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Orange River Integrated Water Resources Management Plan

Demographics and Economic Activity in the four Orange Basin States

ORASECOM 008/2007
Date Submitted: November 2007

WRP (Pty) Ltd, Jeffares Green Parkman Consultants (Pty) Ltd,
Sechaba Consultants, Water Surveys Botswana and
Windhoek Consulting Engineers
in association

WRP_FC/0816.cdr

Study Name:	Orange River Integrated Water Resources Management Plan
Report Title:	Demographic and Economic Activity in the four Orange Basin States
Submitted By:	WRP Consulting Engineers, Jeffares and Green, Sechaba Consulting, WCE Pty Ltd, Water Surveys Botswana (Pty) Ltd
Authors:	D Hall, G Jennings
Date of Issue:	August 2007
Distribution:	Botswana: DWA: 2 copies (Katai, Setloboko)
	Lesotho: Commissioner of Water: 2 copies (Ramosoeu, Nthathakane)
	Namibia: MAWRD: 2 copies (Amakali)
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LIST OF ABBREVIATIONS

Acronym	Description
AIDS	Acquired Immune Deficiency Syndrome
ART	Anti Retroviral Treatment
ASSA	Actuarial Society of South Africa
BMR	Bureau of Market Research
BNWMP	Botswana National Water Master Plan
BSO	Bureau of Statistics (Lesotho)
CAS	Census Administration System
CBDC	Cross-boundary District Council
CBLC	Cross-boundary Local Council
CSO	Central Statistics Office
DBSA	Development Bank of South Africa
DC	District Council
DHS	Demographic Health Systems
DM	District Municipalities
DMA	District Management Area
DWA	Department of Water Affairs (Botswana)
DWAF	Department of Water Affairs and Forestry (South Africa)
EA	Enumerator Area
EC	Eastern Cape
FS	Free State
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GOB	Government of Botswana
GPS	Global Positioning Systems
HIV	Human immuno-defiency virus
HSRC	Human Sciences Research Council
IT	Information Technology
IWRMP	Integrated Water Resources Management Plan
KZN	KwaZulu-Natal
LDS	Lesotho Demographic Survey
LLWSFS	Lesotho Lowlands Water Supply Scheme Feasibility Study
LM	Local Municipality
Metro	Metropolitan area
MP	Mpumalanga
MRC	Medical Research Council
NC	Northern Cape

Acronym	Description
NP	Limpopo (former Northern Province)
NW	North West
ORASECOM	Orange / Senqu Commission
PES	Post Enumeration Survey
PMTCT	Prevention of mother-to-child transmissions
RVWSDM	Rural Village Water Supply Design Manual
SAMP	South African Migration Project
SIAPAC	Social Impact and Policy Assessment Corporation
STATSSA	Statistics South Africa
TAMS	TAMS Consulting Engineering
TFR	Total Fertility Rate
TOR	Terms of Reference
UNAIDS	The joint United Nations programme on HIV/AIDS
USAID	United States Aid for International Development
WC	Western Cape

SECTION ONE

DEMOGRAPHICS

1 INTRODUCTION

This report is the main output of Task 10 of the ORASECOM study. The Terms of Reference (TOR) specify that for this task the consultants should: "Obtain available information on the population distribution, population growth and demographic movements". Further to this, the TOR required the consultants to: "Provide an overview of economic activity in the Orange River Basin, and highlight potential economic stimulants and growth areas (and) include a discussion on the economic value of water for different uses".

This report presents first the demographic aspects of Task 10, and then looks at the key economic activities in the Basin followed by a discussion of economic value of water for different users.

The activities proposed in the TOR to meet the demographic objectives of Task 10 included:

- A review of Census data in all countries;
- A review of post-census reports, particularly those dealing with the impact of HIV/AIDS;
- The creation of a basic demographic map showing variations in population density and growth;
- A review of reports dealing with key areas of economic activity, particularly of water-dependent sectors;
- A review of websites with electronic data and / or reports; and
- The noting of future links from the Information Database to be established as part of Task 2.

As can be seen from the above list, Task 10 is not intended to generate a definite report on the demographics of the Basin but rather to review existing data and reports. In conducting the review the consultants have been able to comment on issues pertaining to data quality, accessibility and gaps. This information can be used in the preparation of comprehensive demographic analysis that will form part of the Integrated Water Resources Management Plan (IWRMP). The Consultants have also been able to go beyond the requirements of the TOR to provide details on the broad demographic trends of the region. This report begins with an overview of these trends and then provides detailed information on Botswana, followed by Lesotho, Namibia and then South Africa.

The section on South Africa is significantly more detailed, partly due to the volume of available data, but also due to the largest proportion of the Basin's population being resident in South Africa. The final sections of the demographic part of the report look specifically at the crosscutting themes of migration, gender and data sources.

The sections dealing with economic activities and the value of water are presented in a way that is intended to highlight key issues and stimulate debate regarding the future management of the Basin's water resources. As will be seen, this is not intended to be a comprehensive listing of all economic activities, but rather an introduction to major themes. As one of the ORASECOM Commissioners put: "Please don't throw the Gauteng Yellow Pages at us."

2 OVERVIEW OF DEMOGRAPHIC TRENDS IN THE BASIN

The review of reports and data undertaken by the demographic team reveals a number of trends that will need to be examined in greater detail when the IWRMP is drawn up. Before looking at these, it is pertinent to note that the Basin as a whole is home to some 15.7 million people, the vast majority of whom (85%) live in South Africa. Botswana and Namibia have relatively few people living in the Basin (0.3 and 1.1 respectively), while Lesotho's entire population is in the Basin, making up just over 13% of the total number in the Basin.

Table 1: Population of the Orange River Basin 2001

Country	Total Population	Number in Basin	% in Basin	% of Number in Basin
Botswana	1,680,863	47,661	2.8	0.3
Lesotho	2,127,539	2,127,539	100	13.5
Namibia	1,830,330	163,093	8.9	1.3
South Africa	44,819,778	13,357,298	29.8	84.9
Total	50,458,510	15,738,115		100

Source: Country specific reports based on 2001 figures

As will be seen later in this report, although there is considerable variation in the number of people each country 'contributes' to the Basin, they share numerous similarities with regard to demographic trends. In all cases the following can be observed:

Urbanisation: All Basin states are undergoing rapid urbanisation driven primarily by high levels of unemployment in rural areas and perceived work opportunities in urban areas. This results in rural areas experiencing out-migration (population declines), whilst urban areas – especially major conglomerates – witness growth rates well in excess of the national averages.

Migration: Internal migration is closely associated with urbanisation, with all major urban centres within the Basin states experiencing growth at the expense of their rural hinterlands. However, the Basin is also a magnet for international migrants and attracts people from well beyond the national borders of the Basin states. This is particularly the case for the Gauteng province of South Africa, which is the economic hub of the region. However, even in sparsely populated parts of Namibia, sudden demographic shifts can occur in response to new economic opportunities such as the opening of a mine.

Declining fertility: Fertility rates have been in decline in all Basin states for at least a decade. This is attributed partly to increased access to education, contraceptive prevalence and (in some cases) improved economic status. However, the HIV/AIDS pandemic also contributes to this, as women of childbearing age succumb to the disease.

HIV/AIDS: Without exception, all the Basin states have been severely impacted by HIV/AIDS, with Botswana and Lesotho being particularly hard hit. While high prevalence rates will have a long-term demographic impact on national growth rates, they are unlikely to significantly reduce the growth of key urban areas due to the high demand for jobs and the availability of a large unemployed (or underemployed) workforce.

These key trends need to be closely monitored as the IWRMP is developed and eventually implemented. The reason for this is the rapidly changing socio-economic environment that can have major impacts on demography within a relatively short time. For example, should Anti-Retroviral (ARV) medication become available on a wide scale in the next decade, mortality rates will decline and the current population projections will need to be adjusted. Equally important, regional migration patterns could be suddenly changed by, for example, improvements in the political situations of countries such as Zimbabwe which could result in a decline (or even a reversal) in the number of international migrants moving to Gauteng. Likewise, the decline of particular industries (such as diamond mines in the Northern Cape or the garment industry in Lesotho) could have significant consequences for local population movements. In short, demographic trends are highly susceptible to forces of change in the broader environment and must be constantly monitored. This immediately implies a need for good quality data that is frequently collected or updated and made easily accessible to policy makers. Determining the status and availability of such data has been the main undertaking of Task 10 and is the focus of subsequent sections of this report.

3 BOTSWANA

3.1 Introduction

The review of existing demographic information showed that, in the case of Botswana, much of the data – and related background information – is available electronically through the well-managed and presented web site of the Central Statistics Office (CSO) (www.cso.gov.bw). The availability and accessibility of the data will be advantageous in the preparation of the IWRMP. In this section of the report we briefly describe the history of census taking in Botswana and present the key findings from the latest census of 2001. Thereafter we consider some of the control measures that have been put in place to help ensure the relatively high standard of census data. Mention is also made of other related studies and the impact of the HIV/AIDS pandemic is discussed. Finally, information is provided on the relatively small population that live within the part of the country that is located in the Molopo basin which is a tributary of the Orange River Basin.

3.2 History of Census Taking in Botswana

According to the CSO, census taking in Botswana can be traced back to the beginning of the twentieth century. The first census was held in 1904 shortly after the Anglo-Boer war. Despite many difficulties, such as fear and suspicion on the part of the population, poor communication and the fact that the country was large and sparsely inhabited, the exercise provided insights that made the later censuses easier.

With no wars or disturbances, the Bechuanaland Protectorate joined the rest of the British Empire in conducting the 1911 and the 1921 decennial censuses. In view of the worldwide economic depression of the late twenties and early thirties, there was no census in 1931. The census was held in 1936 instead. The reliability of the 1936 Census results were questioned, mainly because the district figures were too different from the 1921 Census figures. The questionnaire for the 1946 Population Census was much longer and more complicated than previous ones and this meant that tabulation preparation dragged on towards the preparatory time for the 1951 census. As a result, the 1951 census was delayed until 1956. With the urgent need for information on which to base development plans and accurate population figures for constituency delimitation, the 1964 Population Census was conducted. This was the first to follow a house-to-house canvassing method.

Following the attainment of independence in 1966 it was found necessary to return to a year ending with 0 or 1 as recommended by the United Nations, hence the next census

was re-scheduled for 1971. The 1971 Population Census was the first to be conducted on a *de facto* basis with the idea of enumeration areas being applied for the first time in Botswana's census history. In terms of the quality of data obtained and the wide subject coverage, it was an important census for future planning. It also provided a basis for sampling in later surveys.

According to the CSO, the 1981 Census was the first one to include a housing component in its questionnaire. In view of better cartographic support, effective publicity campaigns and stronger administrative backing, as well as an improved level of education, the 1981 Census could be considered as having had better coverage than the 1971 Census. The 1991 Population and Housing Census is considered by the CSO to be "another success story" as it had even more comprehensive coverage of topics and the cartographic work had greatly improved, resulting in very few incidents of locality omission during enumeration.

The summary of census results from the 1904 to 1991 is presented in the Table 2 below:

Table 2: Botswana Population Census Results: 1904 - 1991

Year	Population	Growth Rate %
1904	120 776	
1911	124 350	0.5
1921	152 983	2.0
1936	265 756	3.8
1946	296 310	1.1
1956	309 175	0.4
1964	549 510	7.5
1971	596 994	1.2
1981	941 027	4.7
1991	1,326,796	3.5
Source: Government of Botswana, CSO.		

In 2001 Botswana's census formed part of the SADC 2000 Census Project. This project has the aim of harmonizing all census-taking activities for better comparability of demographic characteristics within SADC. Although resources are pooled and common questions shared, countries are still free to add-in their own specific topics to the regional minimal set.

The key findings from the 2001 Census are summarised in the table below. These are broken down by administrative districts, the key areas of interest to the ORASECOM project being the South and South East.

Table 3: Botswana 2001 Census Results by Administrative District

Code	District	Area Sq. Km	Households	Non-Inst. Population	Institutional Population	Total Population
01	Gaborone	169	58,476	181,627	4,380	186,007
02	Francistown	79	23,124	81,003	2,020	83,023
03	Lobatse	42	8,523	28,801	888	29,689
04	Selibe Phikwe	50	15,258	48,825	1,024	49,849
05	Orapa	17	2,578	8,306	845	9,151
06	Jwaneng	100	4,681	14,559	620	15,179
07	Sowa	159	979	2,726	153	2,879
10	Southern	28,470	37,202	170,981	671	171,652
20	South East	1,780	14,780	59,877	746	60,623
30	Kweneng	31,100	52,578	227,986	2,349	230,335
40	Kgatleng	7,960	17,054	73,199	308	73,507
50	Serowe/Palapye	31,381	33,969	151,884	1,151	153,035
51	Central Mahalapye	16,507	23,730	108,324	1,487	109,811
52	Central Bobonong	14,242	15,057	66,602	362	66,964
53	Central Boteti	33,806	10,363	47,738	319	48,057
54	Central Tutume	46,140	27,168	122,696	818	123,514
60	North East	5,120	10,834	49,249	150	49,399
70	Ngamiland	86,400	16,129	72,926	2,144	75,070
71	Okavango	22,730	10,184	49,189	453	49,642
72	Chobe	20,800	4,600	16,547	1,711	18,258
80	Ghanzi	117,910	7,776	32,707	463	33,170
90	Kgalagadi South	32,800	5,679	25,617	321	25,938
91	Kgalagadi North	72,400	3,984	16,067	44	16,111
	Total	581,730	404,706	1,657,436	23,427	1,680,863

From the above it is apparent that although Botswana contributes relatively small amounts of surface water to the Orange River Basin (via the Molopo river catchment), it also has a relatively small population.

3.3 Quality Control Measures

As there can be considerable variations in the quality of census exercises it is prudent to look at what quality control measures were put in place for the most recent census. In the case of Botswana it is apparent that considerable effort was made to ensure both public support and quality.

3.3.1 Census Committees

The case of Botswana demonstrates a high level of political will with regard to the national census. This is very apparent from the measures put in place for the 2001 Census. For example, in order to ensure that activities were kept on track, the CSO put in place a Census Technical Advisory Committee (comprising experts from Government Ministries, Para-statals and Research Institutions) overseen by the Census Central Committee (membership comprising Permanent Secretaries), which endorsed the topics for inclusion in the census. Subsequent to that, Cabinet approved the topics in June 2000. Then, in July 2000, a National Census Communications Committee, with associated lower level committees in the districts, was formed.

Particular measures taken to ensure quality included the following:

- Launching of census education and publicity campaigns.
- Mapping and listing of all settlements.
- Delineation of Census Districts; Enumeration and Supervision Areas.
- Pre-testing of census questionnaire.
- Identification and contracting of IT Consultants to process census data.
- Development of instruments; and computing software.
- Development of the necessary legislation.
- Conducting of the Pilot Census in the Year 2000.
- Conducting of the main census in 2001 and release of preliminary results.
- Analysis of census data and release of main results.
- Digitisation of census maps.

The experience of Botswana shows that preparatory cartographic work is critical. For the 2001 census this began in October 1999 and involved listing of all dwelling units, household heads, and the number of persons in the household etc. Through this exercise, maps for the whole country were compiled and were further divided into enumeration areas assigned to enumerators. The enumerators, supervised at district level, wore

census badges identifying them and were sworn to secrecy to assure the public that the answers given would be kept in the strictest confidence and only be used for Census purposes. A Pilot census of over 7000 households tested both the questionnaire and administrative logistics. Census data processing was contracted to a private IT Consultant. All of the above contributed to ensuring quality, indicating that the latest Census results can be depended upon for the purposes of the ORASECOM project.

3.4 Other Relevant Surveys

While the Census data is most critical for the purposes of determining the overall population of the country, supplementary household surveys shed light on factors that influence growth in general, and water demand in particular. Over the last two decades relevant surveys in the case of Botswana include:

- Household Income and Expenditure Survey -I in 1985/86, 93/94 and 02/03;
- Demographic Survey -I in 1987 and 1998
- Botswana Family Health Survey -II in 1988 and 1996
- Informal Sector Survey in 1999
- Botswana Multiple Indicator Survey (MICS), 2000
- Botswana Aids Impact Survey 2001

3.5 Demographic overview of Botswana

Over the last ten years, the demographics of the country have changed significantly with increasing numbers concentrated around the urban centres. Botswana's population is becoming increasingly urbanised. The traditional way of life of people moving between the village home, the fields, lands and cattle kraals is in decline with more people having additional town domiciles. Both education and healthcare continue to be priority areas for Botswana. The Government of Botswana (GOB) continues to improve and expand the education system, consuming over a fourth of the 2000-2001 allocated expenditure budget. The health care system has also received substantial inputs resulting in about 85% of the rural population living within 15km of a health facility. Public health expenditure averaged 5-8% of the national budget between 1980 and 1999.

