A Preliminary Basin Profile of the Orange/Senqu River

by
Anton Earle, Daniel Malzbender, Anthony Turton & Emmanuel Manzungu

INWENT in cooperation with the African Water Issues Research Unit, CIPS, University of Pretoria, in support to the SADC Water Division and ORASECOM

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Senior Programme manager: Thomas Petermann,
Thomas.Petermann@inwent.org
Department 5 - Environment, Natural Resources and Food, Leipzig-Zschortau, Germany. Inwent, Lindenstr. 41, D-04519 Rackwitz (Zschortau), Germany

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Design and layout by Glita Design: glita@mweb.co.za
Cover photo credit: Jeffrey Barbee: looksouth@worldonline.co.za

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Foreword

Water – as a precious resource in an arid environment impacts and is impacted by the life forms coming into contact with it in a river basin. For Integrated Water Resource Management (IWRM) to be effective a process of harmonising the various rights to and needs for water in a basin needs to be developed. This process is one of strategic management that shapes the way in which we think, act and enjoy the benefits of water and its inherent values. New water developments, or changes in the way we use or allocate water, require acceptance by stakeholders, must pass agreed ecological criteria, and must demonstrate that they do not erode the overall value of water to human society. The process of IWRM implies the co-management of resources and activities such as land, water, wild animals, agriculture, industry and mining.

Inwent (Germany), as part of their objective of contributing to capacity building around river basin governance in the Southern African Development Community (SADC) area, have collaborated with the African Water Issues Research Unit (AWIRU), based in the Centre for International Political Studies at the University of Pretoria (South Africa) to produce this preliminary profile of the Orange River. The Orange River basin represents many of the challenges being faced by water resource managers in the region and globally in attempting to balance the various, often competing, needs for water in a basin. This preliminary profile serves as an introduction to the various issues pertinent to the management of the basin, including information on the people living in the basin, its hydrology, climate, economy and environmental issues.

Note

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While the above inputs are acknowledged responsibility for the views, statements, descriptions and assertions contained in the profile are those of the authors alone and not, necessarily, those of any of the organisations involved.

Introduction

At almost one million square kilometres the Orange River basin is the largest basin south of the Zambezi. It is also the most developed transboundary river basin in the southern African region, with a variety of water transfer schemes to supply water to municipalities, industries and farms in and outside of the basin.

Orange Basin - Major features	
Total basin area	896,368 km^2
Area rainfall (mm/y)	Average: 330; range >2000 to <50
Average discharge	Vaal River: 4.27 km^3/yr, Senqu River: 4.73 km^3/yr Estuary: 11.5 km^3/yr
Water demand	Total = 6,5 km^3/yr ; Agriculture 64%, Urban supply 23%, Rural supply 6%, Mining and other 7%
Population	19 million (year 2002)
Water availability	<1000 m^3 per capita

Note: 1 km^3/yr = 1,000,000,000 m^3/yr = 1,000 M m^3/yr

Contrary to popular belief, the Orange River was not named after the reddish orange colour of its silt-laden water. It was in fact named in 1779 by Colonel Robert Gordon, the commander of the garrison of the Dutch East India Company (Cape Town) during a reconnaissance into the interior, in honour of the Dutch House of Orange (DWAF, 2005). The Lesotho part of the river is called the Senqu and the whole river is sometimes referred to the as the Orange-Senqu. In South Africa the name Gariep has been used for the river as this was the name used by the earliest pre-colonial inhabitants of the interior of the country. This publication will use the term Orange River as this is still the internationally recognised name.

As the basin plays host to one of the most industrially developed parts of Africa (the region around Johannesburg, South Africa) and supports a range of commercial and subsistence farmers there are several issues posing a challenge for water managers responsible for the basin as well as communities relying on the resources of the basin (see Figure 1).

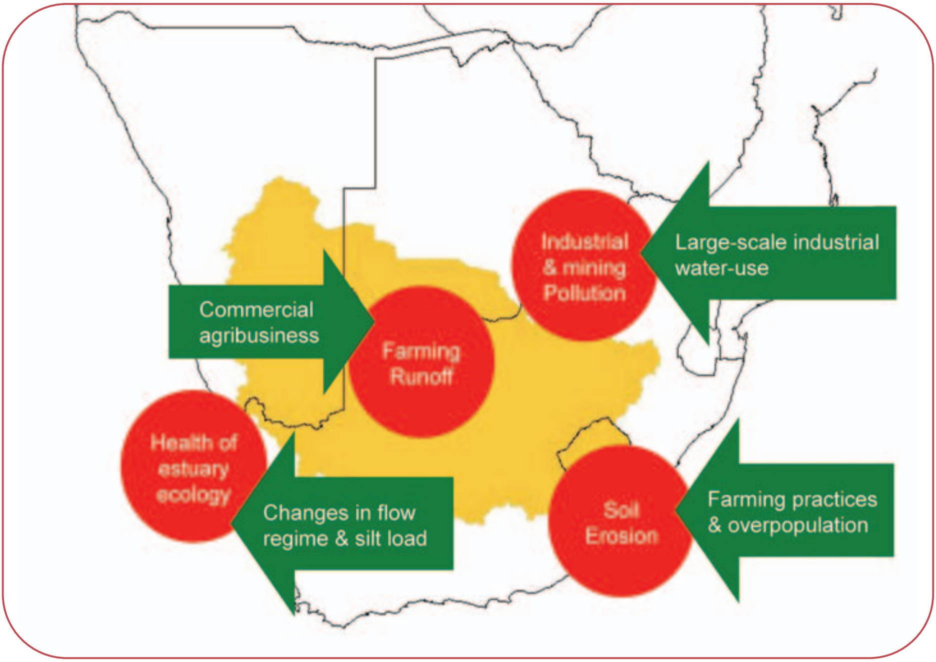

Figure 1: Environmental issues & driving forces posing a challenge to IWRM in the Orange River basin

Physical characteristics of the river

The basin stretches over four countries - South Africa, Lesotho, Botswana and Namibia, with the Orange River itself forming part of the border between South Africa and Namibia (see Figure 2). These countries cover a range of ecological zones – the high-rainfall mountainous areas of the Lesotho Highlands, through the savannah grasslands of the central plateau to the desert conditions in the western part of the basin (Bohensky et al, 2004). Note the variation in run-off between the different sub-basins (these are based on assumed "natural flow conditions not taking into account water use).

The two main tributaries of the Orange River are the Senqu and the Vaal rivers. The river is sometimes called the Orange-Senqu, with reference to that tributary. The headwaters of the Senqu rise in the Maluti mountain range in Lesotho at an altitude of about 3,000 metres above sea level (See Figure 3). In these eastern

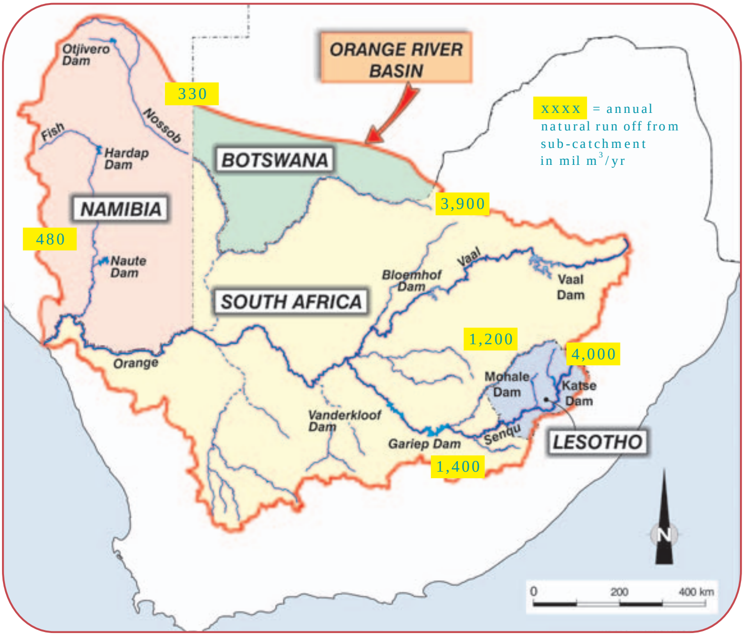

Figure 2: The Orange River Basin *(Source: WRP)*

parts of the basin rainfall is high – over 2,000 mm annually, and exceeds the annual evaporation of 1,200 mm comfortably (Heyns, 2004).

