong command and control measures has a parallel in Lesotho's management of the waste from the clothing factories. Lesotho's status as a 'least developed' nation creates a positive spin off in terms of attracting exporting businesses, but also challenges with respect to potentially chasing these businesses away through increasing the costs of waste management. The establishment of the multi-stakeholder and multi-sector committees seems to have addressed the immediate problem of the discharge of dyes to the rivers in Maseru. However, the problem of increased salt concentrations in the final effluent from the Maseru WWTW is likely to remain a more intractable problem.

In both Botswana and Lesotho the problem of managing another sphere of government has been to some extent addressed by the establishment of Para-State organisations responsible for water and sanitation services. In Lesotho, the establishment of WASCO means that the costs of operating the Maseru WWTW can now be borne by both the national budget as well as the users, thus avoiding the cost recovery and failing WWTW problems faced by South Africa. Similarly, in Botswana the WUC can be regulated by government agencies, and provides perhaps better opportunities for using the national budget to support local waste management.

While, the viable approaches to and solutions for the urban pollution problems are likely to be specific to each Member State, certain experiences could be shared between the 4 Parties. In particular;

- South Africa's Green Drop System provides a useful transparent and publically accessible means of reporting on WWTW. This could be adopted in some form by all the Parties.
- The establishment of Para-State agencies in Botswana and Lesotho can facilitate regulatory management and may provide the opportunity to 'ring-fence' national funding for improved waste management through national government support to these agencies.

- The establishment of multi-sector committees like that established in Lesotho can help address particularly intractable problems[6].
- Complex legislation, while providing a raft of different options to address both point and non-point source pollution, can led to dichotomies in approaches making enforcement more complex.

[6] A similar committee has been established to address the Acid Mine Drainage problem in Gauteng.

Chapter 4: Conclusions

4.1 Introduction

This study is primarily defined by its 'scoping' nature. It provides a *brief* overview of the possible geographical scope of this problem in the basin, the legislation available in each of the Member States to address the problem, and the key challenges facing each of the Parties in addressing this problem.

It is hoped that this will help exchange experiences between the Parties. However, the scoping nature of this work has precluded the complete analysis of the problem necessary to offer up potential solutions or clear recommendations.

4.2 Defining urban pollution

Urban pollution was defined for this study as the impacts of contaminated water from:

- Sewage from wastewater treatment plants or on site sanitation,
- Sullage (grey water),
- Storm water drainage,
- Solid waste leachates and litter.

Contamination from these sources includes a range of pollutants, chiefly; nutrients, microbiological components, and metals from storm water washed of roads. Urban pollution may also affect both surface waters as well as groundwater particularly where on site sanitation systems are used. Effluent from waste water treatment plants may also contain pollutants from industries which discharge their waste to the sewers.

Importantly, urban pollution poses unique challenges for water quality management Urban water pollution derived from household waste mainly results from vital human needs for water and sanitation, and falls to Para-state or state organisations, and the costs of these services is recovered in services payments. However, often the poor struggle to pay for appropriate levels of services. Simple application of polluter pays principles and command and control management of urban pollution is therefore complex, and requires institutional, governance, financial as well as technical solutions.

This scoping study has highlighted that this is particularly a problem in South Africa where local government is struggling to effectively operate and maintain WWTW and other waste management systems. This is exacerbated by the rapid growth in the number of households connected to sewerage systems. The rapid growth in informal settlements is also posing a growing problem. While similar problems are noted for Namibia, the smaller number of WWTW and local authorities make cooperative management more feasible.

4.3 The geographic scope of urban pollution problems

This scoping study has shown that there are potentially 7 areas where population densities and numbers of people are high enough to pose potential threats to regional water quality;

1) The southern Gauteng region.
2) The West Rand region (west of Johannesburg).
3) The gold mining areas of the northern Free State around Welkom.
4) The Bloemfontein / Botshebelo region.
5) Phuthadithaba area in the eastern Free State.
6) The Lesotho lowlands around Maseru.
7) The Mafikeng area in the North West Province of South Africa.

Of these only 3 seem to result in regional water quality problems. The *southern Gauteng and West Rand regions* certainly seem to hold the biggest threat to regional water quality *downstream of the*

Vaal Barrage. Effluent return flows dominate river flows in these areas and significant water quality problems are noted along the length of the middle and lower Vaal River.

The *Bloemfontein / Botshebelo / Thaba Nchu* area also shows up as a large densely populated area, potentially *affecting the Riet / Modder sub-basin*. This is also reflected in poorer water quality in this part of the basin – potentially from urban pollution.

The population density data for the *Lesotho lowlands suggests that urban pollution may be a concern for these parts of the basin*. However, most of this population is using on-site sanitation systems, and impacts on the surface water appear to be limited. There is nevertheless evidence that pollution from clothing manufacturing in Maseru is having transboundary impacts. This is also the only clearly transboundary urban pollution problem in the basin.

Population densities in Namibia and Botswana are too low to have regional impacts, although localised problems may occur.

4.4 Legislation and challenges in the Member States

Legislation in all four Member States provides for the regulation of urban pollution through the issuing of waste discharge permits and /or 'controlled activities'. In all four States the legislation provides (or will provide) the opportunity to establish resource quality objectives in the receiving waters and hence the establishment of specific environmental flow and quality objectives. However, the capacity to implement this legislation and the particular complexity of regulating other (often under resourced) spheres of government, is limited. This is complicated by poor cost recovery, particularly for higher levels of sanitation services, from poor communities. Complex legislation can also led to dichotomies in approaches to managing urban pollution, from establishing technically appropriate and financially feasible uniform standards, to setting site specific standards based on loadings required to maintain instream Resource Quality Objectives.

South Africa faces the most significant and growing problems with respect to managing pollution from urban settlements. This problem is however deeply rooted in the post-apartheid landscape of South Africa, and the relationships between National and Local Government. A lack of a clear policy in the Department of Water Affairs with regard to their regulatory control over local authorities with respect to pollution management makes management of urban pollution even more complex. Addressing these issues is a priority for South Africa, and resources are being channelled into addressing the problem. Evidence from the Green Drop System suggests that this is a significant and possibly growing problem, but it is too early to tell if this system would have long term benefits for addressing urban pollution. However, at this stage, this does not appear to be a transboundary threat.

This issue is to some extent relevant to the Namibia experience. Here too management of urban pollution is complicated by a lack of resources in local government, but as the problem is much more limited in scope a greater emphasis on collaborative solutions is possible. Moreover, the very sparsely populated Namibian portion of the basin means that urban pollution is limited and localised.

This has a parallel in Lesotho's management of the waste from the clothing manufacturing plants, which must balance the need to attract business with the need to protect the water resource. The establishment of the multi-stakeholder and multi-sector committees seems to have addressed the immediate problem of the discharge of dyes to the rivers in Maseru. However, the problem of increased salt concentrations in the final effluent from the Maseru WWTW is likely to remain a more intractable problem.

In both Botswana and Lesotho the problem of intra-government regulation has been addressed by the establishment of Para-State organisations responsible for water and sanitation services. In Lesotho, the establishment of WASCO means that the costs of operating the Maseru WWTW can now be borne by both the national budget as well as the users, thus avoiding the cost recovery and failing WWTW problems faced by South Africa. Similarly, in Botswana the WUC can be regulated by government agencies, and provides opportunities for using the national budget to support local waste management.