Between the 1974/75 and 1999/2000 financial years, the Gross Domestic Product (GDP) of Botswana grew at an average rate of 9.1% increasing from (in Pula) P228 million to P26 billion in 1999/2000. This expansion was fuelled primarily in the structure of the economy

from agriculture and financial services to mining and public sector. Mining is now the leading sector in the national economy, constituting more than 50% of Government revenues and nearly 80% of foreign exchange earnings. Through diversification efforts by the GOB and shifts in the global economy, the mining sector now represents about one third of the GDP.

3.6 Demographics of the South East

It can be anticipated that a future ORASECOM water management plan will take particular interest in the southern parts of Botswana in the Molopo river basin which is a tributary basin of the Orange River. Consequently demographic data for the area has been sourced from the CSO.

Southern Botswana hosts a very low rural population density confined to the sparsely populated Kgalagadi District and the moderately populated Southern District.

Some 2.8% of Botswana's population lives within the Molopo Basin area. Population centres include: Goodhope, Gathwane, Mogojogojowe, Mmathethe, Digawana, Thareseleele, Ramatlabama, Mokatako, Phitshane-Molopo Mmakgori, Tshidilamolomo, Mabule, Selokolela, Metlobo, Magoriapitse, Sekoma, Khakhea, Makopong, Khisa, Omaweneno, Maleshe, Tsabong, Werda, Maralaleng, Struizendam, Rappelspan, Khuis, Bogogobo, Middlepits, Khawa, Gakhibane and Bokspits.

As mentioned above, the Botswana Central Statistic Office (CSO) carries out a national population census every ten years. Population statistics derived from the CSO 2001 census and the associated 2010 and 2020 population projections for the Molopo River Basin are presented in the table below.

Table 4: Summary of Population Statistics - Molopo River Basin Area

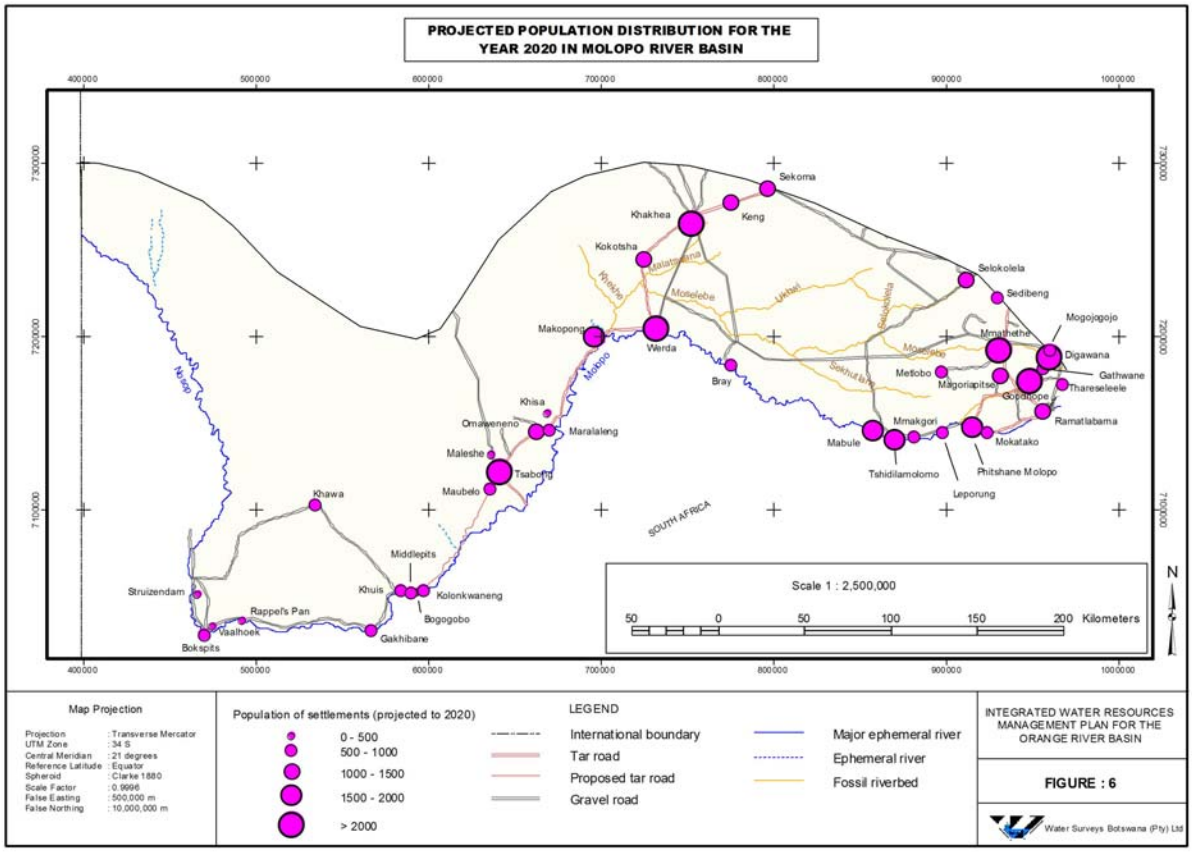
LOCALITY/TOWN	POPULATION		
	2001	2010	2020
Goodhope	2934	3300	3414
Gathwane	922	927	928
Bogogobo	341	336	335
Sekoma	1033	1151	1188
Magoriapitse	969	1107	1151
Makopong	1501	1577	1600
Khakhea	2035	2096	2114
Omaweneno	1068	1127	1166
Khisa	423	455	464
Khonkhwa	473	490	495
Keng	931	1007	1031
Leporung	582	587	588
Werda,	1961	2108	2153
Tsabong	6591	7546	7848
Maleshe,	389	403	407
Maralaleng	487	567	625
Struizendam	313	318	335
Rappelspan	278	315	327
Khuis	755	791	802
Khawa	517	538	544
Gakhibane	501	515	519
Bokspits	499	528	537
Thareseleele	767	778	781
Selokolela	1188	1296	1329
Metlobo	925	942	947
Mabule	1589	1631	1643
Tshidilamolomo	673	1783	1851
Mokatako	967	978	961
Mmakgori	742	834	863
Ramatlabama,	1174	1179	1180
Phitshane-Molopo	1569	1783	1851

LOCALITY/TOWN	POPULATION		
	2001	2010	2020
Mogojogojowe	603	654	670
Kokotsha	1021	1053	1062
Kolonkwaneng	591	594	595
Vaalhoek	346	377	387
Dikhukhung	288	279	276
Bray	899	927	936
Sedibeng	616	701	728
Mmathethe	4415	4809	4930
Middlepits	657	707	722
Maubelo	453	491	516
Digawana	2675	2832	2879
Population in Molopo River Basin area	47661		
Total population in Botswana	1680863		
Population outside Molopo River Basin area	1587038		
% Population in study area	2.8		

Source – CSO 2001 Population Census

A map showing the projected population distribution for the year 2020 in settlements within the study area is shown in the Figure below.

Figure 1: Population Projection for the Molopo River Basin



3.7 Impact of HIV/AIDS

Of the various supplementary surveys conducted in Botswana in recent times the Aids Impact Survey of 2001 is probably the most critical. The impact of HIV and AIDS has been highly significant and has serious consequences for the growth of the population and the economy, both of which determine water demand. For this reason particular attention has been paid to reviewing the HIV/AIDS situation in Botswana. Drawing primarily on reports by the CSO, a summary of the main trends is given below.

The first cases of HIV in Botswana were diagnosed in 1985 and the disease has spread very rapidly since then, with UNAIDS estimating that by the end of 1999, at least one in four adults in Botswana was living with HIV. A variety of programmes have been implemented to improve the knowledge about how HIV is transmitted as well as strategies for HIV/AIDS prevention and control. However, despite these efforts, the infection rate has not declined significantly.

The HIV / AIDS epidemic continues to deepen in Botswana. The overall, adjusted HIV prevalence rate for pregnant women aged 15-49 has increased from 33.6% in 2000 to 36.2% in 2001. This increase is reflected across nearly all age groups. The trend of HIV prevalence from 1993 to 2001 indicates that the prevalence rates for 2001 are double those for 1993.

In 2001 the CSO conducted an impact survey to obtain more information on topics related to HIV/AIDS. In particular the survey set out to do the following:

- Assess whether people are changing their sexual behaviour;
- Establish the proportion of people in need of care due to HIV infection;
- Establish the proportion at risk of HIV infection;
- Assess the impact of the pandemic at household level and
- Provide information on issues related to the impact of HIV/AIDS on household and communities.

The population growth structure continues to be altered as a result of the HIV and the AIDS epidemic. Mortality across age groups is on the rise in Botswana and life expectancy has began a steady decline, from a GOB estimated high of about 66.2 years to a projected low of 47.4 years (1999 & 2000 GOB Human Development Reports). It is estimated that by the year 2010 life expectancy could reach a staggering low of 29 years. Additionally, if nothing is done to halt the deepening of the epidemic, 30% of Botswana's adult population could be lost over the next eight to ten years.

The epidemic has had a significant impact on children. The survey found that 28 percent of children aged 0-14 are not living with both parents. Children who have lost one or both parents to death amount to about 13 percent of all children aged 0-14. The mean age at first marriage or cohabitation is 27 years. The mean duration of current marriage or cohabitation is 3 years. The survey gives the mean age at first having sex as 24 years, although other reports indicated a lower – and more plausible - age of first sex at 17 to 18 years (Dr D. Cownie, - pers. com).

The structure of the population will shift to increasing numbers of both the very young and very old. Household income levels are expected to drop at least 8% due to HIV and AIDS, pushing the number of household below the poverty line up by around 5%. Ever decreasing household resources may be increasingly channelled to medical and care

expenses, with less going to education and social amenities. The impact of HIV / AIDS is keenly felt in the social sector in particular education and health. A high incidence of morbidity and mortality among teachers reduces the number of classroom hours being taught. At home, ill health among family reduces the time children spend at school or attending to schoolwork. Similarly, the nation's health system is stretched to the limit as the shear magnitude of the epidemic threatens to consume both health resources and facilities. The massive burden of caring for and treating HIV and AIDS in Botswana will increasingly limit the health care system to deliver even the most basic care to the rest of the population.

The epidemic is having a catastrophic impact on the economy with an HIV prevalence of some 36% among the workforce. The number and quality of people available to work will decline over the next five to ten years. The loss of skills, institutional memory and experience will create a vacuum in the labour market. Labour costs will rise along with recruitment and retraining costs in order to meet the need of business and industry. Added to that the costs of meeting expected medical and support costs may seriously reduce corporate earnings, savings and investment levels, depressing the economy. It has been estimated that the HIV / AIDS epidemic will cause a contraction of GDP by 1.5% over the next 20-25 years resulting in an economy at least 31% smaller than would otherwise be projected without the impact of the epidemic. The impact of the epidemic in respect of water demands has not as yet been quantified by the GOB.

The findings raise cause for concern as 21 percent were unable to mention at least one way of reducing chances of HIV infection and only 25 percent mentioning both partners having no other partners as a way of preventing infection. Only 31 percent of the population correctly identified three misconceptions about HIV transmission and only 14 percent have been tested for their status. Given these results, there is little to indicate that the infection rate will be significantly reduced in the coming years.

3.8 Water Demand

The economic success of the Republic of Botswana has translated into improved infrastructure nationwide and increased household per capita income in rural villages. This new buying power enables more households to have water connections. These connections have proved to encourage high water consumption per capita as compared to public standpipes. As such there is increased demand for a reliable and convenient potable water supply. Rural village water demand calculations are based on the

Department of Water Affairs (DWA) (1989) Rural Village Water Supply Design Manual (RVWSDM). Rural water supply schemes are designed to the following design criteria:

- Public standpipe (30 litres/day/person)
- Yard connection (60 litres/day/person)
- Household connection (150 litres/day/person)

The percentage of the rural population served to these criteria is given in the following table:

Table 5: Rural Village Water Supply Methods

Connection Type		% Served
Private connections	House connection	15%
	Yard connection	20%
Public standpipes		65%

Source – DWA 1989 Rural Village Water Supply Demand Manual

The last decade has seen rapid infrastructural developments at rural village level, which makes many of the RVWSDM water demand calculation formulae obsolete. There has been a large increase in the number of housing developments at village level, which now exceeds the 15% stated in the RVWSDM. Waterborne sewage systems are being emplaced in the larger villages. Primary and Junior Secondary Schools nationwide are being equipped with waterborne sanitation facilities. The Ministry of Health is establishing a network of primary hospitals located at sub-district HQ and major villages. This combined with the many new developments (businesses, shopping malls etc.) in the larger villages and the resulting urban life style (modern housing) of the population results in a much higher water demand.

For major villages supplied from well fields separate water demand studies are implemented (as is the case in the Molopo River Basin). The studies are also based on the consumption statistics given the RVWSDM and the Botswana National Water Master Plan (BNWMP) planning documents.

Water demand forecasts contained in the BNWMP (1991) are presented in the table below. It is understood that the BNWMP is currently under revision.

Table 6: Settlement Water Demand Forecasts (Nationwide)

Year	1990	2000	2010	2020
Population (10^3)				
Urban Centres	262	437	647	949
Major Villages	294	431	597	816
Rural Villages	289	386	498	629
Minor Settlements	444	515	593	641
Domestic Demands (10^6m^3)				
Urban Centres	8.1	17.0	26.6	41.9
Major Villages	3.1	8.8	15.1	24.4
Rural Villages	1.8	3.2	5.1	6.8
Minor Settlements	2.4	2.8	3.3	3.5
Overall Demands (10^6m^3)				
Urban Centres	19.6	41.3	68.2	107.2
Major Villages	7.4	17.5	27.9	43.3
Rural Villages	3.6	6.3	9.5	12.6
Minor Settlements	3.3	3.8	4.4	4.7

Source – 1991 BNWMP

The 1991 BNWMP identifies five main water demand users: Domestic/settlements, Mines & Energy, Livestock, Irrigation & Forestry and Wildlife. Percentage usage figures for the different categories are presented in the Table below as well as the two Figures below.

Table 7: Percentage Water Demand Usage Nationwide

Year Demand Category	1990 %	2000 %	2010 %	2020 %
Settlements	28.6	38	45	51
Mines & energy	19.3	18.6	21.4	17.9
Livestock	30.7	22.7	14.3	14
Irrigation/forestry	16.4	17.4	16.9	15
Wildlife	5	3.3	2.4	2

Source BNWMP, 1991

Water demand projections for the categories are presented in the following table.

Table 8: Water Demand per demand category

Year Demand Category	1990	2000	2010	2020
Settlements	33.7	68.8	109.9	167.8
Mines & energy	22.9	33.6	52.2	58.7
Livestock	36.5	41	34.8	46.7
Irrigation/forestry	19.5	31.6	41.3	49.8
Wildlife	6	6	6	6
Total	118.6	181	244.2	329

Source BNWMP, 1991. All figures (x $10^6 m^3$/annum)

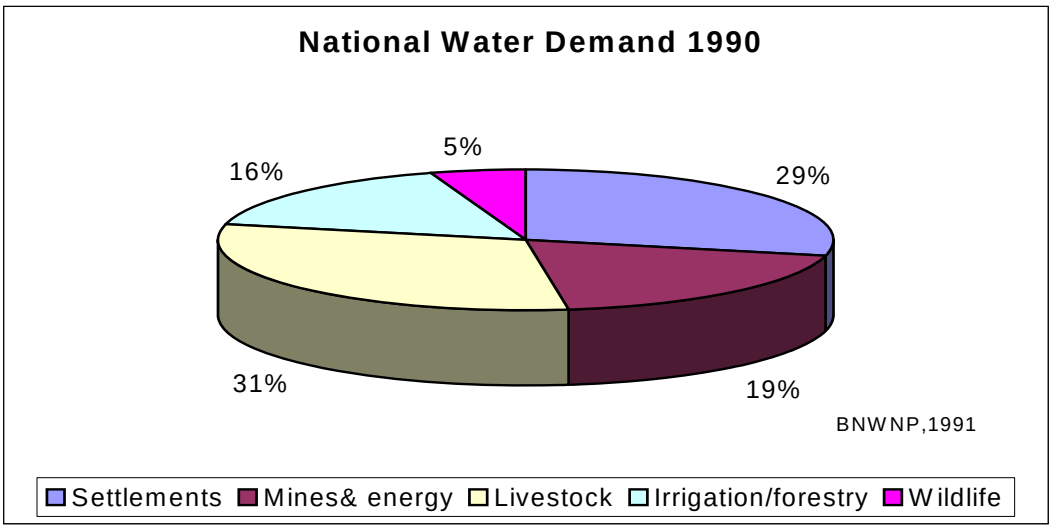


Figure 2: National Water Demand and Usage for 1990

These water demand figures have been calculated using a range of water consumption between 15 - 130 litres/day/person.