Box 1: The Lesotho Highlands Water Project (LHWP)

The LHWP is the largest international interbasin transfer (IBT) in the world (DWAF, 2004d). The project was initiated to provide water to the industrial heartland of South Africa – Gauteng province including the city of Johannesburg. This city is unique in the world in that it is the only major city not situated on a large water source and it is on the watershed dividing two river basins. The result is that water is continually draining away from the city. Water is pumped to the city from the Vaal River, about 50 km away. In 1986 the Lesotho Highlands Water Project Treaty was signed between South Africa & Lesotho. The Treaty has 4 protocols covering in detail aspects of design, construction, operation and maintenance, and the institutional arrangements needed to manage such a complex project. Royalty payments to Lesotho were determined as half of the difference in cost for supplying 70m3/sec from the LHWP, and the least cost of the alternative Orange Vaal Transfer Scheme (DWAF, 2004d). The minimum quantities of water to be delivered by the LHWP over time were agreed to, starting with 57 million m^3/yr in 1995, and ending with 2,208 million m^3/yr after 2020. Overall the project has been well received, with most interest groups agreeing with the need for its construction as well as supporting the efforts made to ensure that the project is socially and environmentally benign. However when the initial treaty was signed in 1986 there was much less emphasis placed on stakeholder participation and the inclusion of environmental considerations than what there is today and thus some of the interests of these groups were overlooked. Attempts are underway to address these issues and incorporate them in the running of the project. At present the South African government has commissioned a study to make a recommendation as to the feasibility of proceeding with Phase 2 of the project.

Figure 3: Lesotho Highlands Water Project possible water transfers
(Source: DWAF, 2004d)

The entire country of Lesotho falls within the Orange River basin, with the river flowing from there into South Africa's Free State province.

The other main tributary, the Vaal River, rises on the eastern highveld escarpment in north-east South Africa. Shallow hollows and low hillocks form a natural sponge where water collects in pans, vleis (wetlands) and streams. These streams link up and the Vaal River is born, flowing westward on a long course, without rapids or waterfalls, broadening into a large river. To the Bushmen, the river was known as Gij'Gariep ("tawny") from its muddy colour. The European name, Vaal, also means tawny. The Sotho called it iliGwa ("erratic") because of the unpredictable variations in its flow (Rand Water, 2004). The Vaal River flows to the south of the industrial heartland of the region, Johannesburg, supplying most of the industrial and municipal water to the city.

The Vaal catchment is highly populated and urbanized, with 48 percent of the population of South Africa living in the catchment and relying on its water (Heyns, 2004). Most of South Africa's heavy industry and mining activities are also situated within the catchment. Much of the catchment areas are heavily modified by impoundments and water transfer schemes both removing and augmenting the natural water supply to compensate for the natural variability of the water flow.

By contrast, at its western extreme, the Orange River flows through hyper-arid areas where the annual evaporation of 3000 mm/yr greatly exceeds the limited rainfall of 50 mm/yr (see Figure 4). This leads to a mean annual precipitation (MAP) to mean annual runoff (MAR) conversion rate of less than 10 percent for the basin as a whole and a rate approaching one percent in some of the drier lower reaches.

Coupled with the spatial and temporal variability of rainfall over the region much of the basin experiences some degree of water stress. Average per capita availability of water in the basin is just over 1,000 cubic metres annually, placing it on the border between what Falkenmark calls chronic scarcity (500 – 1000 m^3/yr) and water stressed (1000 – 1700 m^3/yr) (see Falkenmark & Widstrand, 1992 and Bohensky et al, 2004).

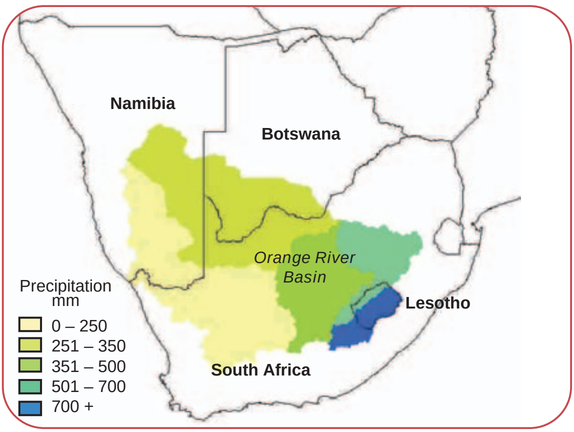

Figure 4: Precipitation in the Orange River basin *(FAO, 2001)*

Population density in these dry areas is correspondingly far lower than in the upper reaches. Agriculture is the major economic activity, with livestock being kept in the drier areas, and grapes and vegetables being farmed in a narrow riparian strip supported by intensive irrigation drawn from the river. There are also several mining operations in the lower reaches of the basin (refer to Section 4 of this profile).

As can be seen from Figure 5 South Africa at about 60 percent has the largest portion of the basin area within its borders and contributes a commensurate amount to runoff. Namibia has a relatively large portion of the basin within its borders but its runoff contribution is less than four percent of the annual total.

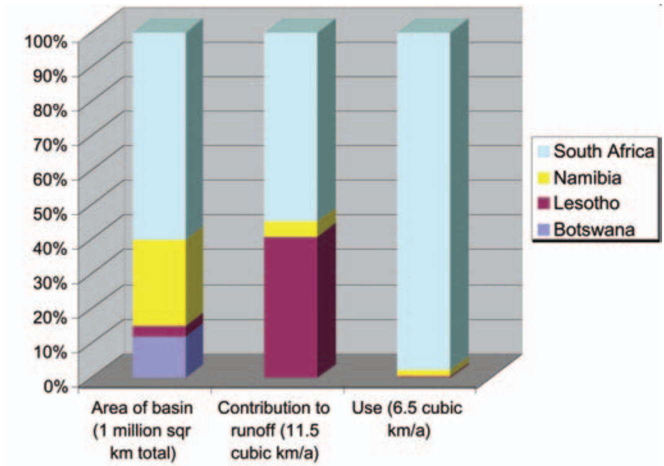

Figure 5: Country contributions to area, runoff and water use of the Orange River basin *(Data from Heyns, 2004)*

Conversely, Lesotho contributes over 40 percent of the streamflow from only five percent of the total basin area. The Molopo River, which forms the border between Botswana and South Africa, is a fossil river, which once flowed into the Orange River. Now it receives most of its very occasional flows from its tributaries in the Northern Cape province of South Africa.

At present South Africa is the largest user of water from the river – accounting for around 82% of annual total use (including environmental flows and inter-basin transfers). This asymmetry in runoff contribution from the various basin states is largely explained by the differences in rainfall in the basin areas of the states (see Figure 6).

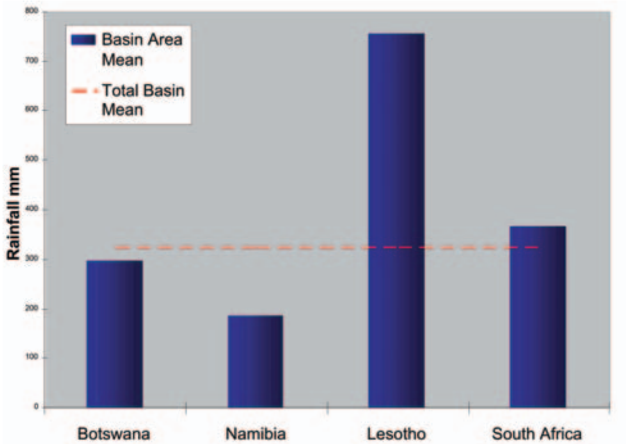

Figure 6: Mean annual rainfall in Orange River basin states - area in basin *(Data source: FAO, 1997)*

The Lesotho part of the basin receives over twice the annual mean rainfall of the whole basin, while the portion of Namibia lying in the basin receives around half the annual mean.

Historic settlement patterns in the Orange River Basin – a brief overview

The Orange River Basin has been populated from the earliest days of human-kind, in fact the earliest remains of humans were found in the basin, near Taung in the North-west Province of South Africa (Turton et. al., 2004).

Before the first humans lived in the basin it was already inhabited by early hominoids like the Australopithecus africanus, Homo habilis and Homo erectus. After the Homo sapiens of the Middle Stone Age (700 000 to 125 000 years ago), humans of the Later Stone Age came to settle in the Orange River basin whose latest representatives were the San people (see Box 2) (Turton et. al. , 2004). The San left evidence of their society in the form of rock art adorning the cave walls where they lived in the Maluti Mountains in Lesotho (see Figure 7). This art depicts animals and humans in dream-like sequences evoking scenes from hunting trips which the men embarked on. The San were the only basin inhabitants for tens of thousands of years before, 2500 to 2000 years ago the Khoi-Khoi (men of men) arrived in the Orange River Basin from an area where modern Botswana, Zambia and Angola meet (Turton et. al., 2004).