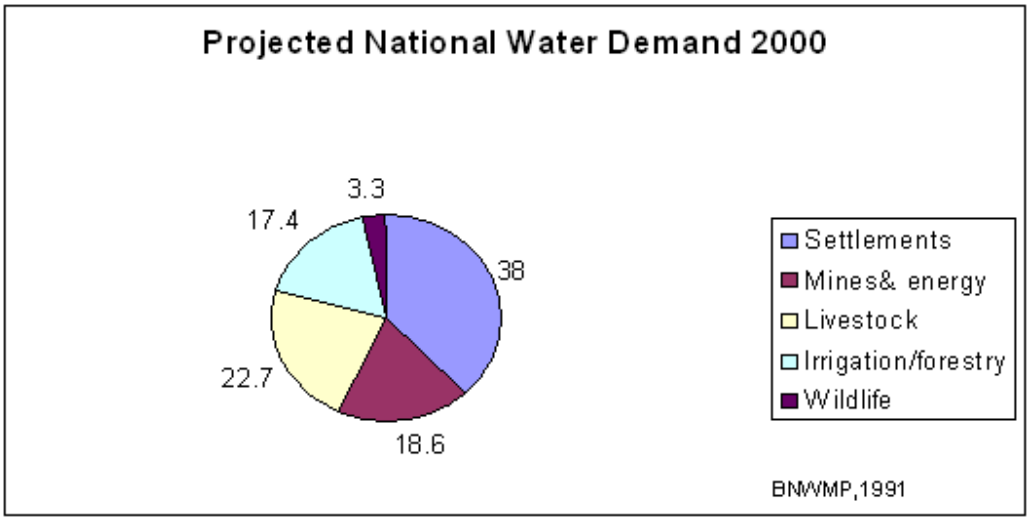


Figure 3: Projected 2000 National Water Demand

The domestic water demand for settlements increases with time to a projected total of 51% of the total national water demand in 2020 as shown in Figure 4. In comparison the percentage proportion of other users remains static or even declines with time (as in the case of livestock).

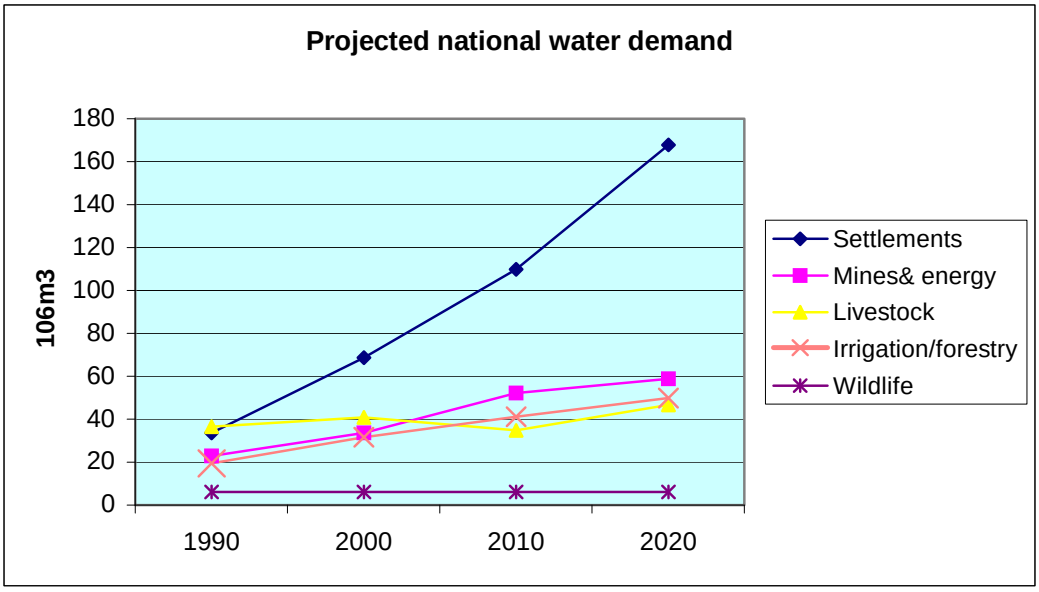


Figure 4: Projected National Water Demand & Usage for Year 2020

3.8.1 Water Demands for the Molopo (Orange) River Basin

Tsabong, Goodhope, Mmathethe, Digawana and Khakhea are considered major villages in the Molopo River Basin. These villages have the highest water demand compared to minor villages. The water demands of these villages are presented in the table below.

Table 9: Water Demand in the Molopo River Basin

Village	Population			Water Demand (m^3/d)		
	2001	2010	2020	2001	2010	2020
Goodhope	2934	3300	3414	220.05	247.50	256.05
Gathwane	922	927	928	69.15	69.53	69.60
Bogogobo	341	336	335	25.58	25.20	25.13
Sekoma	1033	1151	1188	77.48	86.33	89.10
Magoriapitse	969	1107	1151	72.68	83.03	86.33
Makopong	1501	1577	1600	112.58	118.28	120.00
Khakhea	2035	2096	2114	152.63	157.20	158.55
Omaweneno	1068	1127	1166	80.10	84.53	87.45
Khisa	423	455	464	31.73	34.13	34.80
Khonkhwa	473	490	495	35.48	36.75	37.13
Keng	931	1007	1031	69.83	75.53	77.33
Leporung	582	587	588	43.65	44.03	44.10
Werda,	1961	2108	2153	147.08	158.10	161.48
Tsabong	6591	7546	7848	494.33	565.95	588.60
Maleshe,	389	403	407	29.18	30.23	30.53
Maralaleng	487	567	625	36.53	42.53	46.88
Struizendam	313	318	335	23.48	23.85	25.13
Rappelspan	278	315	327	20.85	23.63	24.53
Khuis	755	791	802	56.63	59.33	60.15
Khawa,	517	538	544	38.78	40.35	40.80
Gakhibane	501	515	519	37.58	38.63	38.93
Bokspits	499	528	537	37.43	39.60	40.28
Thareseleele	767	778	781	57.53	58.35	58.58
Selokolela	1188	1296	1329	89.10	97.20	99.68
Metlobo	925	942	947	69.38	70.65	71.03
Mabule	1589	1631	1643	119.18	122.33	123.23
Tshidilamolomo	673	1783	1851	50.48	133.73	138.83
Mokatako	967	978	961	72.53	73.35	72.08
Mmakgori	742	834	863	55.65	62.55	64.73
Ramatlabama,	1174	1179	1180	88.05	88.43	88.50
PhitshaneMolopo	1569	1783	1851	117.68	133.73	138.83
Mogojogojo	603	654	670	45.23	49.05	50.25
Kokotsha	1021	1053	1062	76.58	78.98	79.65
Kolonkwaneng	591	594	595	44.33	44.55	44.63
Vaalhoek	346	377	387	25.95	28.28	29.03
Dikhukhung	288	279	276	21.60	20.93	20.70

Village	Population			Water Demand (m^3/d)		
	2001	2010	2020	2001	2010	2020
Bray	899	927	936	67.43	69.53	70.20
Sedibeng	616	701	728	46.20	52.58	54.60
Mmathethe	4415	4809	4930	331.13	360.68	369.75
Middlepits	657	707	722	49.28	53.03	54.15
Maubelo	453	491	516	33.98	36.83	38.70
Digawana	2675	2832	2879	200.63	212.40	215.93
Totals	47661	52417	53678	3574.58	3931.28	4025.85

4 LESOTHO

4.1 Introduction

Of the four riparian countries that make up ORASECOM, Lesotho is the only one where the entire population falls within the catchment of the Seqnu-Orange River. From a demographic point of view this has a distinct advantage, as *national* statistics can be applied for analysis and planning (unlike in the other countries where only a proportion of the population falls within the basin).

As was the case with Botswana, the initial objective of the demographic work in Lesotho has been to determine the extent, availability and quality of relevant demographic data. In reviewing available documents it was found that the recently completed *Lesotho Lowlands Water Supply Scheme Feasibility Study* (LLWSFS) provides valuable information on the country's demographics and water demand. In addition it was found that the Bureau of Statistics has a range of reports from census and household survey reports, some of which are available electronically. It was further found that a number of international agencies, NGOs and private sector consultants have produced reports which are relevant to understanding the demographics of the country, particularly with regard to migration and the impact of HIV/AIDS.

The work carried out so far consists of reviewing the key documents and data sets that are most readily available. Particular attention has been given to the work done under the LLWSFS as this is very recent and relevant. The sections that follow build on this growing body of data that will be substantially augmented in 2006 when the next census is carried out. The section below begins with a brief overview of Lesotho's census history, followed by an assessment of the quality of the most recent census, conducted in 1996.

4.2 History of Census Taking in Lesotho

Census taking in Lesotho has a longer history going back to 1875, with subsequent censuses in 1891, 1904, 1911 and 1921. Since 1936 decennial censuses have been the norm, with those conducted over the period 1936 to 1986 using schoolteachers as enumerators. Earlier census reports failed to explain their methodologies, and the precision of their results cannot be other than spurious. The 1956 census was the first in which the Census Officer outlined the methodology used in detail. Enumeration was then, as in all subsequent censuses, by households. In 1965 this amounted to 793,639 people in

158,569 households, amounting to a household size of almost exactly 5 persons, a figure which has remained virtually unchanged in subsequent censuses.

Lesotho's demographers are in agreement that, following a series of wars in the 19th century, the population of Lesotho only began to expand in the early 20th century as a result of political events across the border that forced many Basotho to move to Lesotho. This resulted in a high growth rate until the early 1920s. Thereafter, the growth of economic opportunities in South Africa led not only to a large population of migrant workers, but also to permanent out-migration, primarily to South African urban and industrial areas. As a result there was very little growth in the population in the 1930s and 1940s, with it remaining at just over 660,000 for a decade.

After 1948, when the Nationalist Party came to power in South Africa, it became more difficult for Basotho to settle in South Africa, so the population within Lesotho's boundaries grew faster than had previously been the case. By Independence in 1966, the *de jure* population of Lesotho was almost exactly one million, almost twice that of Botswana. Although there was initially not much out-migration in the post-Independence period, there was considerable internal migration that continues to this day. By 1986 the population had grown to 1,600,000, averaging 2.6 percent per annum over the pervious decade. The latest census (discussed in more detail below) returned a figure of 1,860,000, however the Bureau of Statistic concluded that there was a 5 percent under enumeration.

4.3 Quality

One weakness that has been identified in the censuses relates to cartography. To analyse the growth of particular areas over time it is essential to maintain consistent enumeration areas that are clearly demarcated on reliable maps. By 1966, a series of 1:50,000 maps of Lesotho became available for the first time and enumeration areas (EAs) were delineated on these. However, in the 1976 Census the maps were not always strictly adhered to, partly because many village names did not appear on the maps. In 1986 new boundaries were accepted but the EA boundaries were never published, and no backup reference set was made. As a result, when sheets from the original set were lost they could not be readily replaced. As a result the 1986 Census, while providing data at constituency and district levels, does not allow for easy comparisons between census years at local level. Comparisons of population at local level might still have been possible from village lists (which have been published or made available electronically for all censuses since 1956), however, unlike Botswana, Lesotho does not have a standard,

officially-recognised set of village names. Comparison is therefore very difficult as Lesotho's villages frequently have more than one commonly used name. Analysts note that the need for standardised village names is as essential as ever and recommend that these names be standardised on all maps, and also used for voter registration, censuses and local government purposes (personal com. Prof. David Ambrose).

The 1996 Census encountered various problems that have been set out in the *1996 Population Census administration report, volume 1* [preface dated July 1999, but published in 2000]. Suffice it to say that schoolteachers were not used and the 3,077 unemployed school leavers did not offer the same level of experience or maturity in their approach to the work. According to the BOS the final total figure for the *de jure* population of Lesotho amounted to 1,862,275 compared with a 1986 population of 1,605,177. This implied a 1.5% growth rate between the two censuses, which is believed to be too low, so it is concluded that coverage errors must have occurred (*1996 Population Census Volume IIIA*, p. 4). If the 2.6% growth rate between 1976 and 1986 had continued, the population would have been 2.1 million, which implies an under-enumeration of some 276,000 people. The authors of the commentary come to the conclusion that the 1996 census under-enumeration was about 5%, and provided a method for producing a smoothed age pyramid (adding 117,702 people aged 0 to 9 years) which results in a total population of 1,960,069, equivalent to a 2.0% inter-census growth rate. The problems with the 1996 census include many hardly credible figures, particularly relating to urban populations. For example, the Maseru population is given as 137,837, and this corresponds to an inter-census growth rate of just 3.5%, the lowest growth rate of any urban area except Qacha's Nek. This is clearly improbable, given the known expansion of Maseru in the period 1986 to 1996, and it seems likely that Maseru was massively under-enumerated, although to what extent is difficult to assess.

It is not possible to independently assess the quality of the 1996 census data, as the data are not available to the public.

Given these difficulties it would be wise for the ORASECOM project to treat Lesotho's 1996 census data with a higher degree of caution than that of Botswana. It is hoped that any uncertainty will be ended in the 2006 census. Early indications are that many of the problems encountered in 1996 and being addressed in the 2006 census plans. However, at the time of writing (February 2006) it was not yet possible to assess progress on this. For this reason, an assessment is made below of the 2001 Lesotho Demographic Survey.

4.4 The 2001 Lesotho Demographic Survey

Although Lesotho did not conduct a full census in 2001, the BOS conducted a sample census, or Demographic Survey, which provides useful background detail for population planning purposes. The key findings from this study include the following[1]:

- The average household size is 4.9 people.
- Life expectancy, based on an adult HIV/AIDS prevalence rate of 31%, has declined to 39.1 years for males and 40.8 years for females.
- Females have a greater tendency to move from their places of birth than males, due to marriage customs and, more recently, work opportunities. As a result 72.3% of males and 46.0% of females where found to be living in the settlement where they were born.

The total population, estimated by the Lesotho Demographic Survey (LDS), is shown in the table below by gender and district:

Table 10: Distribution of Lesotho's Population by Gender and District

District	Male	Female	Total
Butha-Buthe	63,608	63,299	126,907
Leribe	181,627	180,712	362,339
Berea	151,000	149,557	300,557
Maseru	229,573	248,026	447,599
Mafeteng	119,126	119,820	238,946
Mohale's Hoek	101,565	105,277	206,842
Quthing	70,556	70,085	140,641
Qacha's Nek	37,991	42,332	80,323
Mokhotlong	43,707	45,998	89,705
Thaba-Tseka	66,731	66,949	133,680
TOTAL			2,127,539
Source: BOS, Government of Lesotho, 2001			

Significantly, the LDS found that the Total Fertility Rate (TFR) had decreased from 4.9 in 1996 to 4.2 in 2001. This is a decrease of 0.7 in 5 years, far higher than would normally

1 The full report of the LDS is available on the internet (www.bos.gov.ls)

be expected. This rapid drop, which has very significant consequences for population projections, is considered to be partly due to a higher rate of contraceptive prevalence than has previously been the case. The Bureau of Statistics reports a contraceptive prevalence rate of 41% (high by African standards but similar to rates in South Africa), which would normally decrease TFR by 0.3 in five years. The fact that the TFR has dropped by 0.7, well in excess of expected rates, is an indication of the severe impact that HIV/AIDS has already had on the demographic structure of the population.