The Khoi-Khoi were hunters as well as pastoralists herding sheep and cattle and made use of the Orange River water whenever their nomadic lifestyle brought them to the shores of the main stem of the river or one of its tributaries. Most of the water used by the Khoi-Khoi was to supply drinking water for their livestock.

Figure 7: Rock art of the San people graphically depicts some of the animals found in the Maluti mountains area of Lesotho

A few hundred years later the Bantu-speaking peoples migrated southwards and settled over parts of southern Africa. The first of these movements went south along the east coast of Africa and reached modern-day Mpumalanga and KwaZulu-Natal about 1 700 years ago (Maggs, 1986). Around 1 500 years ago, a second distribution of Bantu-speaking people took place from the north (Turton et. al.,

2004) through modern day Zimbabwe. After initially only settling in the bushveld and savannah regions of modern day South Africa; north and south of the Vaal River, the Bantu-speaking peoples settled in new areas within the Orange River Basin between 1300 and 1600 AD (Turton et. al., 2004).

The Bantu people were agro-pastoralists practicing a more established lifestyle growing grains like sorghum, babala, manna and rapoko, pulses like black beans and peanuts and members of the pumpkin family like calabash and sweet melon (Maggs, 1986). Because the climatic conditions beyond the 200mm rainfall barrier did not support their agro-pastoralist lifestyles, the Bantu peoples did not migrate to the western parts of the Orange River Basin.

Box 2: The San People

The San people were the last representatives of the humans of the Later Stone Age and direct descendants of the prehistoric humans that lived in South Africa during the Early Stone Age (Turton et.al., 2004). They settled in the Orange River Basin as well as most other parts of southern Africa. The San people were hunters, gatherers and fishers and the low population density allowed them to live relatively comfortably off the natural resources in their immediate surroundings. The San people have over time been severely decimated by in-migrating Khoi-Khoi and Bantu tribes as well as European settlers. Under the South African Apartheid government many of the remaining San were employed in the South African army where their traditional tracking skills were made use of. After the transition to democracy in South Africa the San lost their jobs in the army and most San communities have been relocated to government-built camps in the Northern Cape. Today the San society is strongly affected by poverty, high degrees of alcohol abuse and associated social problems. Some hope for the San might lie in a successful claim that awarded the community the rights to benefits from the tourism income generated in the Kgalagadi-Transfrontier Park, an ancient San hunting ground.

The 200 mm rainfall barrier formed a natural and ecological boundary between the Khoi-Khoi and the Bantu peoples, although interactions between them as well as the San occurred.

The use of the Orange River water changed dramatically with the arrival of the European settlers. In 1652 Jan van Riebeeck established a fortified refreshment station for the ships of the Dutch East India Company at the Cape. Over the following centuries European settlers moved further and further inland from the Cape and the first farmers settled in the Orange River Basin in the 1690s. With the exception of the area around Cape Town farming practices initially concentrated on extensive farming and in the drier inland areas of the Orange River Basin, livestock farming remained the predominant farming practice. With the rapid increase of the European population in the 19th century the transition from subsistence to commercial farming accelerated and large-scale commercial farming firmly took root after the closing of the frontier between 1870 and 1900 (Turton et.al., 2004). With the increase in farming activities the need for water rose dramatically and the Orange River became an ever more important natural resource. Until today most of the Orange's water is used for irrigation farming.

In 1867, the first diamond was discovered near the Orange River in the Hopetown district, subsequently leading to a diamond rush and a rapid increase in population in this region. These were the beginnings of commercial mining, which until today accounts for a substantial amount of water use in the Orange River Basin.

The establishment of the country of Lesotho, in which the source and the upper reaches of the Orange River lie, is directly linked to the arrival of European settlers in the region. The area of present day Lesotho, formerly known as Basutoland, was only populated by San until the end of the 16th century. Thereafter refugees from the Bantu-speaking peoples in the surrounding areas gradually formed the Basotho ethnic group and in 1818 Moshoeshoe consolidated various groups and became their king. When the territory of the Basotho came under threat in a series of wars with the South African Boer Republics between 1856-1868, Moshoeshoe appealed to Queen Victoria for assistance. In 1868 the territory, which forms present day Lesotho, was placed under British protection. Lesotho gained independence in 1966.

Present Population Distribution

To date, the population of about 19 million people (Bohensky et.al., 2004) in the Orange River Basin, is a reflection of the basin's historic settlement patterns.

The population is most homogeneous in Lesotho, where 99,7% of the population (of 2 million) are Basothos (Bohensky et.al. 2004), with the remainder being a small number of Asians and Whites. The capital Maseru is the only large urban area (with a population of around 170,000) in the country and due to the mountainous terrain there are only a few other towns. As a consequence, the majority of the Lesotho population is rural, living in small mountain villages in the Drakensberg and the western lowlands where subsistence farming is the main source of livelihoods.

Figure 8: Basotho children *(Photo: Daniel Malzbender)*

The South African part of the basin reflects the diversity of the country's population and language groups. All of the country's 11 official language groups (Ndebele, Isixhosa, Isizulu, Sepedi, Sesotho, Setswana, Seswati, Venda, Xitsonga, Afrikaans and English) are represented with Isizulu, Sesotho, Setswana and Afrikaans being the predominant ones. Afrikaans is spoken mainly by the white farmers and the so-called Coloured population, which are the biggest population group in the western parts of the basin in the Northern Cape Province. Although knowledge of the San languages is rapidly declining, they are still spoken by some members of the San communities in the South African and the Botswana part of the basin.

An interesting feature is the settlement of Orania, near Hopetown, on the banks of the Orange River. The little town is populated by Whites only; who follow the idea of autonomy for Afrikaners and attempt to establish a more or less selfsufficient Afrikaner "homeland" - this in the centre of modern multiracial South Africa.

With the exception of the capital Windhoek, which lies at the northern periphery of the basin (and like Johannesburg is on the watershed divide), the population density in the Namibian part of the basin is low. Keetmanshoop, relatively small by any standards, is the biggest town in the area with a population of 20,000. The biggest population group in this part of the basin is the Nama, with a number of European (mainly farmers) and so-called Coloureds accounting for the remainder. Extensive livestock farming, primarily of sheep and goats, is the predominant economic activity in the Namibian basin area, although there are some irrigation schemes along the banks of the Orange river, such as the large Aussenkehr table-grape farm, as well as some mining developments.

The Botswana part of the basin is sparsely populated as the south of the country forms part of the Kalahari desert. With the exception of some San communities living in this part of the Kalahari desert, the majority of the population belongs to the Tswana ethnic group. The main urban area in Botswana's south, the capital Gaborone, lies outside the basin. Due to the low population density, Botswana's use of the basin's water resources is very limited. The only surface water resources in the Botswana part of the basin, the Nossop and the Molopo River, are ephemeral and endoreic downstream of the confluence and dissipate in the desert before reaching the Orange River (Heyns, 2004). The country's main use of basin water is therefore groundwater use.

Throughout the basin there has been a trend towards increased levels of urbanisation (see Figure 9). People move into the larger cities in search of work, especially in the industrialised Gauteng part of the basin. Of course this shift in demographics has had an impact on water resources, with a greater volume of water now being needed by the urban areas for industrial and municipal uses. The high prevelance of HIV/AIDS amongst both rural and urban communities contributes to a projection that population levels will decline after 2005.