The availability of data from the LDS enabled demographers working on an impact study of HIV/AIDS on the education sector to project the impact of HIV/AIDS on the national population. This work was reviewed and extensively used by the LLWSSFS team. The anticipated impact of HIV/AIDS and other major demographic trends is examined in more detail in the section titled “The Impact of HIV/AIDS” below.

4.5 Broad Demographic Trends

4.5.1 Internal Migration

The first major trend to note is the internal population shifts within the national boundaries of Lesotho. A water resources study conducted by TAMS in 1996 showed a significant shift in population was occurring, with many people moving from the Mountains to the Lowlands of the country. The study showed that the process of urbanisation and movement to the Lowlands is one which impacts very strongly on water resource planning as the shift is from areas of relatively abundant and largely unutilised water resources to areas of Lesotho where water resources are relatively scarce and under considerable pressure. The extent of internal migration is such that part of the country – particularly the remote mountains – are experiencing a decline in population while the fastest growing peri-urban areas are growing at well over twice the national average.

This trend was confirmed by the LLWSSFS which used a ‘block build approach’ to project the expansion of the main settlements (with populations of over 2,500) to the year 2035. Detailed demographic analysis of these larger settlements revealed that all are likely to grow faster than the remaining smaller settlements, which are likely to lose population due to HIV/AIDS and out-migration. However, the larger settlements will themselves grow at very different speeds. This will result in fundamental changes to the composition of Lesotho’s settlement pattern in years to come. As can be seen from the figure below, in 1996 the sum total of all the category five small settlements was greater than the capital,

Maseru, but by the year 2000 Maseru exceeded this sum total and, thereafter, it rapidly started to exceed the sum total of other category types. The towns with industry also rapidly started to overtake settlements without any prospects of industrial development.

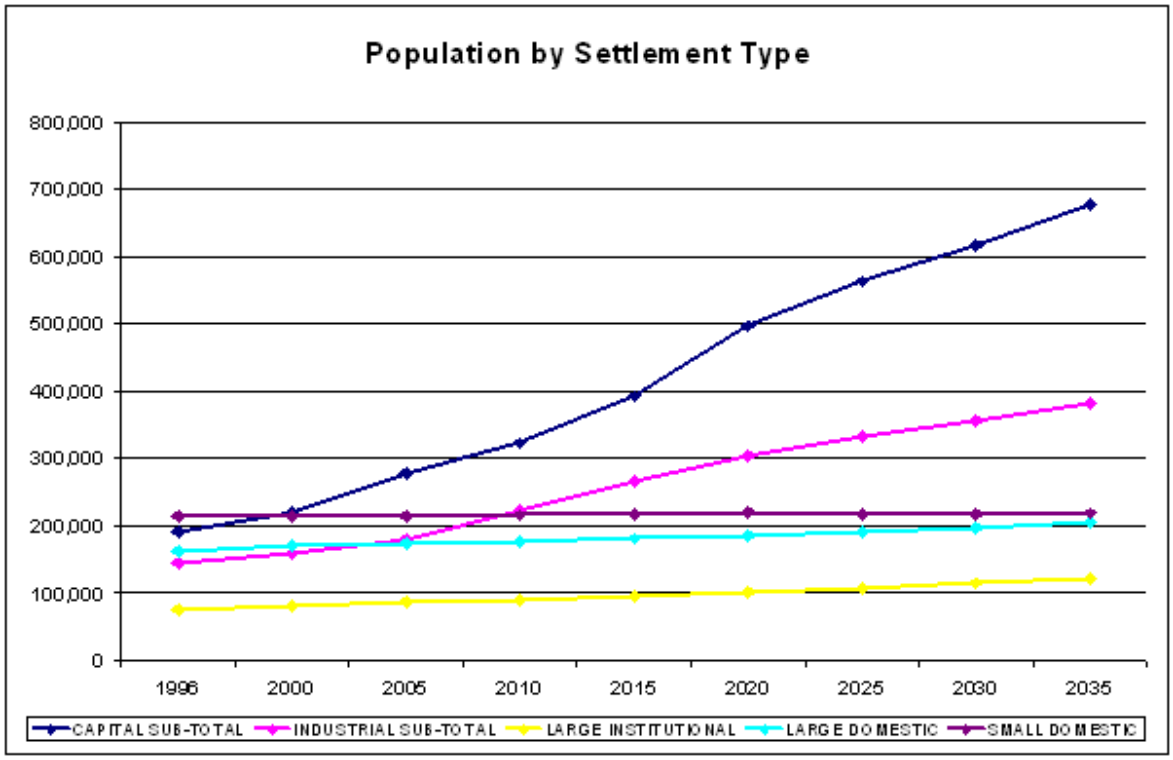


Figure 5: Growth by Settlement Type

4.5.2 External Migration

Lesotho is entirely surrounded by its much larger neighbour, South Africa. The social and cultural links between the two countries are very strong, with more Basotho said to be living on the South African side of the border than within Lesotho itself. The extent and durability of these links has made it relatively easy for Basotho to move between the two countries and many have a 'foot on each side of the border'. In the last decade important changes in South Africa have clearly had an influence on external migration. The reasons for this include the following:

- Many Basotho were able to register as South Africans in the run up to the 1994 elections (when requirements were relatively loose) enabling them to gain access to resources unavailable in Lesotho, including state pension, social grants, housing subsidies and low cost education and health services.

- The announcement by South Africa that long-term Basotho migrants would be given the opportunity to settle with their families permanently in South Africa encouraged some to leave. The extent to which this has actually happened is not easy to quantify, but in 1998 25% of them said it was likely that they would settle permanently if given the opportunity[2].
- An increasing porosity in the Lesotho/South African border, and incentives for Basotho families to move to South Africa if at least one member could qualify for a South African pension or other social security benefits.
- An increased opportunity for well qualified Basotho to study and work in South Africa, creating a brain drain of major economic importance, even if demographically relatively slight.

The exact extent of external migration is not known, partly because the last census was conducted nine years ago, but also because many of those who move retain some contact with Lesotho so they would also be counted as *de jure* citizens even if they rarely return home. The next census should be able to shed more light on external migration patterns especially if from the *de facto* point of view.

4.5.3 The Demographic Impacts of HIV/AIDS

Factors driving the epidemic

Earlier it was indicated that HIV/AIDS, rather than contraceptive prevalence, is the key factor driving down the country's Total Fertility Rate. Lesotho has one of the highest levels of HIV infection in the world, exceeded only by Swaziland and Botswana. Lesotho's high prevalence rates are a result of a number of high risk factors that include: long-term male (and now also female) migration; a high prevalence of multiple partner relationships; low levels of condom use; inconsistent condom use; and a relatively young age for the onset of sexual activity.

2 The actual numbers of Basotho migrants to South African mines over the past 12 years has suffered a fairly steady decline. According to the Central Bank of Lesotho Quarterly Review, which reports the relevant statistics in each issue, the average number of Basotho mineworkers in South Africa peaked at an average of 127,386 in 1990, after which it declined steadily to a low in 2001 of 61,412, less than half of the 1990 figure. There was a slight recovery, possibly due to the improved gold price, to 62,158 in 2002.

The growth of the epidemic

The first AIDS case was reported in Lesotho in 1986, according to the Ministry of Health and Social Welfare. Since then, the Ministry has records for a cumulative total of 10,880 AIDS cases reported by the end of 1999. However, most AIDS deaths are not reported as AIDS deaths, suggesting that the official figure is well below the reality. UNAIDS estimates that 16,000 people died of AIDS in Lesotho in 1999 alone, rising to 25,000 during the year 2001. The current projections made by the HIV/AIDS Impact Assessment study done by SIAPAC for the Ministry of Education are similar to that of other agencies, with estimates of 16,650 people dying of AIDS in 1999, rising to 22,750 during 2001. The estimate of cumulative deaths by 1999 was 77,540.

Of all AIDS cases, an estimated 12% were under the age of five (World Bank, 2000). Family Health International estimates that some 20% of all pregnant and lactating mothers are HIV positive, meaning that each year 2,000 to 3,000 children are born HIV positive (assuming that one-in-three HIV positive mothers transmit the virus to their children).

A considerable increase in the number of orphans is one of the long-term implications of the HIV/AIDS epidemic, as parents die before their children can grow up. As of 2001, it was estimated by the BOS that 73,000 Basotho under the age of fifteen had lost their mother or father or both parents to AIDS, and were therefore classified as orphans.

HIV Prevalence

Knowing the prevalence rate has, over the years, been hampered by small sample sizes, insufficient sites, and gaps in years that sero-prevalence data were collected. However, by 1999 sufficient data existed for estimates to suggest that adults aged 15-49 had a prevalence of 23.6%. Then in 2002 a UNDP estimate in 2002 placed the prevalent rate at 31%, a figure confirmed by the LLWSSFS as a high prevalence scenario. Urban and peri-urban areas were noted to have higher than average prevalence rates.

Modelling done by SIAPAC for the Ministry of Education Study, and confirmed by the LLWSSFS indicates that, overall, HIV prevalence in Lesotho appears to be close to its peak. The report indicated that if the epidemic continued to follow past trends, HIV prevalence would peak at 33.8% by 2007 based on the high prevalence projection and at 28.63% for the low prevalence projection. It was, however, noted that the estimates were based on data known to contain a number of gaps that would need to be addressed before greater certainty could be established.

Fortunately the 2004 Lesotho Demographic & Health Survey (LDHS) incorporated HIV testing of adults at the household level and facilitated a better understanding of the magnitude and patterns of HIV in a wider and more representative sample of the general population. This showed an adult HIV prevalence rate of 24%, less than had been anticipated by past modelling exercises. Then, the updated 2005 UNAIDS/WHO projections, based on the 2005 HIV sentinel survey and calibrated with the 2004 LDHS, estimated the adult prevalence rate to be approximately 23%. Consistency of the 2005 projections with the 2004 LDHS value validates the official 2005 updated adult HIV prevalence of 23.2%. Once again urban areas were shown to have a higher rate than rural ones (28.8% vs 21.8%).

Number of People Infected with HIV

Based on the prevalence projections made above, the LLWSSFS model indicates that some 384,000 people are presently HIV-positive and that this will rise to 422,000 individuals by 2015 under the high prevalence scenario or 375,000 under the low prevalence scenario. The number of people infected in the early stages of the epidemic is increasing rapidly. Gradually, the rate at which people are infected will slow because a greater proportion of those vulnerable to the disease are already infected with HIV.

Mortality

As the rate of HIV infection declines, the mortality rate will increase as more of those who are HIV-positive progress to AIDS and die. The model shows that although HIV prevalence will stabilise, the number of HIV infected people will continue to increase until about 2010, despite a constant prevalence rate. At that point the number of infections will start to stabilise because of the large number of deaths and the consequent decrease in population size.

While HIV prevalence is close to its peak, the lag between infection and death means that a full AIDS epidemic is a number of years away. The AIDS death rate is likely to peak only eight years after HIV has peaked.

Based on the high prevalence scenario, the number of AIDS deaths is projected to increase to 43,000 AIDS deaths annually, at its peak, by 2010. Under the low prevalence scenario the number would be about 38,000 annually by the same year. (These figures are similar to estimations given by UNAIDS).

By 2010 the cumulative number of AIDS deaths may be as high as 435,000 without access to anti-retroviral treatment. By 2015, cumulative AIDS deaths are expected to exceed 650,000, but it is important to stress that many of these can be avoided.

Following the low HIV prevalence scenario, Lesotho has currently lost 142,000 people; this will increase to 370,000 by 2010 and 558,000 by 2015.

Impact of mortality on population growth

AIDS-related deaths will decrease the population of the country in two ways. First, the deaths will directly affect the size of the country's population as people die. Secondly, HIV/AIDS affects young adults and the death of young adults reduces the number of children born. Thus the population of the country will, therefore, be smaller than it would have been without AIDS, as its citizens die and others are never born. The extent to which this will happen will, however, be largely influenced by the range and effectiveness of programmes that are introduced and expanded in the next few years. Of particular importance are antiretroviral therapies, including the Prevention of Mother to Child Transmission, which is relatively inexpensive.

With HIV/AIDS, the natural growth rate of Lesotho is declining and is projected to continue to decline until it reaches a zero growth rate by 2007/2008, and negative rates thereafter. This will result in a slow population growth rate until 2010 after which a slow reduction in population size is projected. Without HIV/AIDS the population was projected to increase to about 3.3 million by 2015 but due to the impact of HIV/AIDS, it will not grow much beyond 2.3 million by the end of the decade, and will thereafter decline if no fundamental changes are brought about on a national scale.

The socio-economic impact of HIV/AIDS is considerable. This is not only because of the number of deaths and the resultant reduction in the rate of population growth, but because those who are dying are in the productive or working age groups. Unlike epidemics of the past that targeted the weak, the very young and the old, HIV infects the sexually active population, with infection rates highest in the 25-35 year old age group. The age groups with the greatest increases in mortality as a result of AIDS are those most responsible for economic activity and social care. The impact of HIV/AIDS on both the population and the economy as a whole has important implications for assessing water demand. It is important that ORASECOM continue to monitor changes in this critical area for many years to come.

5 NAMIBIA

5.1 Overview

The demography of Namibia is strongly influenced by its vast size, its arid climate and its political history. The country covers an area of 824,116 km2 with a coastline of 1,572 kilometres. It is sub-Saharan Africa's driest country. About 40% of the land surface of Namibia could be classified as arid, 40% as semi-arid, 5% as sub-humid, and a narrow rim in the west and southwest that could be better described as hyper-arid or desert (15%). Over 85% of the country these climatic zones order themselves in savannah landscapes that are of a varying ecological constitution, but the boundaries between them are neither static nor abrupt, because drylands are exposed to high inter-annual variability. The main rainy season occurs from December to March. Rainfall varies from less than 50 mm along the coast, to 200 mm in the south, 350 mm in the central areas, 450-550 mm in the north central areas, and 700 mm in the far northeast (see figure below). Rainfall patterns largely dictated the early patterns of human settlement, with the more arid areas being the least densely populated still today.

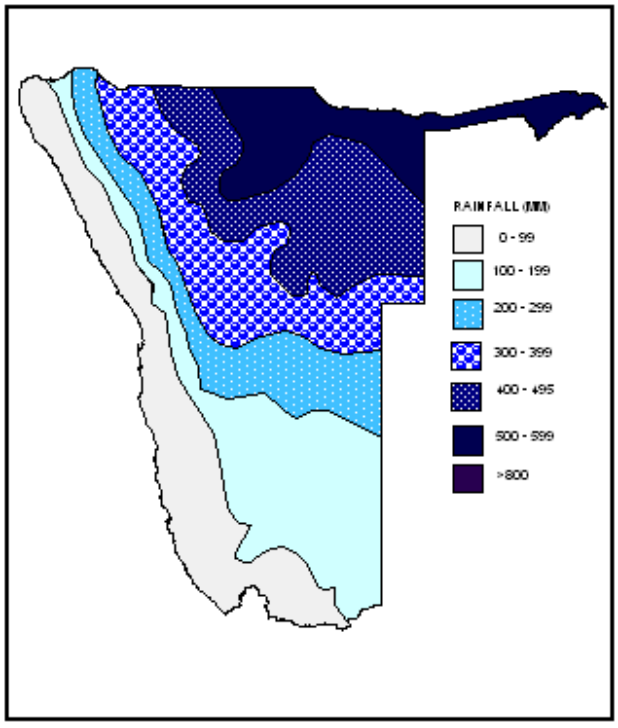


Figure 6: Rainfall distribution of Namibia

The general settlement patterns in Namibia's past have been altered by its recent complex political history, which have caused a distinctive skew distribution of population densities and concentrations of poverty and underdevelopment. The majority of Namibians live in the north of the country. One explanation for the higher density is the more favourable natural environment, especially the better availability of surface water and the higher rainfall. For many years the central and southern parts remained sparsely populated with only nomads roaming the land – as a result white settlers on commercial farms occupied the "vacant" land. The finding of groundwater was a decisive drive in this regard.

Moreover, the 130 years of colonial rule before independence laid the foundation for the way in which Namibia's land is currently divided and utilized. Under South African rule, for example, many indigenous Namibians were forced into reserves, later called "homelands" and movement between the different parts of Namibia were restricted. In this way the north of Namibia remained densely populated, compared to the rest of Namibia. Mainly as a result of colonial rule, less than 10% of the population own all freehold farming areas. This privately owned land constitutes approximately 44% of the total land area. About 1.5% of the total land area is comprised of exclusive diamond concession areas and 13.5% has been proclaimed as conservation areas. An estimated 60% of Namibia's population practice subsistence agro–pastoralism on communal land, which constitutes approximately 41% of the total land area.