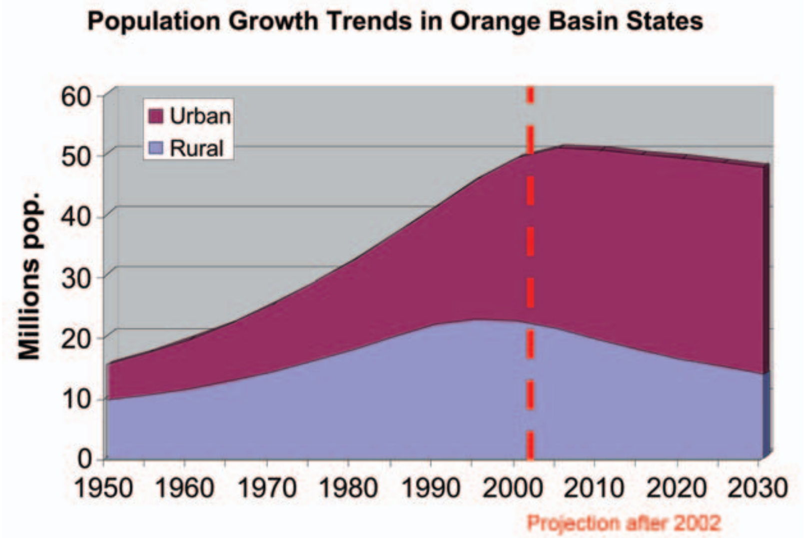

Figure 9: The populations of the Orange basin states became predominantly urban-based in the early 1990s *(FAO, 2004)*

Economic use of the Orange River's water resources

The scarcity and unequal distribution of freshwater resources is considered one of the fundamental factors posing a threat to the economic and social development of the southern African region (Heyns, 2004). The situation is particularly acute in the Orange River basin as it supplies water to the industrial heartland of South Africa, while having to provide livelihoods for people downstream in the arid western part of the basin.

The water resources of the Orange River basin are used for various purposes, with irrigation, mining, industries, power generation and domestic consumption being the main user groups (see Figure 10). The type of use differs from region to region, with agriculture being a major user of water on the mid to lower reaches while industrial and municipal uses predominate on the upper reaches, of the Vaal River (see Figure 14).

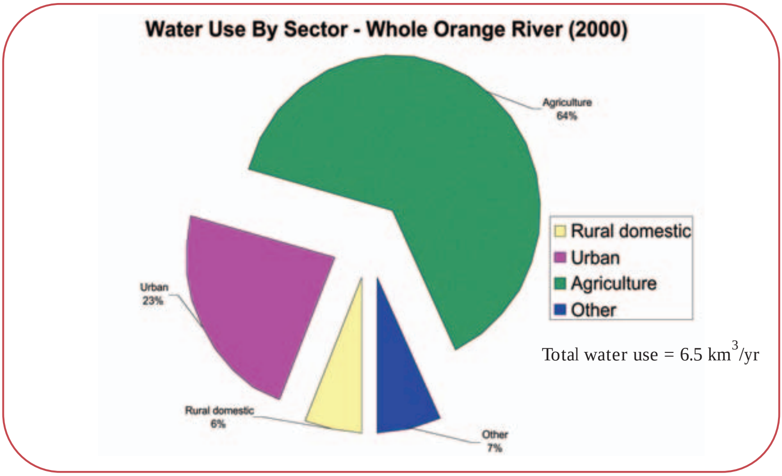

Figure 10: Water of the Orange River is used by a range of sectors (Note: "Other" includes mining & hydro-power) *(DWAF, 2004)*

The four basin states, while at different levels of industrial development, have as a whole seen a reduction in the role agriculture plays in their national incomes. From being net exporters of cereals until the mid 1980s the basin states now import an increasing amount of their staple food requirements (see Figure 11).

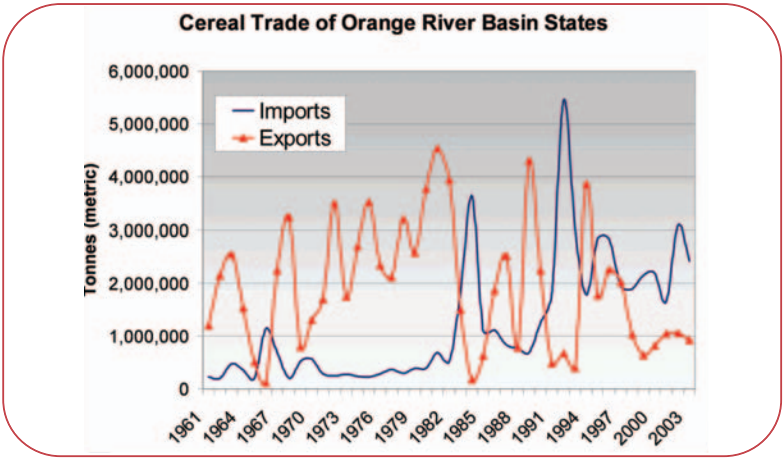

Figure 11: The Orange basin states have become net cereal importers over the past decade *(FAOSTAT, 2004)*

Considering that each tonne of cereal* consumes over 1,000 tonnes of water, the impact of this shift in the food balance is profound (Earle & Turton, 2003). This water consumed by crops as they grow has been referred to by the catchy name of virtual water and serves as a visualisation of the interaction between the international grain trade, food security and water resources. The three million tonnes of grain imported by the basin states in 2002 translates to around three cubic kilometres of water saved locally – a significant amount in relation to the average annual flow of the Orange river of 11.5 cubic kilometres.

Factors such as agricultural subsidies paid to farmers in the developed-world, import barriers protecting developed-world farmers, food aid and increasing water scarcity in the southern African region will dictate future trends in agricultural water use in the Orange River basin. A switch towards increased production of higher value crops, such as table grapes, olives and nuts has started and will become more entrenched over the coming years.

Lesotho

In Lesotho, almost 50% of the population sustains their livelihoods from crop cultivation and agriculture accounts for around half the country's income. The main commercial agricultural zone is the western lowlands but small-scale agriculture is also practiced wherever the terrain of the Maluti Mountains allows it. There is a high reliance on rainfed agriculture, with only around three percent of the total irrigable area under water management (FAO, 1995).

*Cereals include the major crops grown and consumed in the region – maize, wheat, rice, sorghum and millet. Figures for water use vary between these crops but an average of 1,000 tonnes of water per tonne of crop mass is used.

Figure 12: Ecotourism provides an additional income earning opportunity for rural communities *(Photo: Daniel Malzbender)*

In addition to agriculture and animal husbandry, ecotourism provides an additional, though modest, income earning opportunity. The scenic beauty of the Orange River Basin in Lesotho's mountain ranges has led to the development of ecotourism ventures (such as pony-trekking – see Figure 12) that, to some extent, involve the surrounding communities and contribute to their incomes.

Lesotho's consumptive use of its available water resources is low – around 0.05 cubic kilometres per year, out of a total of just over five cubic kilometres available (FAO Aquastat, 2005). There are, however, plans to meet the growing water needs of the capital Maseru through the development of the proposed Metolong dam. As part of the Lesotho Highlands Water Project (LHWP) (see Box 1), Lesotho uses some water (non-consumptively) for hydro-power generation, which is meant to increase with the completion of further phases of the project.

The most significant benefit Lesotho derives from the Orange River water is from the transfer of water into South Africa through the LHWP, currently at around two cubic kilometres per year, earning the country sufficient income to completely pay off its foreign debt, making it one of the few countries in Africa with no foreign debt to service. With the realisation of further phases of the project the amounts of water delivered to South Africa will increase as will the sale of electricity generated in Lesotho through the LHWP infrastructure. Lesotho's royalty income from water delivery and electricity sales will make the water resources of the

Orange River Basin an even more important factor for the national economy, even though the country does not use most of the water for itself.

In recent years the mining industry in the country has been developed. The Letseng diamond mine, the world's highest at 3,200 metres above sea level, has started producing some of the largest diamonds in the world (The Times, 2005). The mining activities have started providing jobs to people in the Highlands area, although there are possible environmental impacts associated with the mining operations (see Figure 13).

Figure 13: Blasting from mining operations contributes to soil erosion in the upper reaches of the basin *(Photo: Peter Whitelock)*

South Africa

South Africa is by far the biggest user of the water resources of the Orange River Basin. Overall, most of the water is used for irrigation purposes, with mining, industry and domestic consumption being the other main users. Whilst irrigation is the main utilisation along the main stem of the Orange River, mining, industry and domestic consumption are the main factors in the Vaal River Basin, as the following regional breakdown will illustrate.

The Vaal River

The Vaal River Basin, which forms part of the Orange River Basin, is the heartland of South Africa's economy. More than 25% of South Africa's GDP is produced in this area and the basin supports a population of about 12 million people (DWAF, 2004c). Water transfers into and out of the Vaal River Basin are part of the highly developed infrastructure of the basin. The substantial transfers into the Vaal Basin from Lesotho show the great significance of the LHWP for South Africa's economy.

Large urban and industrial areas, including parts of Johannesburg, Vereeniging, Vanderbijlpark and Potchefstroom, account for the greatest amount of water use in the eastern parts of the Vaal Basin. Although some mines have become inactive there are still some large mining operations in the area which constitute a further large water user group.