The post-independent government made considerable efforts to improve living standards through political and administrative changes. This includes the reorganisation of the country in to 13 administrative regions. For the purposes of this study three of these regions – the Karas, Hardap and Omaheke Regions, are defined as part of the Orange River Basin. A fourth one – the Khomas Region – contains only a tiny part of the Orange River Basin and is not taken into account for practical reasons. The thirteen regions provide the spatial framework within which the state functions and within which planning and development is accommodated. As a result, decentralization became an important policy and governing approach. Both the 1991 and 2001 national censuses, for example, made use of the regional divisions in providing demographic data.

Namibia had a particularly large challenge to face – not only to shift to a new paradigm of sustainable development, but also to overcome the legacies of colonialism such as rural and urban poverty, huge disparities in income distribution, unequal access to land and natural resources, poor education, health and housing, and many other more subtle

issues. Greater freedom of movement was allowed and has had demographic consequences, but recent economic developments – such as the establishment of mines – had caused even more sudden changes in population density as people are attracted to growth nodes in previously uninhabited areas. Nevertheless, the majority of Namibians remain directly or indirectly dependent on agriculture and this high dependence on primary production renders the economy vulnerable to climatic and other external forces. The economy is broadly characterized by low physical investment, low domestic savings and very high government consumption. While it is government policy to reduce dependence on the primary sector, the manufacturing base remains small and under-developed. Increasing economic growth and employment, reducing poverty and improving equity remain a pivotal part of development objectives. Despite improvements in the education and health sectors, efforts need to be further intensified at all levels of society in order to fully redress Namibia's past inequalities and to improve public sector capacity. Namibia still suffers from comparatively low levels of education and strong social, gender and regional disparities in educational levels and outputs, low public sector capacity and a high reliance on foreign technical experts and consultants and a brain drain within the civil service (NPC, 2001).

The unemployment rate in Namibia is about 31% (NPC, 2003), and poverty and inequity remained endemic after Independence. Namibia is one of the most unequal societies in the world, even worse that Brazil and Bangladesh. Income distribution is especially skew - the richest 10% of society receive 65% of income, leaving only 35% for the remaining 90%. This means that half of Namibia's population survives on approximately 10% of the average income, while 5% receives incomes that are five times the national average of about US$2,000 GNP per capita (UNDP, 1998). Steadily growing at the high annual rate of 3%, the Namibian population is young and will sustain high growth rates over the coming years. The rapid population growth is closely coupled with a fast increase in dependants, mainly as a result of HIV/AIDS. Furthermore, Namibia is still mainly a rural society and possible migration to towns and cities tends to put urban settlements under pressure. Poverty is especially prevalent in the central and southern parts of the country, with more than 30% of all people living in absolute poverty in 1998 (UNDP, 1998). In summary, the key socio-economic challenges that threaten sustainable development in Namibia, and that have stayed top priorities since 1990, are the high dependency on natural resources, high population growth and skew population distribution patterns, human health and

HIV/AIDS, poverty and inequality, access to land and natural resources, poor governance, and knowledge and human capacity.

Much of the post-independent development in Namibia has focused on urban centres. As a result Namibia is expected to have an increasingly urbanised population in the decades ahead. This is illustrated in the figure below:

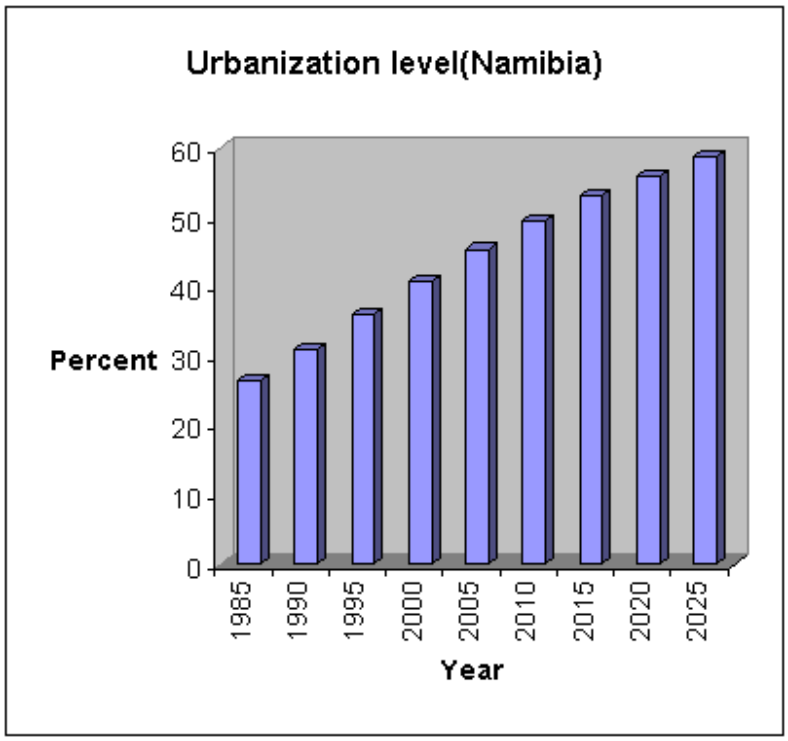


Figure 7: Projections of urbanization rates in Namibia: 1985 to 2025

According to the 2001 Population and Housing Census the unemployment rate of the Hardap Region is 34%, for the Karas Region 28% and for the Omaheke Region 24%. The presence of the mining activities at Oranjemund and Rosh Pinah contribute to the lower unemployment rate in the Karas Region. In contrast the sparsely populated Hardap Region, which experiences an out-migration, has a higher unemployment rate - most of the unemployed being pensioners residing within the rural areas. The data on unemployment should be used with caution as no information was detailed or verified, either on the number of working hours or on underemployment.

Inadequate sanitation and lack of access to potable water create conducive environments for the spread of infectious and parasitic diseases and are therefore a pubic health

concern. The rural water supply schemes introduced since Namibia's independence have greatly contributed in providing the rural communities with access to safe and drinkable water supply. Access to safe and potable water is quite high in all three Namibian regions: 95% of the population residing in the Hardap Region, 94% of the Karas Region and 90% of the Omaheke Regions have access to safe water (NPC, 2003).

5.2 Introduction to census issues

The objective of the activities conducted to date has been to establish the nature and quality of available demographic data, and identify gaps in data and interpretation. The task has consisted principally of a review of existing published data, and the interpretation of available information based on the consultant's knowledge of the project area.

5.3 Background on census issues

During the first population census in 1921 about 229,000 people were reported living within the country (Mendelsohn et al., 2002). The population has increased more than eight-fold since then. In 1970 there were an estimated 393,400 males and 400,400 females in the country, the total estimated population being 793,800. The 1981 census took place at a time when the liberation struggle was especially intense, the results of this census were not published in the same detail as that of the former censuses. Since no mid-year estimates or surveys were conducted between the respective dates estimations had to be made.

Namibia became independent on 21 March 1990, independence preceded by almost twenty-five years of the liberation struggle. Organisation for the first post-independence census took place immediately after independence, with the census itself conducted in August, 1991. Not surprisingly, it suffered from numerous problems associated with lack of capacity, insufficiently trained personnel, problems with quality control, etc. This was, however, less of a problem in the central and southern regions when compared to the populous northern regions. By contrast, the 2001 census was well planned and well implemented. While there were a number of disputes associated with the census, especially in urban locations where local authorities felt that undercounts had occurred, the

most serious disputes were in communities located in regions outside the Orange River Basin3.

5.4 Census results

The total enumerated population of Namibia on 1 August 2001 was 1,830,330. Of these, 942,572 (51%) were female and 887,721 (49%) were male, giving Namibia a sex ratio of 94.2 males per 100 females. There were a total of 346,455 households.

Rates of population growth increased from about 2% per annum in the first half of the 20th century to 3% in the last five decades. Projections suggest that the population will rise to about 2,250,00 in 2010 and 2,600,00 by the year 2020. Even though the total population will increase by about 800,000 over the next 20 years, the rate of growth is expected to drop steadily from the current 3% to about 1.5% in 2006. Much of this decline will be due to the negative impacts of HIV/AIDS while higher levels of education amongst women, and involvement in the cash economy will lead to lower birth rates and, therefore, lower growth rates.

Of the total population of 1,830,330 people (2001), 33% were living in gazetted urban areas and 67% were living in rural areas. A total of 39% of the population were younger than 15 years of age in 2001. Corresponding figures for the three regions are 41% for Omaheke, 39% for Hardap and 31% for Karas. The distribution of the population across Namibia's thirteen regions is indicated in the figure below.

[3] As with all censuses, the count is of the number of people who overnight in a particular location on the night before the census. Urban communities particularly in the west are affected by dramatic population fluctuations arising from the seasonality of employment in important economic sectors, notably the fishing and fish processing industries. For this reason, the two communities of Lüderitz and Walvis Bay in the southern and central coastal areas, respectively, often have populations significantly higher than reflected in the census. This is also the case for Swakopmund, near Walvis Bay, which has significant short-term in-migration during weekends and holidays. This may be the root cause of the disagreements by town officials about population counts.

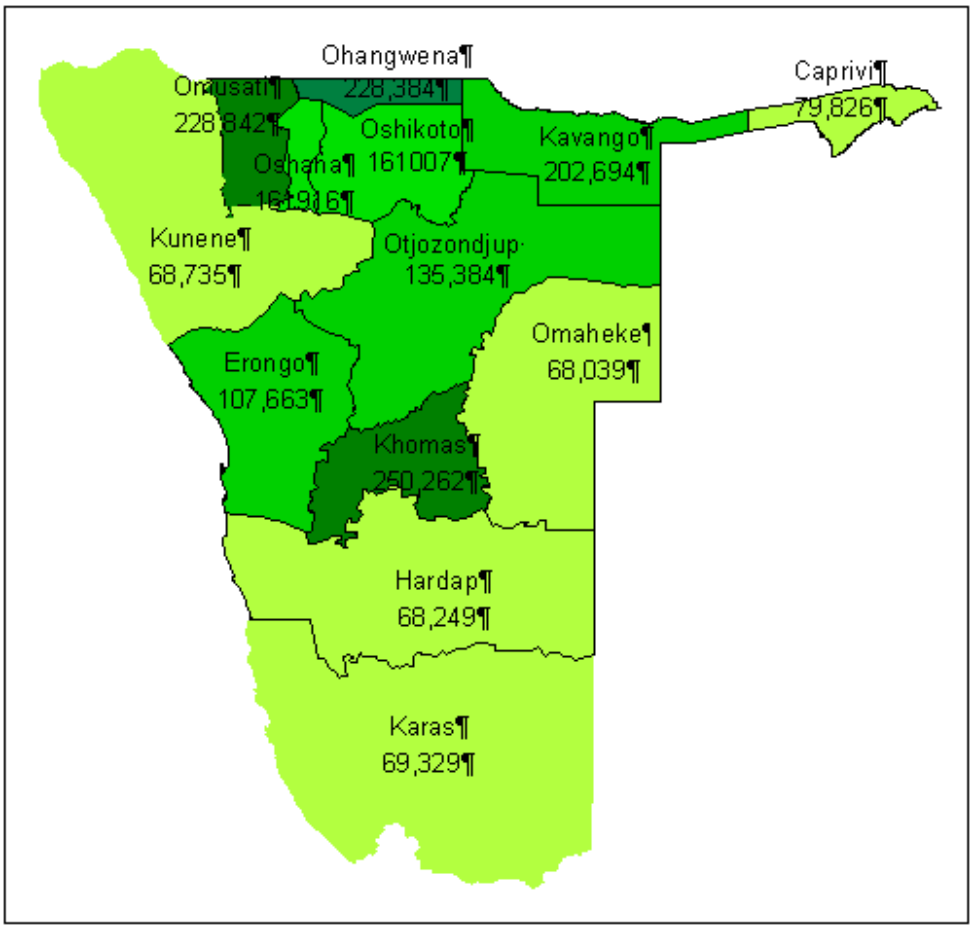


Figure 8: Population distribution map of Namibia

The following table reflects the population structure and composition residing within the three regions during the 1991 and 2001 census survey periods.

Table 11 Comparative Populations for the Karas, Hardap and Omaheke Regions

Region	Population size	Females	Males	% Urban	% Rural	Growth rate	Persons per km
Karas:							
1991	61,162	27,239	33,923	45	55		
2001	69,329	32,346	36,976	54	46	1.3	0.4
Hardap							
1991	66,495	32,767	33,728	44	56		
2001	68,249	33,665	34,579	46	54	0.3	0.6
Omaheke							
1991	52,735	25,423	27,312	16	84		
2001	68,039	32,484	35 554	28	72	2.5	0.8
2001 Total	205,617	98,495	107,109	40*	60*	1.37*	0.6*

Source: 2001 Population and Housing Census (* = calculated 2001 average)

Together the three regions falling within the basin comprise 11% of Namibia's total population residing on 355,478 km² (43%) of Namibia's total area of 824,116 km².

While the Omaheke Region experiences a growth rate of 2.5%, the Karas and Hardap regions experience a mere 1.3% and 0.3% respectively. This is partially due to out-migration from the south, arising from the decline in job opportunities and the pull of urban centres for job seekers. However, it is also due to two other factors: 1) the number of in-migrant households to the south which are small; and 2) the lower natural population growth rates among populations in the south compared to other parts of Namibia. The Karas Region, for example, grew only by 1.3% from 1991 to 2001, and the Hardap Region by only 0.3% (the lowest in the country), compared to a national rate of 2.6%. This might also be a result of the undercounts that occurred in the north in 1991, 'adjusted' through a redistribution of population numbers for these regions from 1991 to 2001. Put differently, the undercount in the north during 1991 meant that the south appeared to have a higher proportion of the population in 1991. The strong mining sector found within the Karas region results in a high number of in-migrant households to the region partially balancing the lower natural population growth rates among populations in the south compared to those living in the northern parts of Namibia. The low growth rate of the Hardap Region could be ascribed to limited economic employment opportunities, a high HIV/AIDS rate and low natural population growth. Consequently, it is expected that the growth rate for the Hardap region may actually decline in the near future.

While quite small, the population of the Hardap and Karas Regions would be significantly lower if it were not for urban settlements, mining activities and irrigation schemes, as the hyper-arid, arid and semi-arid conditions of the south supports a sparse rural population distribution. Vast parts of the south, as well as the Omaheke Region, exist of extremely large but sparsely populated commercial farms.

In the Karas Region 54% of the population lives in urban areas, compared to only 46% in the Hardap Region and 28% in the Omaheke Region. The low figure of the Omaheke Region could be explained as a result of the predominant extensive farming areas. The regions continue to rapidly urbanise, especially in the Karas Region where more and more of the population is concentrated in the following four settlements: the regional capital of Keetmanshoop, the mining town of Oranjemund, the port of Lüderitz, and the rapidly-growing mining town of Rosh Pinah. Of these, three - Keetmanshoop, Oranjemund, and Rosh Pinah – are closely related to the Orange River4.

In all three regions there exists a growing awareness about the economic potential of tourism. As a result the many emerging tourism enterprises may finally stabilize the exodus of the population from the rural parts. With the exception of Mariental, where the Hardap Irrigation Scheme is found, little economic activity other than extensive sheep and cattle farming and high value tourism in the Naukluft / Sossus Vlei area is experienced in the Hardap Region. The region is furthermore characterized by a low birth rate (3.7 children per woman), high infant death rate (63 per 1,000 for both sexes) a presumable high rate of out-migration of farm workers and a high HIV/AIDS rate. Consequently, very nominal economic development occurs in the region. The economic situation in the Omaheke Region is very similar to the Hardap Region, but the birth rate is slightly higher – 4,9 children per woman – and infant death rate slightly lower – 55 per 1,000 for both sexes.

Sex ratios of all three regions reflect the dominance of males related to in-migration from the north. The Karas Region has 114 males for every 100 females, the highest such ratio in Namibia. The Omaheke Region has 109 males for every 100 females. In the Hardap Region, the ratio was 103 males for every 100 females. Many of these migrants will leave

[4] Rosh Pinah was not gazetted as an urban area for the 2001 census. It is, nevertheless, perhaps the fastest growing town in Namibia, due to the recent commissioning of the Skorpion Zinc Mine.

the south for their permanent northern homes eventually. Pull factors behind the in-migration relate specifically to mining, irrigation and industrial developments in the two regions.