Further westwards important water users are the urban areas of Klerksdorp, Welkom and Kroonstad and mining is the dominant economic activity. Agriculture becomes more prevalent compared to the eastern parts of the Vaal Basin and is characterised by extensive dry-land agriculture. Irrigated agriculture is practiced downstream of dams along the main tributaries and the main stem of the Vaal River (DWAF, 2004c).

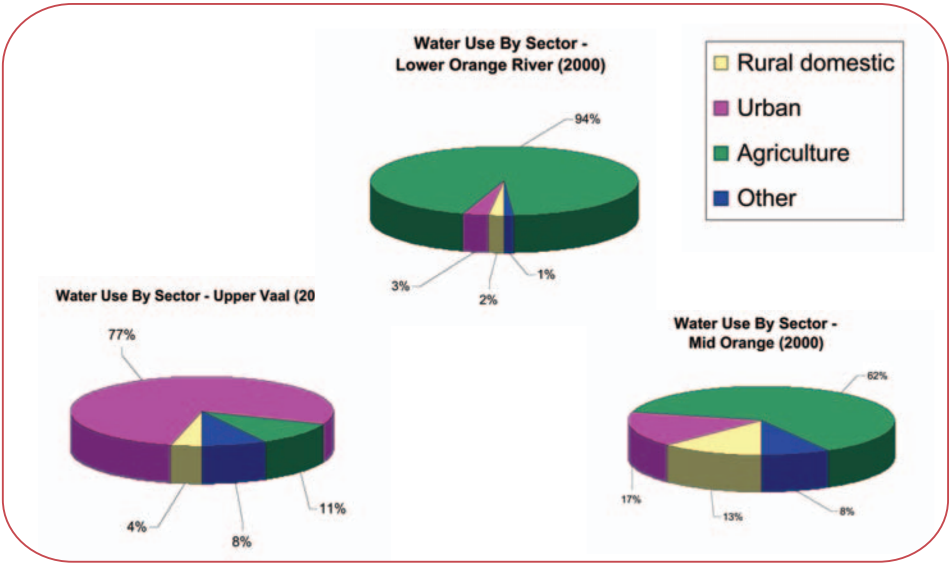

Figure 14: Water use by sector in the Orange River sub-catchments (note the high "Urban" water use in the Upper Vaal) *(DWAF, 2004)*

Further west, towards the confluence with the Orange River, agriculture becomes the most important economic activity and intensive irrigation scheme such as the Vaalhartz Government Irrigation Scheme account for much of the water used (DWAF, 2004c). The diamond mining operations around Kimberly account for most of the non-agricultural economic use in the area. Kimberly is also the largest urban area in this region and accounts for most of the household water use.

The Orange River

The distribution of water use between different sectors differs substantially between the Vaal River area and the Orange River (see Figure 14). Generally speaking mining, other industries and urban water use is less significant and commercial agriculture is by far the biggest user of water in these parts of the basin. Along the Middle Orange, (defined for this study as the area from the South Africa/Lesotho border to the Vaal/Orange confluence), mining activities have declined and the only considerable urban and industrial developments are Bloemfontein and Thaba 'Nchu. The production of grains and commercial livestock farming are the main agricultural activities. Along the main river, large areas under irrigation have been developed, mostly for the growing of grain, fodder crops and grapes (DWAF, 2004a).

This stretch of the Orange River includes the two largest dams in South Africa, the Gariep dam and the Vanderkloof dam. These dams form the major storage reservoirs along the Orange River and are essential for the regulation of stream flow in the lower Orange River. A significant amount of water from the Orange River is transferred from the Gariep dam into the Fish River catchment in the Eastern Cape to supply irrigation requirements for about 51 500 ha in this province as well a part of the requirements of the city of Port Elizabeth. When released from the Gariep and Vanderkloof dams the water is used for hydropower generation and forms part of Escom's (the national electricity supplier) capacity to meet peak electricity demands.

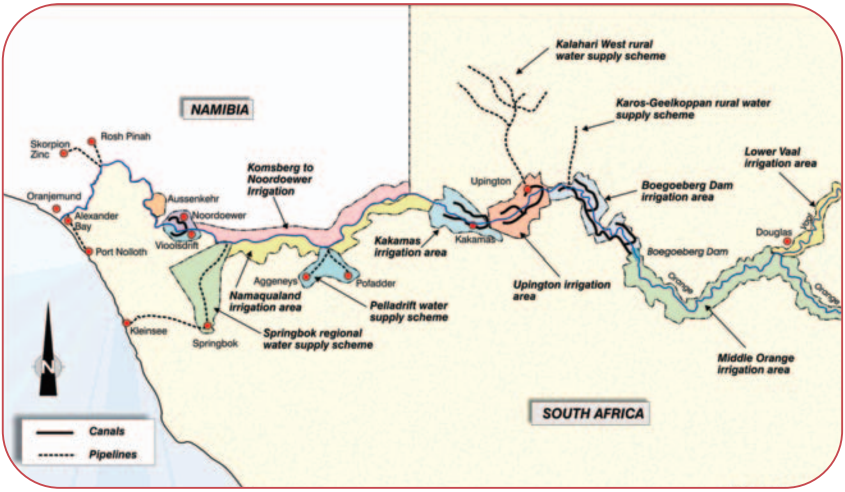

Figure 15: Areas under irrigation and water supply schemes in the South African part of the lower Orange River Basin *(Source: DWAF, 2004d)*

In the Lower Orange River area, (the area from the Orange/Vaal confluence to the river mouth at Oranjemund), the significance of commercial agriculture as a user sector becomes even greater. There are no large urban areas in this region and the water requirements for Upington and Kakamas, as well as the inland towns served by supply schemes from the river, such as Sprinkbok and Port Nolloth, are comparatively small. Although mining is an important economic factor in this region, the amount of water used by mining operations is negligible compared to the amounts required for the various irrigation schemes along the river. Figure 14 shows that irrigated agriculture accounts for 94% of the current total requirement for water of 1, 130 million m^3/yr (DWAF, 2004b).

Unlike the Middle Orange, where most irrigation is used for the production of lower value crops such as grains and fodder, irrigated agricultural production in the lower parts of the basin concentrates on high value crops such as citrus, table grapes as well as pistachios and pecan nuts. As far as commercial agriculture is concerned, the value created per unit of water is thus much higher here than in other parts of the basin.

An important feature of the Lower Orange River Basin is the importance of groundwater. In the areas away from the main stem of the river, about 60% to 70% of the available water is supplied from groundwater. Groundwater also constitutes an important source for rural water supplies and is frequently the only available source of water (DWAF, 2004b). Whilst some of these areas are conservation zones (Kgalagadi Transfrontier Park, Augrabies National Park and Richtersveld National Park) extensive farming of sheep and goats, both commercial and subsistence, is the main economic activity in these regions.

Namibia

The water requirements in the Namibian part of the basin are similar to the ones of South Africa in the Lower Orange River Basin. The domestic use of water is relatively small and there is currently no significant industrial development. Diamond mining takes place in the restricted area at the Atlantic coast and two zinc mines are in operation. Additional water will be required in the future for the development of the proposed Kudu gas field power station at Oranjemund (Heyns, 2004). The main user of the Orange River water allocated to Namibia (currently 110 M m^3/yr until 2007, thereafter the amount will be renegotiated) is irrigated agriculture, most notably the table grape farm at Aussenkehr.

Botswana

The Botswana part of the basin is entirely covered by the Kalahari Desert and much of the area forms part of the Botswana part of the Kgalagadi Transfrontier Park. Outside the park the main economic activity is extensive livestock farming. The water requirements of these ranches are mainly met through groundwater, which due to the ephemeral nature of the Molopo River, is the only reliable water supply in this part of the basin.

Future water requirements

A comparison between the water demands at 1994 levels and 2005 levels indicates that the requirements that need to be supported from the Orange River Basin are increasing.

While total demand at 1994 level lies at about 3,5 km^3/yr, the total requirements at 2005 level, as determined by the Orange River Replanning Study, are estimated to be at just over 4,5 km^3/yr (see Figure 16).