5.5 Impacts of HIV/AIDS

Like the rest of sub-Saharan Africa, Namibia is severely affected by HIV/AIDS. The national infection rate is estimated at 22% for people aged 15-49 (2002 data), with rates highest in the north and lowest in the south and northwest. Rates of HIV prevalence amongst pregnant women are indicated in the figure below.

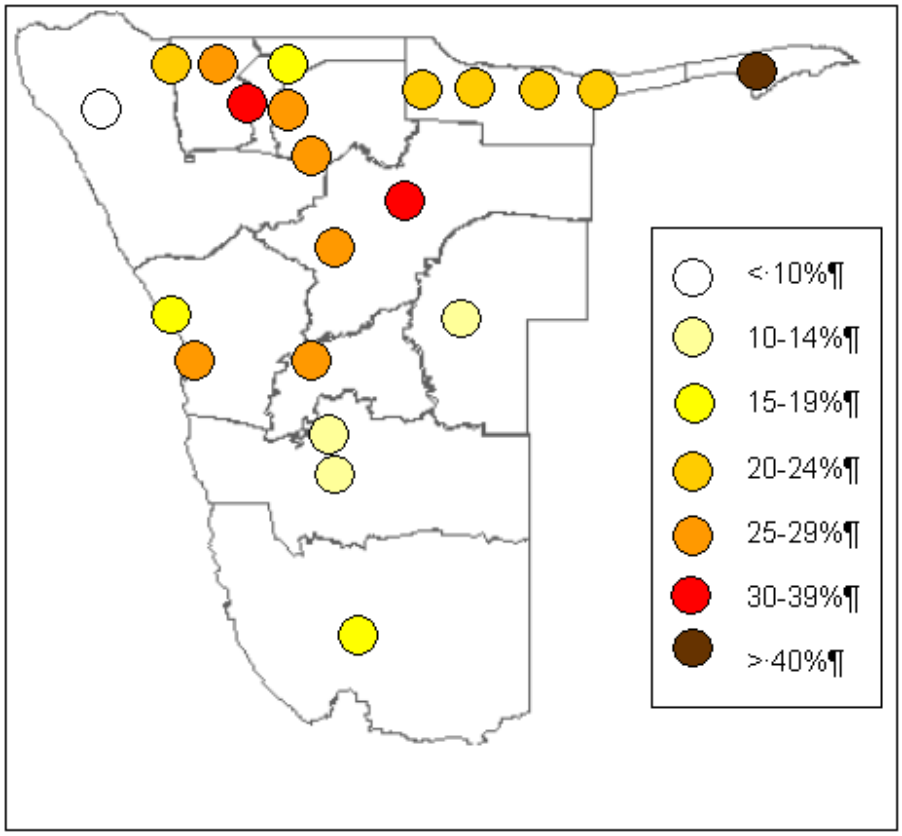


Figure 9: Distribution Map of HIV Prevalence amongst Pregnant Women in Different Sentinel Sites, Namibia 2002

Infection rates are growing in all locations in Namibia as reflected in the figure below showing comparative rates of infection in 1998.

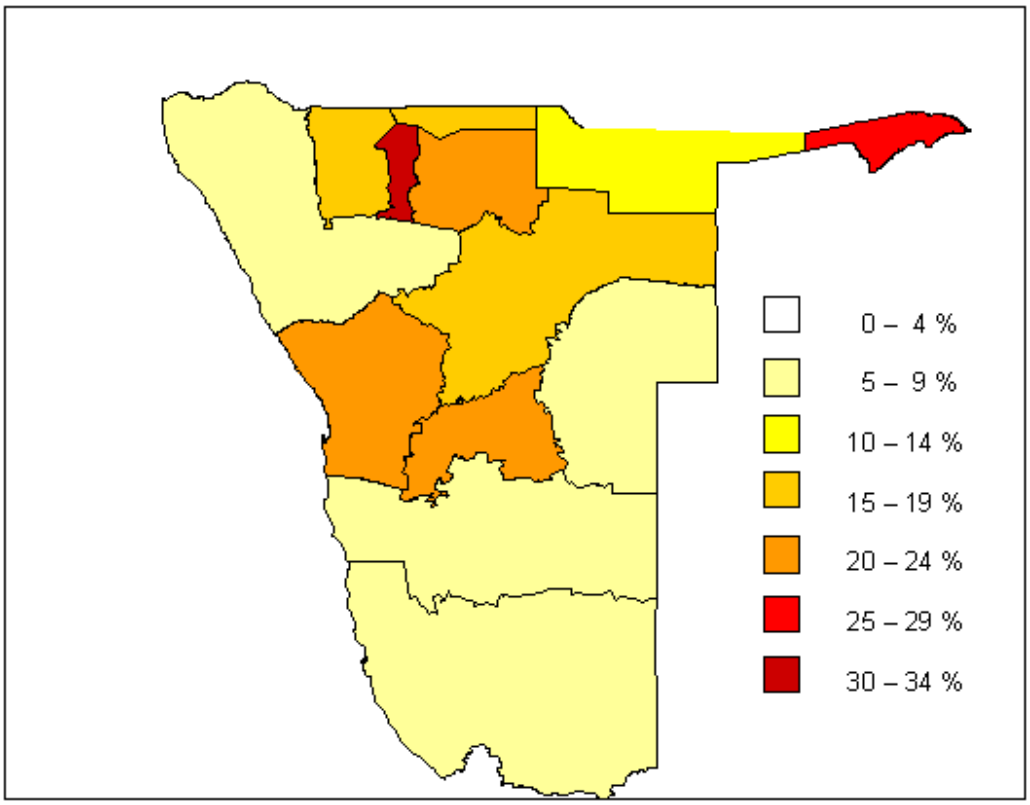


Figure 10: Rates of HIV Infection in Namibia (1998)

Presumably the infection rates in the three regions vary between 10 and 15% in 2005. Unfortunately, the impacts of HIV/AIDS on the growth rates of the regions are not well comprehended. Most key informants do not believe that HIV/AIDS will have an important impact on population growth rates for the regions overall, largely because population growth is driven principally by economic opportunities in these regions, and not by local death rates. The loss of working age adults may therefore draw more migrants to the regions. If, on the other hand, economic opportunities in these regions decline, the resultant reduction in in-migration may cause the effect of AIDS-related deaths to be more prominent.

While HIV/AIDS will slow the Namibian population growth rate over time, it is apparent that the epidemic will not prevent the significant population movements associated with emerging economic opportunities in the south. This is the key determinant of population growth in the south, and of particular interest to ORASECOM. If, for example, a mine opens on the Orange River, and creates 500 jobs (as in the case of the Skorpion Mine), it will draw about five times more people from the northern parts of Namibia. It is thus clear that a mine of such magnitude may draw enough people to replace at least half of all

AIDS-related deaths in the Karas region over the next five years. It also means that if the mining activities at Oranjemund expand at the same magnitude, in-migration would likely surpass AIDS-related deaths.

In order to understand the impact that AIDS has on the population as a whole, the following section explores trends based on modelling similar to that done in Lesotho.

5.6 HIV/AIDS Trends

In 1991, some 14,000 Namibians were HIV positive and had not yet died of AIDS. This has risen rapidly to 28,200 in 1992; 50,000 in 1993; 77,400 in 1994; and tripled to 240,200 by 2001. Rapid increases will presumably level off by the year 2006 at around 273,300, with cases averaging near 367,400 from 2016. As noted earlier, it is estimated that the average HIV positive person will take eight and a half years from infection before AIDS develops. Therefore, the number of AIDS-related deaths will lag behind HIV-infection by about a ten-year period. The Spectrum model indicates the exponential growth in cumulative AIDS-related deaths, rising to over 500,000 total deaths by the year 2020, while the annual AIDS-related death rate will begin to decrease, based on the current model estimates.

A UNAIDS report from 2000 summarises the demographic changes arising from AIDS as follows:

“The base of the pyramid is less broad. Many HIV-infected women die or become infertile long before the end of their reproductive years, which means that fewer babies are being born; and up to a third of the infants born to HIV-positive mothers will acquire and succumb to the infection. But the dramatic change in the population pyramid comes around 10 or 15 years after the age at which people first become sexually active, when those infected with HIV early in their sexual lives begin to die off. The populations of women above their early 20s and men above their early 30s shrink radically. As only those who have not been infected survive to older ages, the pyramid becomes a chimney.”

For the age group 5-18, deaths from AIDS had little impact until the end of the 1990s, with 1995 showing the first year of decline. Most of this decline is due to children never being born because one or more parent has died of AIDS, and to a lesser extent due to HIV positive children being born but dying before their fifth birthday.

5.7 Looking Ahead

Because the population in the study area is relatively small compared to the vast area, the relative influence of economic developments on the size of the population is considerable.

While most parts of the ORASECOM catchment area receives summer rainfall, the south-western part is classified as a winter rainfall area. Although experiencing a low annual rainfall of between 100 mm and 200 mm per annum, the successful production of table grapes and dates along the northern banks of the Orange (mainly at Aussenkjer) and at the Naute Dam has demonstrated the possibility to utilize the natural resources, the sustainability of which need to be monitored.

Tourism, which has developed into Namibia's fastest growing sector after mining and agriculture, holds potential in further developing the southern and eastern parts of the ORASECOM catchment area, especially along the Konkiep, Fish River Canyon and the Karas Mountain area. Recognition must also be given to the fast growing cultural tourism sector which can capitalize from culture and tradition of the Nama who inhabited Namibia's south during the 1740's, generally entering the country from South Africa at the Velloorsdrift area, or the following Orlam Nama (1800's) and Rehoboth Baster (1870) tribes following the Nama but penetrating even further north.

Studies are currently being conducted to introduce olive and date farming along the northern banks of the Orange River near Oranjemund while the possibility to introduce cash crop farming and a horticulture project at Rosh Pinah is also investigated. The town of Rosh Pinah has probably almost tripled in size because of the development of the Skorpion Zinc Mine. Alternatively, the reduction in land-based mining activities over the past ten years near Oranjemund has resulted in a decline in the town's population, although this appears to have been halted by off-shore developments. A feasibility study has been conducted for another mine near the Orange River, near Noordoewer but a number of key informants do not think that the mine will take off.

There is also a feasibility study currently underway investigating the possibility to establish the Haib copper mine at Noordoewer while an irrigation scheme near Noordoewer is also investigated. There has also been some discussion of expanding irrigation at Aussenkjer, but a dispute has arisen with a mining company who has rights over land in the area.

With regard to the Hardap Region, there are not many new economic developments, with a few exceptions. An irrigation scheme is planned at Brukkaros. The town of Tses, near

the irrigation site, would probably grow considerably, especially during the construction phase. The town has a severely restricted water supply and this would temporarily worsen, until the dam is built and provides water for the town. In addition, the Ministry of Lands and Resettlement is investigating the possibility to introduce an agricultural scheme at Voigtsgrund, one of its resettlement farms in the Hardap Region.

In short, economic opportunities have important impacts on how many people will live in these regions, how many of them would be migrants from outside the region, whether they will establish themselves for the long-term in the region, and whether they will migrate for short or long periods of time. The table below illustrates the main economic activities practiced and development potential of the regions and the economic active urban areas falling within the Namibian catchment area of the Orange river.

Table 12 Regional Economic activities

Region	Activity / Major Centres	
Omaheke Region	Cattle farming; game (farming, hunting); tourism (cultural, wildlife)	
	Gobabis	Regional administration and governance; agricultural and transport service centre; tourism; feedlot and dairy production
	Leonardville	Irrigation (cash crops, fodder); tourism
Hardap Region	Sheep and cattle farming; tourism (scenery, wildlife)	
	Rehoboth	Tourism; agricultural service centre; irrigation (fodder and horticulture)
	Mariental	Regional administration and governance; regional and agricultural service centre; irrigation scheme (cash crops, fodder); tourism
	Maltahöhe	Tourism; service centre
Karas Region	Mining (diamonds, zinc, lead, copper); sheep and cattle farming; tourism (scenery, wildlife, cultural); trade (import / export); fishing, irrigation (table grapes, olives, dates); aquaculture	
	Keetmanshoop	Regional administration and governance; regional, agricultural and transport service centre; tourism; meat processing (sheep, ostrich)
	Lüderitz	Service centre; harbour; tourism; aquaculture
	Oranjemund	Mining; irrigation (dates and olives); eco-tourism; aquaculture
	Rosh Pinah	Mining; service centre; eco-tourism
	Karasburg	Agricultural service centre

5.8 Key Namibian Literature

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6 SOUTH AFRICA

6.1 Introduction

This section of the report seeks to review available information on population distribution, population growth, demographic movements and the impact of HIV/AIDS on the South African population living within the Orange River basin. The objective of the review is to give an indication of the extent, availability, nature and quality of the available demographic data.

6.2 Method

The task has consisted principally of the collection, review and interpretation of existing published demographic data. Particularly data made available by Statistics SA (STATSSA), the legislated statistical department of the SA government.

The methodology followed in pursuit of the objective includes:

- Sourcing statistical data on population distribution, population growth, migration and HIV/AIDS from a range of sources including: government departments, District Municipalities (DM), research institutes, professional bodies and private companies.
- Establishing what methodologies, approaches and assumptions are being used to determine population and HIV/AIDS statistics and migration dynamics.
- Reviewing, assessing and comparing data, assumptions and approaches.

6.3 The Orange River Basin & Demographics in South Africa

STATSSA is South Africa's legislated demographer, however there are numerous institutions generating demographic data for a range of purposes. This scenario has produced a lively debate fuelled by a range of interested parties including academics, the private sector, government (at all levels), NGOs and Community Based Organisations, politicians and so on. The interests themselves are equally broad and include those whose interests lie in methodology and fine tuning models, those, such as the insurance industry, who need to determine risk profiles, those whose interests lie in the delivery of services, such as municipalities, and those with political agendas. In general the debate is healthy.

With respect to the demographics of specific river basins, South African demographic data is understandably limited as there is limited demand for data making use of basins as geographic entities. Nevertheless it is reasonable to assume that one can build a picture of a particular basin's demographics by making use of geographic entities originally demarcated for alternative purposes. What is more problematic in determining basin demographics is the purpose for collecting such data. In most cases it is to make calculations about current and future water requirements and this purpose is complicated by inter-basin transfers (there are additional complicating factors e.g. groundwater reserves which obviously do not reflect the same geographic patterns as surface water basins etc but these are not considered in this study).

The focus of this study is the demographics of the Orange River basin. This basin is by far the largest in South Africa and covers a considerable extent of the country including most of the densely populated Gauteng province as well as the sparsely populated areas of the Northern Cape. In addition to the area of the basin itself there are three significant inter-basin transfers to be taken cognisance of in determining any relationship between population and access to water. These are:

- The transfer out of the basin from the Gariep dam to the Eastern Cape via the Fish River Tunnel,
- The transfer out of the basin by Rand Water to serve the northern parts of the Johannesburg Metropolitan area (the Witwatersrand which forms the watershed between the Orange-Vaal basin and the Limpopo basin runs in an east-west direction through the centre of the Johannesburg Metropolitan area),
- The transfer into the basin from the Tugela River via the Tugela-Vaal pumped storage scheme.

The Lesotho Highlands Water Project is not considered an inter-basin transfers for demographic purposes as the transfer is from one area within the basin to another area within the basin.

Bearing in mind the difficulty of equating exactly the area of the basin with existing geographic entities where population data is known, the approximate total population of the Orange Basin in South Africa was some 13,357,298 people, according to STATSSA in the 2001 Census. This translates in to some 30% of South Africa's population (where the total population is 44,819,778 according to the 2001 census). A detailed breakdown of the

Orange River Basin's population per LM is reflected in the Table below. In addition a population density map is included as an Appendix.

Table 13: Census 2001 population statistics per DM & LM within the Orange River Basin.

District Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	LM Total	DM Total
Kgalagadi	CBDC1	Ga-Segonyana	CBLC1	61154	5,385	66	3,786	70,391	176,917
		Gamagara	NC01B1	7803	4,070	9	4,298	16,180	
		Kalahari	NCDMACB1	4672	500	4	1,065	6,241	
		Moshaweng	NW1a1	83528	523	12	42	84,105	
Frances Baard	DC9	Phokwane	CBLC7	47542	6,906	36	6,842	61,326	324,803
		Sol Plaatje	NC091	109904	63,860	1,590	26,108	201,462	
		Dikgatlong	NC092	21659	11,511	54	2,546	35,770	
		Magareng	NC093	15725	3,695	138	2,174	21,732	
		Diamondfields	NCDMA09	2274	1,832		407	4,513	
West Rand	CBDC8	Merafong City	CBLC8	175770	1,618	279	32,814	210,481	738,369
		Mogale City	GT411	219970	2,109	6,365	61,281	289,725	
		Randfontein	GT412	88680	13,273	221	26,660	128,834	
		Westonaria	GT414	97464	512	178	11,175	109,329	
Ekurhuleni Metropolitan	East Rand	Ekurhuleni Metro	East Rand	1891299	67,210	39,669	482,098	2,480,276	2,480,276
Ukhahlamba	DC14	Senqu	EC142	131918	1,542	39	1,643	135,142	203,766
		Maletswai	EC143	30756	3,390	30	3,131	37,307	
		Gariep	EC144	22774	5,878	3	2,650	31,305	
		Oviston Reserve	ECDMA14	3	9			12	

District Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	LM Total	DM Total
Xhariep	DC16	Letsemeng	FS161	27893	10,846	36	4,205	42,980	135,237
		Kopanong	FS162	40631	9,935	27	5,348	55,941	
		Mohokare	FS163	32382	1,106	6	2,822	36,316	
Motheo	DC17	Naledi	FS171	24790	895	112	1,681	27,478	728,262
		Mangaung	FS172	534171	31,953	1,043	78,271	645,438	
		Mantsopa	FS173	48857	2,483	219	3,787	55,346	
Lejweleputswa	DC18	Masilonyana	FS181	59219	862	9	4,319	64,409	657,017
		Tokologo	FS182	27319	2,208	6	2,925	32,458	
		Tswelopele	FS183	50878	720	15	2,107	53,720	
		Matjhabeng	FS184	355998	9,014	474	42,681	408,167	
		Nala	FS185	92972	602	18	4,671	98,263	
Thabo	DC19	Setsoto	FS191	114922	1,110	636	6,529	123,197	725,942
Mofutsanyane		Dihlabeng	FS192	114671	1,834	175	12,248	128,928	
		Nketoana	FS193	58211	147	24	3,569	61,951	
		Maluti a Phofung	FS194	355395	438	439	4,515	360,787	
		Phumelela	FS195	47436	102	36	3,334	50,908	
		Golden Gate Park	FSDMA19	162			9	171	
Northern Free	DC20	Moqhaka	FS201	144673	4,814	180	18,226	167,893	460,315
State		Ngwathe	FS203	102166	3,638	78	12,930	118,812	
		Metsimaholo	FS204	93976	617	190	21,188	115,971	
		Mafube	FS205	53421	312	36	3,870	57,639	

District Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	LM Total	DM Total
Sedibeng	DC42	Emfuleni	GT421	553297	7,113	5,845	92,163	658,418	794,598
		Midvaal	GT422	38163	922	293	25,259	64,637	
		Lesedi	GT423	57499	607	565	12,872	71,543	
Johannesburg Metro	JHB	Johannesburg	Johannesburg	2369958	206,552	134,046	515,252	3,225,808	3,225,808
Namakwa	DC6	Richtersveld	NC061	1178	7,708	12	1,232	10,130	87,372
		Nama Khoi	NC062	1372	39,264	63	4,050	44,749	
		Hantam	NC065	288	16,417	27	3,087	9,819	
		Karoo Hoogland	NC066	325	8,321	18	1,849	10,513	
		Khai-Ma	NC067	1447	8,719	9	1,174	11,349	
		Namaqualand	NCDMA06	36	593		183	812	
Karoo	DC7	Ubuntu	NC071	2850	11,847	18	1,660	16,375	164,614
		Umsombomvu	NC072	13883	8,055	18	1,686	23,642	
		Emthanjeni	NC073	10555	20,650	51	4,294	35,550	
		Kareeberg	NC074	190	8,271	24	1,001	9,486	
		Renosterberg	NC075	2491	5,621	6	951	9,069	
		Thembelihle	NC076	1901	10,118	27	1,937	13,983	
		Siyathemba	NC077	3013	13,010	15	1,476	17,514	
		Siyancuma	NC078	9714	22,479	33	3,587	35,813	
		Bo Karoo	NCDMA07	256	2,360		566	3,182	

District Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	LM Total	DM Total
Siyanda	DC28	Mier	NC081	87	6,498	3	253	6,841	209,884
		Kai Garib	NC082	13207	39,993	24	4,457	57,681	
		Khara Hais	NC083	14359	48,499	72	10,860	73,790	
		Kheis	NC084	851	13,739	6	1,434	16,030	
		Tsantsabane	NC085	14721	12,994	48	3,250	31,013	
		Kgatelopele	NC086	7313	5,523	72	2,537	15,445	
		Benede Oranje	NCDMA08	1167	6,304	3	1,610	9,084	
Central	DC38	Setla-Kgobi	NW381	103247	793	27	261	104,328	625,569
		Tswaing	NW382	106120	1,328	72	6,636	114,156	
		Mafikeng	NW383	247569	5,484	1,858	4,571	259,482	
		Ditsobotla	NW384	131693	3,072	410	12,428	147,603	
Bophirima	DC39	Kagisano	NW391	93625	1,465	15	1,283	96,388	439,686
		Naledi	NW392	43223	7,739	607	6,537	58,106	
		Mamusa	NW393	44336	1,107	141	2,784	48,368	
		Greater Taung	NW394	179043	2,085	72	963	182,163	
		Molopo	NW395	10507	276	3	907	11,693	
		Lekwa-Teemane	NW396	34909	2,651	81	5,327	42,968	
Southern	DC40	Ventersdorp	NW401	36940	1,309	69	4,771	43,089	599,687
		Potchefstroom	NW402	90485	8,263	543	29,067	128,358	
		City Council of Klerksdorp	NW403	283944	9,968	1,391	63,900	359,203	
		Maquassi Hills	NW404	60904	1,458	115	6,560	69,037	

District Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	LM Total	DM Total
Govan Mbeki	DC30	Msukaligwa	MP302	111524	342	811	12,141	124,818	569,176
		Lekwa	MP305	89125	1,892	963	1,290	103,270	
		Dipaleseng	MP306	35122	67	290	3,135	38,614	
		Highveld East	MP307	185458	2,396	2,036	31,853	221,743	
		Seme	MP304	74337	422	457	5,515	80,731	
TOTAL POPULATION FOR THE ORANGE RIVER BASIN - SOUTH AFRICA								13,368,054	13,357,298

There are however, as noted above, a range of alternatives to the STATSSA figures which are regularly used, such as those used by the Demarcation Board, the DBSA, the Association of SA Actuaries, the CSIR, the Local and District municipalities and others. Nevertheless, the most accessible data and the data used by the national and provincial governments in the allocation of resources etc remains the STATSSA data and thus it remains a benchmark against which other statistics are most often compared. Thus, in respect of building a data set for the Orange River Basin the point of departure should be the official STATSSA figures and where detailed planning is required for specific areas or developmental projects research should be undertaken to address the specific requirements.

The best practice demographic model currently favoured by statisticians (including STATSSA) makes use of cohort-component methodology. In general the process followed in this methodology is as follows:

- A base population where the number of people and their characteristics is well known is established for a specific year.
- The population is divided into specific age categories (the categories are determined by the common experiences of people of a similar age).
- Trends in fertility, mortality and migration are analysed and assumptions are made in respect of these factors for each age category.
- The fertility, mortality and migratory assumptions are then applied to each existing age categorized cohort (group).
- Each age cohort (group) is then projected through each of the established age categories and as it moves through each of these categories the age specific fertility, mortality and migratory assumptions are applied.

Quite simply the model reflects that, as a group of peers moves from one life stage to the next it experiences different things but that within each life stage most people will have similar experiences. As a result statisticians are able to calculate the fertility, mortality and migratory experiences of each group of similar aged people. It follows therefore that as a group moves from one life stage to another the statistical assumptions relevant to each new life stage can be applied and hence the group's numbers will rise or fall before the group moves on to the next life stage where a new set of statistical assumptions will apply. In this way demographers are able to establish demographic patterns and make projections in to the future.

In respect of the objectives of ORASECOM, a recent (released in 2001) study commissioned by DWAF and led by Professor Lawrence Schlemmer in association with MarkData and Eric Hall & Associates stands out as particularly relevant in that it specifically investigates the population of South Africa's urban areas with respect to water demand. The Schlemmer study was commissioned in 1995 with the objective of formulating scenarios of demographic and economic change relevant to the broad planning and management of water resources, and of providing estimates of water usage for human consumption in all urban areas (consumption centres) throughout the country in five-year increments under these scenarios to the year 2025.

The researchers found the most significant challenges in the forecasting exercise were to correct for probable undercounts and deviations in the census data and to predict the impact of HIV/AIDS on future growth

The study recognized population growth as the key driver of water use for human consumption. However it stressed the significant inter-relationship between the economy and demographics and suggested that a stronger economy would assist in combating factors associated with the HIV/AIDS epidemic, and that a lower level of AIDS infection would alleviate constraints on the economy and economic confidence.

The result of the Schlemmer study in respect of the national population revealed there to be 41,562,000 people in 1995. In addition extrapolations were made in respect of a "Low scenario" and a "High scenario" population forecast for 2025 with the following results:

- Low forecast: 48 to 50 million
- High forecast: 52 to 54 million

In order to make comparisons between the Schlemmer study and the 1996 Census figure of 41,945,000 the study's results were extrapolated using a growth rate of 1,9% to a 1996 figure of 42,379,000 (1,8 million above the census) as reflected in the table below.

Table 14: Comparisons between the 1996 census and the Schlemmer study

	Schlemmer etal			1996 CENSUS		
Provinces	**Rural**	**Urban**	**Total**	**Rural**	**Urban**	**Total**
Eastern Cape	3,916,000	2,740,000	6,656,000	3,942,000	2,635,000	6,577,000
Free State	843,000	1,982,000	2,825,000	803,000	1,831,000	2,634,000
Gauteng	243,000	7,547,000	7,790,000	217,000	7,823,000	8,040,000
KwaZulu-Natal	4,825,000	3,690,000	8,519,000	4,851,000	3,602,000	8,453,000
Mpumalanga	1,424,000	1,511,000	2,939,000	1,710,000	1,242,000	2,952,000
Northern Cape	203,000	628,000	831,000	264,000	576,000	840,000
Northern Province	3,891,000	1,164,000	5,059,000	4,347,000	590,000	4,937,000
North West	1,980,000	1,527,000	3,507,000	2,183,000	1,172,000	3,355,000
Western Cape	424,000	1,527,000	4,270,000	446,000	3,712,000	4,158,000
South Africa	17,744,000	3,846,000	42,379,000	18,762,000	23,183,000	41,945,000

Note: The rural populations of the Schlemmer study are comparatively lower than the 1996 census data, because of the inclusion of functionally urban fringe areas in the urban population due to the growth of informal settlements in many of the areas.

6.4 Official Demographic Statistics - STATSSA

As mentioned above, Statistics SA (STATSSA) is South Africa's official statistics gathering body. It is a legislated institution falling under the ministry of finance and it is obliged to collect and disseminate statistics on a wide range of issues including the country's demographics. It is governed by the Statistics Council which has a sub-committee devoted to census issues.

Notwithstanding the fact that STATSSA has recently admitted to errors in certain calculations and that its figures are at times disputed, its transparency, its openness to debate, its efforts at making information readily available and its willingness to admit to errors has won it credibility. As a result it is currently recognised as a competent arm of government both inside and outside the country and it meets a number of international statistical reporting standards.

Its importance in collecting data for the development of SA in the post apartheid era is significant. Its success in carrying out the 1996 census two years after the first democratic elections (1994) was a major achievement as it was the first census carried out throughout the entire country since the establishment of homelands which had led to a multiplicity of statistics gathering institutions.

With respect to demographics, STATSSA has undertaken two full censuses (1996 and 2001) and has produced mid-year population estimates annually since the advent of democracy.

In reviewing the extent, availability, nature and quality of the country's official demographic statistics this study has looked at a range of reports, publications and data sets produced by STATSSA.

With respect to the availability of data, all STATSSA publications are publicly available and can be accessed from the STATSSA Library in Pretoria or any of the following libraries:

- National Library of South Africa, Pretoria Division,
- National Library of South Africa, Cape Town Division,
- Natal Society Library, Pietermaritzburg,
- Library of Parliament, Cape Town,
- Bloemfontein Public Library,
- Johannesburg Public Library,
- Eastern Cape Library Services, King William's Town,
- Central Regional Library, Polokwane,
- Central Reference Library, Nelspruit,
- Central Reference Collection, Kimberley and the
- Central Reference Library, Mafikeng.

In addition STATSSA runs an official website (www.statssa.gov.za) which is enabled to allow one to download most current publications and where this is impractical a number of digital products can be obtained directly from STATSSA. In the latter respect an easily available and user friendly set of 12 CDs giving one access to all the information captured in the 2001 Census, is available for approximately R1000.00[5]. This data set allows one to access data to sub-place-name level.

[5] Following the sale of the Census 1996 data set in a similar format much debate was generated around the legitimacy of the public having to purchase data which was collected at taxpayer's expense. As a result and in the light of current access to information policies the data is supplied free and the costs are associated with producing, package and distributing the data and training manuals and support in accessing it.

Information can also be accessed through direct contact with STATSSA[6] and their library service and support for technical enquiries is currently effectively supported.

6.5 Census 1996

The 1996 Census was the first fully comprehensive South African census since 1970 and the first in a democratic SA. The extensive use made of the data by a number of institutions, municipalities and organisations has resulted in this data being the basis for extrapolations and predictions which continue to be used, notwithstanding the release of data from the 2001 census. As a result a brief account of it is made in this study.

6.5.1 Census 1996 Background

During Apartheid, census taking was done as separate exercises in the former Transkei, Bophuthatswana, Venda and Ciskei areas and the detailed life circumstances and aspirations of the people of these areas was not collected. In contrast Census '96 was a full census covering the entire country. It was conceptualized and managed in-house as four separate but sequentially linked processes (phases): pre-enumeration, enumeration, data processing, and analysis and dissemination. During the pre-enumeration phase the country was divided into some 86,000 Enumerator Areas (EA) of approximately 150 households each. Thereafter each household was visited and detailed information was collected about each member from a representative who was either interviewed, or who filled in the questionnaire themselves, in one of the 11 official languages.

6.5.2 Census 1996 Problems and Results

Generally the 1996 census was a success. However major difficulties were experienced with the payment of the temporary workers, and the technical and management aspects of data processing.

The most significant issue with respect to the data from the 1996 Census was that, STATSSA could not be sure whether 22% of the households visited during the Post Enumeration Survey (PES) had been visited during the actual count.

The overall result was a population of some 40,583,5573 people.

6 STATSSA Contact details:
User information - Tel: (012) 310 8600, Fax: (012) 310 8500, Email: info@statssa.gov.za
Technical enquiries - Tel: (012) 310 8636, Fax (012) 310 8339, hestonp@statssa.gov.za

6.6 Census 2001 – "How the count was done"[7]

6.6.1 Census 2001 Background

Democratic SA had its second census in October 2001. STATSSA resolved to carry out a full census as in 1996. This was done in order to establish how the end of apartheid had contributed to demographic patterns and to enable comparison between the 1996 and 2001 census data which would be a critical factor in future planning. In order to manage the 2001 census, a census sub-committee of the Statistics Council was created[8] and an advisory committee comprised of a wide variety of stakeholders and users was set up.

Parliamentary authorization was received and a budget was only approved in late 1999, resulting in a critically short planning period. International assistance, both financial and technical, was received from the United States (Census Bureau [USAID]), Sweden (Stats Sweden), Kenya, Tanzania and the UK.

6.6.2 Management Structure & Planning

Unlike the previous census where tasks were carried out sequentially, Census 2001 followed a project-managed approach and was managed as a series of sub-projects falling under a central coordinating office. The following nine operational projects were established:

- Questionnaire design
- Census mapping (demarcation)
- Geographical information system (GIS) updating and maintenance
- Design and completion of the pilot census
- Enumeration
- Post-enumeration survey (PES) design and execution
- Data processing
- Data tabulation and product planning and implementation.