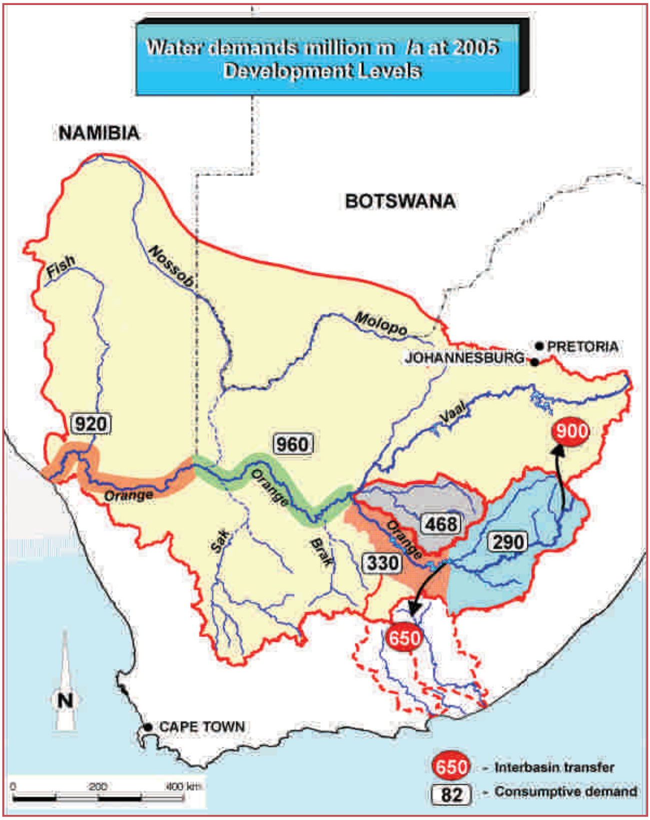

Figure 16: Future Water Demands *(Source: DWAF, 2004d)*

Of this 2968 million m^3/yr are estimated for consumptive use and 1550 m^3/yr are estimated for inter basin transfers into the Vaal River system from the LHWP and into the Fish River system from Gariep dam.

Future growth in water requirements will mainly result from planned developments in the Lesotho lowlands and the extension of irrigation in Namibia and South Africa. In South Africa the development of 12,000 ha of irrigation (4,000 ha each in the Middle Orange, the Lower Orange and the Fish River areas), has been approved for poverty relief and the settlement of emerging farmers (DWAF, 2004a). Based on the assumption of more equitable distribution of wealth in South Africa in the future, which in turn leads to higher average levels of water services, it is expected that the existing system will be fully utilised by 2020 (DWAF, 2004a).

The further development of the resource thereafter depends on the building of new infrastructure. In addition to the development of further phases of the LHWP a solution could lie in a re-regulation or storage dam that could be built on the lower Orange and for which assessments are currently conducted as part of the Lower Orange River Management Study (LORMS). It is estimated that such a dam could save up to 170 M m^3/yr in operational losses in the system. It is also envisaged that improved management by means of this dam could improve the environmental integrity of the Lower Orange, particularly the estuary, which has been designated a RAMSAR site by both Namibian and South Africa (Heyns, 2004).

The Hydropolitical Situation in the Basin

The Orange River Basin is of great importance to all four riparian states. Three of the basin states Botswana, Namibia and South Africa, are the most economically powerful in the southern African region and the previous section has shown that future economic development in both Namibia and South Africa is to some extent dependent on the utilisation of the resources of the Orange River. Lesotho receives a significant amount of its foreign exchange through royalty payments for water exported to South Africa under the LHWP. Lastly, Botswana's interest in the basin is largely of a strategic nature as leverage for concessions in other basins in which it has a more direct interest. It must be noted however that Botswana could be supplied by means of water transfer from the Lesotho Highlands Water Project at some time in the future, so it is strategically important that Botswana keep this option open.

The LHWP, situated in the Orange River Basin, is an example of arguably the most far-reaching water-related cooperation in the southern African region (Turton, 2003a; Turton & Earle, 2005). The ORASECOM agreement reached in 2000 is the first multilateral basin-wide agreement between all riparian states and the Orange-Senqu River Commission (ORASECOM) that is established by the agreement is seen as a major step towards international cooperation on matters relating to the utilisation and management of the basin.

Shortly after making its way through the gorge below the Augrabies Falls (see Figure 17), the Orange River forms the border between Namibia and South Africa, the exact delineation of which is currently contested (see Box 3).

Figure17 : Local legend holds that the gorge below the Augrabies Waterfall in South Africa is filled with diamonds *(Photo: Daniel Malzbender)*

But the advent of a multilateral body such as ORASECOM bodes well for the formalisation of the de-facto cooperation which has characterised the relationship between the two states.

Prior to the establishment of ORASECOM, international cooperation between the riparian states on matters concerning the Orange River Basin was usually bilateral. The first (bilateral) agreement in the Orange River Basin was signed in 1978 when a Joint Technical Committee (JTC) was established between South Africa and Lesotho to investigate the feasibility of the proposed LHWP (see Figure 18). In 1986 the Lesotho Highlands Water Project Treaty was signed – establishing two autonomous statutory parastatal bodies. The Lesotho Highlands Development Authority (LHDA) is responsible for the management of the dam construction and related issues within Lesotho itself while the Trans-Caledon Tunnel Authority (TCTA) is responsible for the management of the complex set of delivery tunnels into South Africa. In addition to these, a Joint Permanent Technical Commission

(JPTC) was established, consisting of delegates from both riparian states, with the responsibility of coordinating the two parastatals, as well as to report back to their respective governments. This regime was further strengthened in 1999 with the agreement of what became known as Protocol VI of the Lesotho Highlands Water Project Treaty, which upgraded the JPTC into the Lesotho Highlands Water Commission (LHWC).

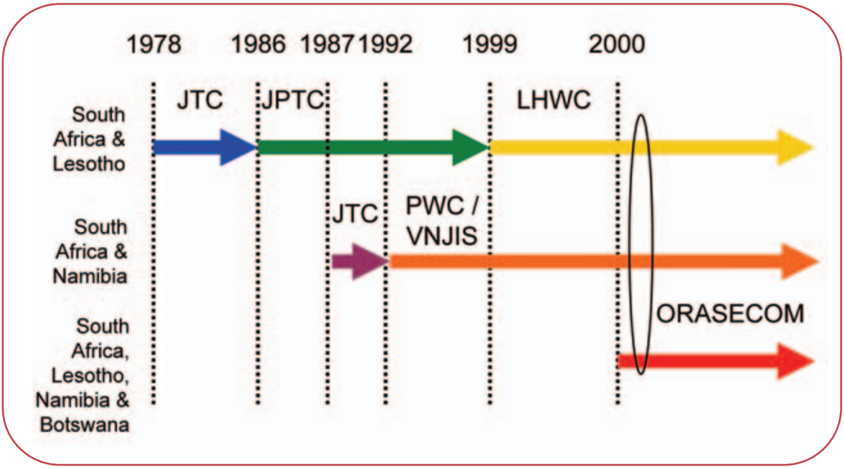

Figure 18: Historic Overview of Regime Creation in the Orange River Basin *(Source: Turton, 2003b)*

There was no bilateral regime creation with respect to the Orange River basin that involved Botswana. This is because bilateral cooperation always involved South Africa and one other, hydropolitically weaker riparian state. Although technically a riparian state, Botswana has contributed no stream flow in living memory and was therefore not included in bilateral cooperation efforts, which effectively were dependent on South Africa's approval. This changed after the conclusion of the multilateral ORASECOM agreement and Botswana is now represented along the other three riparian states. This opens the possibility for Botswana to possibly obtain water from Lesotho - or at least to keep that alternative open to future exploration (Turton, 2003b).

Box 3: The South African-Namibian border disagreement

Over about 550 km to the west of the 20 degree longitude the Orange River forms the border between South Africa and Namibia (DWAF, 2004a). In an agreement signed between the former colonial powers, Britain and Germany, on 1 July 1890 the border between The Cape of Good Hope Colony and German South West Africa respectively was established "by a line commencing at the mouth of the Orange river and ascending the north bank of that river to the point of its intersection by twentieth degree of east longitude". South Africa, following the OAU resolution adopted in July 1964 in which it was agreed to leave existing borders of African states unchanged as on the day of their independence, rejects any changes to the Northern Bank border. Namibia claims that during the run-up to Namibia's independence the two states had agreed that the border should be changed to the middle of the river - during the same process which saw the handing back by South Africa of the enclave of Walvis Bay (Turton et al, 2004). The delineation of the border has major implications for the use of the waters of the Orange River as the current border effectively deprives Namibia of independent access to the water. It is also important for the exploitation of off-shore marine resources, making it a matter of national interest for both countries. Although South Africa has repeatedly stressed that it will not object to the use of Orange River water by Namibia and although bilateral cooperation between the two countries is good, a solution to the border disagreement would be beneficial for joint basin management in the future.

The significance of this case study is that despite the existence of a sovereignty-related issue in the basin, this has never spilled over into the management of water resources. This suggests that water resource management is based on robust normative values of a highly cooperative nature.

On the lower basin, shared between South Africa and Namibia, a Joint Technical Committee (JTC) was established in 1987 to advise the South African government and the then South-West African Transitional government on matters pertaining to the Orange River, referred to as the Cooperation Agreement. In 1992 the JTC was upgraded when a treaty was signed between South Africa and (the by-then independent) Namibia, known as the Agreement on the Establishment of a Permanent Water Commission (PWC).

At the same time an agreement was signed on the establishment of a Joint Irrigation Authority (JIA) to implement the agreement on the Vioolsdrift and Noordoewer Joint Irrigation Schemes (VNJIS). This was followed in 1994 by the launch of the Orange River Replanning Study (ORRS). Initially intended to clarify South Africa's own priorities as a country study, formal invitations were extended to Namibia and Lesotho to participate. This caused officials in those countries some unease at the time because the study was not conducted under the auspices of a recognized international forum. After the inception of the ORRS however, Namibia undertook its own study, to be followed by Lesotho. While these two studies did not have observers from the other riparian states, the results were shared, helping create an improved climate of trust. Shortly after negotiations were then started between all of the riparian states, motivated largely by Namibia, on the establishment of a basin-wide regime. This came to fruition when the Orange-Senqu River Commission (ORASECOM) was formally established on 3 November 2000 under the ORASECOM agreement.

The Orange-Senqu River Commission (ORASECOM) is the fourth basin-wide regime to be established in southern Africa and the first under the SADC Protocol on Shared Watercourse Systems. The ORASECOM Agreement recognises the Helsinki Rules, the United Nations Convention on the Non-Navigational Uses of International Watercourses and the SADC Protocol on Shared Watercourse Systems. It also refers to the Revised Protocol on Shared Watercourses with respect to definitions of the key concepts "equitable and reasonable" and "significant harm". A dispute resolution mechanism is formally vested in the SADC Tribunal, which is a first for regime creation in the regional water sector. It is within this legal and institutional framework that ORASECOM has to balance the interests of the different riparian states in a cooperative manner.

The interests of Lesotho in the Orange River lie in sharing the benefits of using the Orange's water. In fact it can be said that Lesotho is not actually selling South Africa its water – rather it is selling hydraulic pressure and the advantages of high altitude storage in a deep dam with lower evaporative losses than possible elsewhere in the basin (Turton 2003b). Rather than allowing the surplus water to flow downstream unregulated across the border into South Africa, Lesotho benefits from the controlled delivery of the water to South Africa through LHWP infrastructure (Heyns, 2004). The financial benefits from the project to Lesotho, in the form of royalties, has improved the infrastructure in the country and makes a contribution to raising the living standard of Lesotho's predominantly poor

Figure 19: It is important that future water transfers from Lesotho benefit local communities *(Photo: Peter Whitelock)*

population. Thus, Lesotho has a strong interest in continuous international cooperation regarding the utilisation and management of the Orange River Basin.

South Africa has to meet increasing water demands for the growing population in its urban and economic centres situated in the Vaal River Basin - needs which can be met through the transfer of water from Lesotho. It is thus likely that South Africa and Lesotho will continue the current fruitful cooperation for mutual benefit. A similar situation might arise between Botswana and Lesotho with water supply to Botswana's capital Gaborone from Lesotho (via South Africa) being a possibility. Whether and how this would impact the available supply for South Africa and thus on the hydropolitical situation, essentially depends on the actual amounts conveyed and is not possible to predict with certainty at this stage.

Besides a possible water supply option from Lesotho to Gaborone, Botswana's interests in the basin are of a diplomatic, strategic nature. Its inclusion in ORASECOM gives Botswana a wide range of diplomatic options by allowing concessions to be granted to other riparian states in return for political support in River Basin Commissions where they have a greater strategic interest such as in the Limpopo and Okavango basins (Turton, 2003a; 2003b). This makes Botswana the balancer of political power in ORASECOM, with bargaining positions either in support of Namibia (in return for concessions elsewhere such as in the Okavango and Zambezi River basins), or in support of Lesotho (in return for future concessions such as the supply of water to Gaborone).

Namibia's interest in the basin is similar to that of South Africa and is directed at using more water from the lower Orange River for economic development in agriculture, mining and tourism. It would thus appear that the hydropolitical situation is most sensitive between these two states and the ongoing border disagreement, which is essentially a dispute regarding access to the water of the Orange River, bears witness to this.

There is evidence that the experience gained bilaterally between South Africa and Lesotho in the LHWC and between South Africa and Namibia in the PWC, has started to contribute to the growth of institutional knowledge. A specific component of this process was the ORRS, which created a basin-wide set of relatively undisputed hydrological data.

Article 5 of the ORASECOM Agreement contains a number of measures that are conducive to the process of institutional learning and the development of knowledge. This has subsequently led to a much improved spirit of trust between the riparian states and all parties are determined to strengthen cooperative efforts for integrated transboundary management of the Orange River Basin. Based on these experiences it appears that ORASECOM is likely to be in a good position to address the upcoming challenges in a cooperative manner. The decision taken in 2004 by the ORASECOM states to form a permanent secretariat will further contribute to the promotion of good governance in the basin.

Environmental issues in the basin

Given the length of the Orange River, combined with its range of altitude and climacteric zones, the basin covers a wide range of ecological systems (Turton, 2003a; 2003b), and can be regarded as being a linear oasis (Ashton, 2000). Its bio-geographical isolation means that potential for re-colonisation from adjacent rivers and wetlands is very low. The river biota is therefore unusually susceptible to the permanent loss of species (DWAF, 1999).

The Orange River basin includes sections of several biomes, but is predominantly made up of:
• Grasslands (subdivided into dry and montane grasslands)
• Nama karoo; and
• Arid savannah biomes (Bohensky et al, 2004).

These biomes contain a vast array of faunal and floral species variety with several endemic species. They also comprise areas facing environmental threats, such as the extinction of species and changes brought about by desertification.

The economic utilisation of the Orange River's water as well as the land use patterns in the basin strongly influences the environmental state of the river basin. In this context four issues are of particular significance, namely the problem of soil erosion and wetland losses (see Box 4 and Figure 20) in Lesotho, the impact of industrial and municipal effluent in the Vaal River system, agricultural pollution in the Vaal and Orange River and the environmental threats to the Orange River Estuary Ramsar site at the mouth.

Soil erosion and wetland degradation

The most severe ecological problem in the upper reaches of the Orange River is the high degree of soil erosion experienced in Lesotho. Approximately two percent of top-soil is lost in the country each year with adverse effects on habitats as well as agricultural productivity.

Figure 20: Soil erosion in the headwaters of the basin creates sedimentation of downstream dams *(Photo: UN Office for the Coordination of Humanitarian Affairs)*

In its natural state the mostly treeless landscape in Lesotho is vulnerable to soil erosion, particularly during the hard summer rain storms. The natural vulnerability is intensified by the impact of unsuitable agricultural practices and overgrazing. As a result of the cultivation of areas not suitable for agriculture, wind erosion, mostly during winter when fields lie bare, adds to the soil losses caused by the summer rains. Population growth, the return of migrant workers from South Africa gold mines (as old mines retrench workers & new ones become more capital, rather than labour intensive) and movements due to the flooding of land by the Lesotho Highlands Water Project dams has placed more pressure on agricultural land.

As a consequence of the increased need for farm and grazing land the recovery cycle of the natural grassland vegetation is shortened, leading to a degradation of the vegetation cover and subsequent soil erosion. The building of the Katse dam has also exacerbated the situation since the filling of the dam flooded large areas of farm and grazing land and required the relocation of 24,000 people. The loss of these agricultural areas, together with the above-mentioned increased land needed for the returning miners has forced the people to move onto the higher reaches of the mountains and farm the steeper slopes. The topography of these areas is even less suitable for agriculture and livestock farming and soil erosion has subsequently worsened.

Box 4: Lesotho's wetlands

The wetlands in the Lesotho highlands are of great importance for the environmental integrity of the Orange's upper reaches. They accumulate run-off from the surrounding mountain slopes and regulate the release of water into the river systems (LHDA, 1996). Through their filtering system they contribute to the maintenance of the required water quality and quantity in streams and springs. In addition to their important role for the river systems they are unique habitats, which represent a large part of the country's biodiversity.

In recent decades the wetlands in Lesotho have seriously degraded and more wetlands are under threat. The most common causes for wetland destruction are overgrazing, the building of roads and the encroachment of settlements (Mdee, 2004). Where wetlands disappear, rivers and streams are subject to flash floods and consequent soil erosion (LHDA, 1996). Together with rapid increase in soil loss the loss of diversity of flora and the extinction of species (that are restricted to this habitat) can be observed (LHDA, 1996).

Efforts to curb erosion thus far have had limited success. The lack of alternative energy sources (only around three percent of the population has access to electricity) makes firewood the only option for most rural people, a situation which has severely undermined tree planting projects. The main key to curb erosion, the reduction of cattle herds to reduce overgrazing, is difficult to implement due to the economic importance and cultural significance of large herds of cattle for the Basotho.

Industrial and Municipal pollution

Whilst the water quality of the Orange River upstream of Gariep dam is good (River Health Programme, 2003) it deteriorates downstream of Gariep dam and particularly after the confluence of the Vaal River with the Orange River. Water quality is in many instances coupled with water quantity as the ability of the river to absorb wastes decreases with a drop in the flow volume. Large amounts of municipal and industrial effluent are released into the Vaal River in Gauteng. This includes phosphates from sewage treatment plants, as well as nitrates from industrial processes, with a specific hot-spot around the East Rand area that includes the SASOL Secunda plant (see Box 5).

Water quality problems resulting from agricultural activities

There are two main water quality related issues that can be identified in connection with agricultural activities in the basin. The first one is the increasing siltation as a result of the soil erosion in the upper regions, mainly in Lesotho. The increase in soil erosion has started causing downstream dams to accumulate silt at a higher rate than before. These dams supply commercial farmers and municipal areas in South Africa with water and would impact on a planned dam on the portion of the river shared with Namibia. The higher silt loads cause problems for the operation of the dams as well as contributing to the formation of sandbars in the river mouth, disrupting the interchange of ocean water with the river water. This has a negative impact on the marine ecosystem of the Benguela current.

The second is the problem of increased loads of salts and nutrients such as nitrates and phosphates released by farming operations (see Box 6). When used for irrigation, a substantial amount of water is lost through evapotranspiration, leaving the salts that naturally occur in water (even freshwater) in the soil. Once it rains these concentrated salts are washed out and reach the river as return flows. As the losses through evapotranspiration are higher than the replenishment through naturally occurring rainfall, the overall salt concentration in the river is increased, with negative consequences for the river's ecosystem as well as for crop production further downstream.

Figure 21: The return flows from large-scale irrigation lead to increased levels of salinity in the Orange River *(Photo by Turton)*

The large-scale use of fertilizers by commercial agriculture leads to substantially increased levels of phosphates and nitrates in the river. These degrade the quality of the water for downstream users, such as municipalities, communities and farmers and affect river ecosystems through the build-up of nutrients (see Box 6).

Box 5: Water quality problems resulting from mining activities

Parts of the basin, specifically associated with the Vaal sub-catchment, are closely associated with mining. Many of these mines are now reaching the end of their operational life, resulting in a range of highly complex water quality related problems starting to emerge. One of these problems is associated with acid mine drainage (AMD) and acid rock drainage (ARD). Working faces of the mines come into contact with water and oxygen. This stimulates the growth of certain bacteria, which combined with specific chemical processes, result in the development of low pH and high sulphate leachate. Similar things happen when water drains off (or leaches through) mine tailings dams, or dumps of waste rock. This situation is becoming increasingly problematic as more mines are closing down. As these workings get flooded, they start to decant into streams. By virtue of their linkage underground – a safety feature needed when the mines were still operational –

these workings result in a major disturbance to the "normal" subterranean flows of water. Another problem is related to the presence of radioactive nuclides associated with uranium (Wade et al., 2002). In the geology of the highveld, gold bearing reef is closely associated with the presence of uranium. When the gold is extracted, the uranium is disturbed, with pathways back into the environment occurring via slimes dams and through decanting operations. This radioactivity has been found in the sediment of some of the river systems. What is not yet known is how this will be introduced into the water column (say as the result of extreme events), or how this will enter the human food chain (say as the result of the ingestion of fish that have been contaminated by eating insects etc). This is a sensitive issue with many authorities reluctant to discuss it in the open. There is one known case of potential litigation pending, but this has not yet entered the court systems of South Africa.

The state of the Orange River Estuary

The estuary of the Orange is proclaimed a Ramsar site by both South Africa and Namibia and is regarded as the sixth most important coastal wetland in southern Africa in terms of the number of birds supported, at times as high as 26,000 individuals from up to 57 species (DWAF, 2004d).

Box 6: Excessive nutrients and algae

Although nutrients are essential to the health of aquatic ecosystems, excessive nutrient loadings negatively affect water quality and habitats by encouraging the growth of aquatic weeds and algae. Algae are normally an essential component of life in water bodies, however, they respond rapidly to nutrient enrichment. When large numbers of these plants die and decay, they dissolve oxygen in the water leading to an increase in fish kills as the oxygen content of the water drops (River Health Programme, 2003). The so-called "blue-green algae" (Cyanobacteria – they are not algae but bacteria and are only conveniently referred to as "blue-green algae" because they are photosynthetic and aquatic) are a particular problem for water quality because they cause taste and odour problems and produce toxins that kill livestock and fish and can even severely affect human health (River Health Programme, 2003). Algae blooms have become a visible water quality problem in South African rivers, including the Orange River.

Figure 22: The estuary of the Orange River *(Photo by Allan)*

To date the environmental impact caused locally at the river mouth is very low, consisting merely of some recreational use by personnel of the mining organisations. Proposed new economic developments close to the river mouth, such as the Kudu gas field power station, are likely to increase the demand for water from the lower Orange River and could potentially have further adverse effects on the river mouth wetland. The environmental threats to the river mouth currently result primarily from economic activities upstream and the change of the river flow regime through damming of the river.

Like the rest of the lower Orange River the river mouth is to some extent affected by the pollution caused by industrial and municipal effluents as well as agricultural pollution. However, the most significant threat to the Orange River mouth wetland is the loss of inflow of water and sediment due to the upstream damming of the river. The two major dams on the middle reaches of the Orange River, the Gariep and the Vanderkloof dam already limit floods in the lower Orange River to events of very large magnitude and also act as traps restricting the quantity of sediment moved downstream of the middle reaches (DWAF, 1999). The potential building of further dams as part of the LHWP and the subsequent increase in water transfers out of the Orange River system would result in a further inflow reduction. The lack of flow variability and the overall reduction in water volume poses a serious threat to the integrity of the river mouth wetland.

As the area is declared a Ramsar site by South Africa and Namibia the two countries are under an obligation to undertake the necessary measures for the protection of the river mouth. In this regard it is claimed that the building of a dam in the lower Orange River could improve the flow management of the lower part of the river and ensure that sufficient amounts of water are released into the system at all times, which would maintain the integrity of the river mouth ecosystem.

In September 1995, Orange River mouth wetland was placed on the Montreux Record (a record of Ramsar sites where changes in ecological character have occurred, are occurring or are likely to occur) following the collapse of the salt marsh component of the estuary (South African Wetlands Conservation Programme, 1998). The rapid degradation of the salt marsh was the result of a combination of impacts, both at and upstream of the wetland. These included adjacent diamond mining activities, flow regulation of the Orange River as a result of dam construction, mosquito control measures and poor management of the mouth. The result of the collapse of the salt marsh, and the general decline of the mouth in general, has been a significant decrease in the number of waterfowl using the wetland. The impact of the decline in ecological functioning on fish species using the estuary and salt marsh is unknown. It is however suspected that the loss of such an integral component of the wetland system cannot fail to impact on these species. A concerted effort will need to be made in the coming years to ensure that the estuary retains its ecological integrity.

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Ephemeral rivers in the Namibian and Botswanan parts of the catchment, despite their infrequent and intermittent flow patterns, support a range of ecosystems *(Photo:Thomas Petermann)*

The area around Johannesburg in South Africa, although primarily devoted to industrial activities, also contains a surprising amount of agricultural land *(Photo:Thomas Petermann)*

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AWIRU operates in unison with the goals of the New Partnership for Africa's Development (NEPAD), aiming to strengthen transboundary water governance at all levels throughout southern Africa. Cooperation over water resources shared between states, regions and economic sectors can spill over into enhanced regional integration. AWIRU operates at the cutting-edge of Transboundary water management initiatives in southern Africa, being involved in ongoing negotiations, capacity building and research initiatives with a range of stakeholders in the region.

For more information on AWIRU activities consult: www.up.ac.za/academic/libarts/polsci/awiru

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