[7] Most of the information presented in the following subsections is taken from various STATSSA publications. In particular the STATSSA publication "How the count was done" (Ref: 03-02-02).

[8] Members of the Statistics Council who were also members of the census sub-committee were Dr HA Southall (Chair of Council) Prof J Galpin, (Chair of Census sub-committee), Prof RE Dorrington, Mr LC Fouché, Prof JD May, Mr N Mokhesi and Prof CEW Simkins,

- Listing (this task was added after the pilot census revealed a large degree of map illiteracy)

In support of the above operational projects the following seven administrative and support sub-projects were established:

- Financial management and monitoring
- Information technology
- Human resources
- Provisioning
- Logistics
- Provincial management
- Publicity.

Significant inputs from the private sector were made for the first time. These included:

- The payment of temporary workers,
- The technical and management aspects of data processing,
- Publicity and communications,
- Demarcation in various parts of the country,
- Integrating the various management components,
- The development of a computer-based management system - Census Administration System (CAS).

In addition to the National and Provincial offices, 95 regional offices were established, staffed and equipped to carry out the census at local level. The number of regional offices per province was as follows: Eastern Cape 13, Free State 6, Gauteng 16, KwaZulu-Natal 16, Limpopo 6, Mpumalanga 7, Northern Cape 11, North West 7, and Western Cape 13.

6.6.3 Pre-enumeration

Demarcation and map production

With the aid of a Geographic Information System (GIS) the country was demarcated in to some 81,000 Enumerator Areas (EA)[9]. For the first time, on-screen demarcation was possible using the GIS and use was also made of Global Positioning Systems (GPS) to undertake fieldwork in areas of rapid development such as informal settlements.

A geographical hierarchy was established where a number of EAs constituted a sub-place and a number of sub-places constituted a main place and a number of main places constituted an LM or a DMA, and so on, aggregated up to LM, DM, provincial and national level (see figure below). This hierarchy was fundamental in demarcating EAs and later in disseminating census information. In addition to defining the EA boundary, attribute data such as the place name, the type of settlement, and in the case of institutions, the type and name of institution was captured in order to classify the EAs into four primary categories and seven sub-categories according to land use. The four primary categories are as follows:

- Urban Formal Area,
- Urban Informal Area,
- Rural – Commercial Farms,
- Tribal – Traditional areas.

Within these four primary categories EAs were sub-typed as being:

- Residential,
- Farm,
- Small Holding,
- Recreation/Park/State Land,
- Institution,
- Hostel
- Vacant.

[9] Eastern Cape - 18370, Free State – 5183, Gauteng – 13367, KwaZulu-Natal – 12752, Limpopo – 1661, Mpumalanga – 5813, Northern Cape – 10325, North West – 6215, Western Cape – 7101. **Total – 80787**.

Each EA received a unique code number, which was also associated with a bar code and linked to its geographical entities. All subsequent census processes used this number as an identifier and maps were produced for every EA (Approximately 81,000 A3 maps).

The diagram below[10] explains the hierarchical structure used for geographical areas in Census 2001.

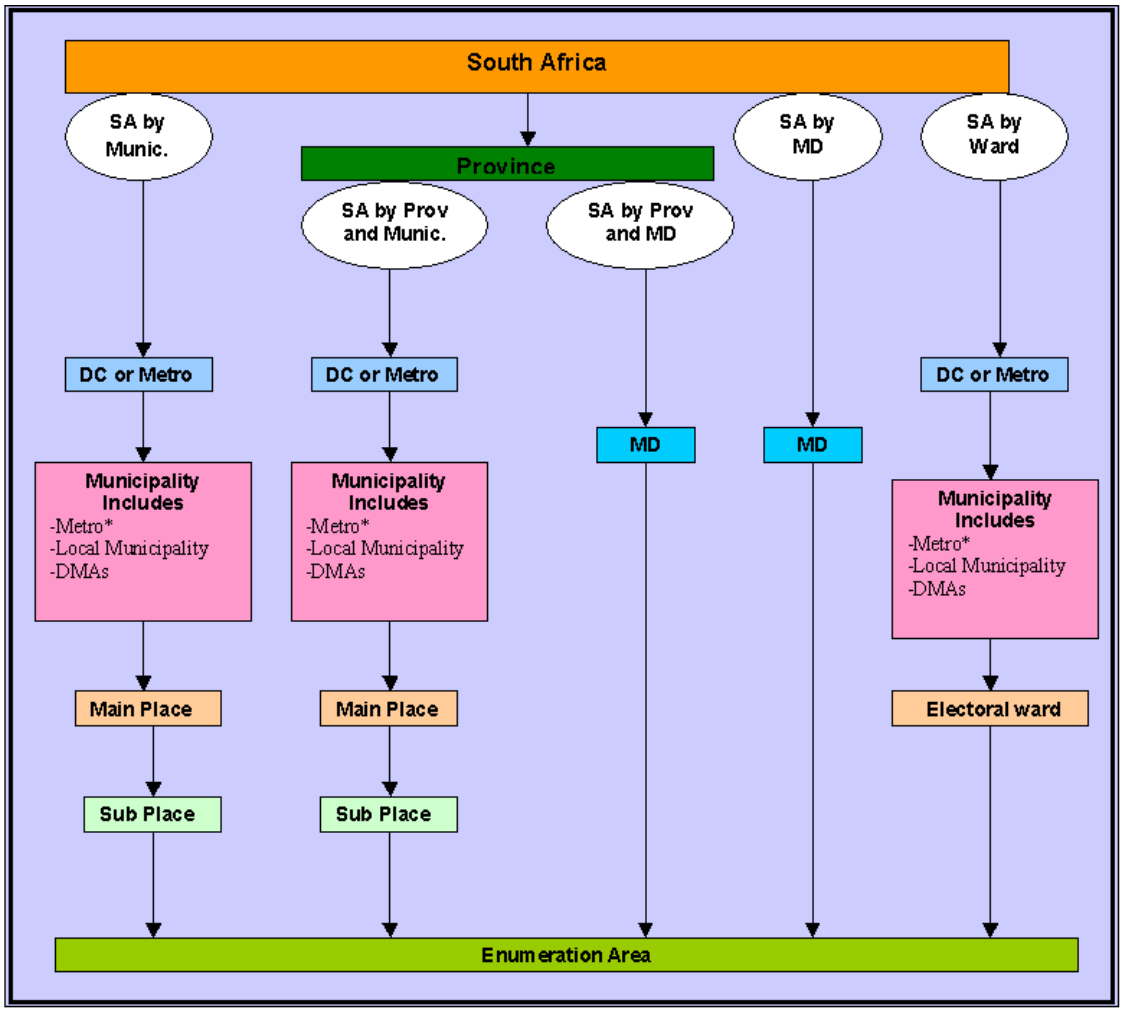


Figure 11: Hierarchical structure used to define geographical areas in Census 2001.

[10] STATSSA publication "How the count was done" (Ref: 03-02-02).

Listing

Listing refers to a list of visiting points within an EA and it has been a common feature of South African census taking and ensures that all households within an EA are visited. The process is relatively difficult in tribal areas and informal areas where formal street addresses do not exist.

In previous censuses listing was undertaken as part of the demarcation and mapping process and included a written description of the EA. In the 2001 census the improvement in mapping technology was presumed originally to be such as to enable the doing away with listing and written description of the EA boundary. After the pilot census, it was discovered that most of those employed were relatively map illiterate and listing was reintroduced as a separate process that was to be undertaken between demarcation and enumeration. Thus a process of employing and training specialized listers to list and write a boundary description for each EA before the census was embarked upon. Ultimately, not all areas in the country were completely listed by the time enumeration began.

Questionnaire

Using the '96 census as a point of departure and after a long process of engaging with stakeholders, three lengthy questionnaires were developed one for households, one for individuals in institutions and one for the institutions themselves. The length of the questionnaire was related to the shortage of available data at local level and the desperate need for information on which to plan for the development of people at grassroots level.

Publicity

Publicity was undertaken to raise awareness and assist in soliciting support from the public to participate in the census. It was one of the areas where the private sector assisted and was approached in a number of ways through various media campaigns and the Census at Schools campaign.

6.6.4 Enumeration

Staff Recruitment

The recruitment, training, and payment for carrying out of enumeration of an enumerator for every EA and a supervisor for every five or so enumerators (approximately 100,000 temporary employees) was an immense task which was doubly difficult considering the short period of time in which it had to be achieved. It is thus not surprising that staff

recruitment, training and payment was a weakness of the census and contributed to a fair share of frustrations.

The staff recruitment function was decentralized to regional offices. Enumerators were expected to have matric, literacy in english, map-reading ability, and knowledge of the language of the area. In addition it was desirable that enumerators come from the area in which they would enumerate in order to facilitate communication and co-operation. Every applicant wrote a standard test and the score was used as a guide to employment. Regrettably the huge applicant list and the time it took to assess tests and appoint staff resulted in the census starting late in some areas. One of the shortcomings was the insufficient number of enumerators recruited from certain communities particularly areas previously designated white. The result was that enumerators designated to these areas knew very little about their areas, had to travel great distances to begin enumeration and were not able to enumerate in the evenings.

Staff Training

Initial training plans relied on cascade training whereby people trained in the processes and methodology, in turn trained further groups of people, and so on down the line. The pilot census revealed an over emphasis on training methods and not enough emphasis on census methodology and a severe lack of map reading skills. Training was subsequently amended to include better training manuals and centralized training. This involved making use of trainers with knowledge of the census process being video-taped and these tapes being used as training materials with head office staff being available for online questions. All enumerators had manuals with instructions for each question.

Staff Payment

Following administrative problems in the 1996 census it was resolved to outsource the payment of staff and the Post Office was initially appointed to undertake the task. However, following payment problems in the payment of those who listed and in the payment of advances to enumerators and supervisors to cover costs of food and travel during enumeration, regional managers were required to become paymasters and later a commercial bank was commissioned to undertake the task. In some areas payment problems delayed the start of the census. On account of the delay in starting and the extension to the counting period, temporary staff in some areas were unsure of whether or not they would be paid for the additional period worked which complicated human

resource problems. Finally it was resolved that once counting was completed and enumerators returned their questionnaires etc they were paid by cheques, which were redeemable from one of the commercial banks.

Pilot

A pilot census was conducted in February and March 2001 which highlighted:

- Limitations to the task-based project management approach which hindered both communication and integration between processes, resulting in task duplication and overlapping, gaps in planning, and in some cases, related tasks being tackled in non-compatible ways.
- A deficiency in lister and enumerator map literacy.
- Differing interpretations of the questionnaires.
- An inadequacy in the administration system, which was unable to capture all the necessary administrative information and was not used correctly.

After the pilot census, revisions to both processes and management methods, including the following, were introduced:

- A revised management process which focused on daily 'Nerve Centre' meetings attended by project and sub-project management to encourage greater integration across sub-projects in order to identify problems and take immediate action. In addition, regular video-conferencing sessions ensured that provincial offices were kept abreast of issues, and a private-sector consultancy was commissioned to assist in management.
- Establishing listing as a process separate from enumeration.
- A review of training methodology which shifted the focus from cascading training downwards to ‘narrowcasting’ which emphasised direct training through video linkages etc.
- The development of a census information and management system, (Census administration system [CAS]) in collaboration with a private sector company.
- The use of a barcode based management system to manage the flow of questionnaires, questionnaire boxes, data etc throughout all processes of the census.

In addition to the pilot census a census test was undertaken in August 2001 to further test logistics and the PES questionnaire and also to verify whether the use of barcode stickers on all visiting points assisted in the matching process, which it did.

Census Enumeration

Enumeration through personal interview or self-completion of the questionnaire took place throughout South Africa. The experience differed from one area to another and between one EA and the next depending on particular circumstances.

In some areas language became an issue as people refused to engage with enumerators who did not speak their language or to fill in questionnaires not in their language. Questionnaires were printed in English, Afrikaans and Zulu but the logistics of accessing those in Afrikaans or Zulu from the field was difficult.

Some people politicized the process and refused to participate, others were reluctant to divulge information seeing it as a security risk and others were not available or were left out by enumerators for a range of reasons.

The management hierarchy during enumeration relied on Regional Office Managers overseeing Fieldwork Co-ordinators who managed the feedback of data from Supervisors in the field who in turn managed groups of Enumerators.

The key role was that of the Supervisors who co-ordinated and managed Enumerators by reporting on progress and ensuring that they completed their work and submitted accurate completed questionnaires and summary books and in addition they were responsible for enumeration quality. However, control processes required by both the enumeration sub-project and the data-processing sub-project were not adequately integrated and had not been tested in the field and thus daily progress reporting was complicated and burdensome.

Quality control during enumeration by supervisors was planned to include assessments of the first batch of questionnaires completed by each enumerator, including visits to randomly-chosen enumerated households in order to correct any errors and avoid repeating these. However the revisiting of enumerated households as a check was not included in training and nor had it been tested and very few supervisors were able to do the necessary verification

Fieldwork Co-ordinators experienced similar checking and progress reporting difficulties to Supervisors and on account of payment problems they ended up focusing on staffing, money and transport problems, at the expense of quality and coverage.

As the period for enumeration neared its end, it became clear that an extension was essential in most areas to increase coverage. The extension was referred to as the 'mop-up' operation and the rationale for it included:

- Abnormally cold and wet weather conditions prior to and in the early stages of enumeration;
- Delayed recruitment and appointment of temporary staff;
- Initial delays in enumerator payment, which delayed the start of counting;
- Difficulties in finding people at home during the day, and insufficient arrangements for enumerating after hours;
- Difficulties in obtaining access to high-walled properties, areas with heavy security, and commercial farms; and
- Problems with the CAS

The extension certainly assisted in increasing coverage but was not without its own problems. In particular there was confusion surrounding the extension, which resulted in management and human resource problems as people expected more money to cover the extended period or were not prepared to continue where they had been paid and were thus no longer employed.

In addition to the extension STATSSA instituted a call centre, which allowed the public to report that they had not been enumerated and resulted in a follow up visit to the caller. Provision was also made for people who chose to complete their questionnaires themselves to deposit their questionnaires at post offices.

Post Enumeration Survey (PES)

Immediately following the census a Post Enumeration Survey (PES) of 600 EAs, making up a representative sample of the country, was undertaken along similar lines to the census, in November 2001. The aim of the PES was to determine the degree of difference between the census and the survey in order to make adjustments for errors of coverage and errors of content so as to achieve more reliable data.

Most of the enumerators used in the PES were selected from the pool of annual October Household Survey fieldworkers and were considered to be highly competent.

The critical factor in such a survey is to match the questionnaire completed during the census with that completed during the PES. This issue was addressed through the use of barcode stickers from the census questionnaire being left at the address and then recorded later at the time of the PES. This innovation was particularly successful in achieving the necessary matching which was undertaken manually.

After adjustments the PES revealed the following percentage undercount per province.

Table 15: Percentage undercount for persons and households per province

Percentage undercount for persons and households per province		
Province	**Persons %**	**Households %**
Eastern Cape	14,74	15,55
Free State	17,63	20,60
Gauteng	18,74	23,02
KwaZulu-Natal	22,51	26,21
Limpopo	14,36	17,04
Mpumalanga	16,08	17,24
Northern Cape	14,07	17,81
North West	16,02	20,29
Western Cape	16,27	16,93
South Africa.	17,64	20,52

6.6.5 Data Processing

Once all the questionnaires were returned to a central processing centre in Pretoria, data-capturing was largely a digital exercise founded on scanning each questionnaire into a database as an image and interpreting the image with appropriate optical character recognition technology. The result, after a year and a half (February 2003) of capturing cleaning and editing was a digital database (with an accuracy level of some 98.9%) which was much easier to manage, and allowed for effective utilization of the data.

“Imputation was used to allocate values for unavailable, unknown, incorrect or inconsistent responses. The editing system uses a combination of both 'logical' imputation techniques and 'hot decks' (dynamic imputation). 'Undetermined' values were used for only a few variables in a few cases (such as industry and occupation). Logical imputations, in which a consistent value is calculated or deduced from other information in the household, are usually preferred over hot deck imputations. Generally, the editing system attempts to

resolve inconsistencies first by looking at other characteristics of the household (for example, a married person with an invalid response for sex would be assigned the opposite sex to their spouse). If this is unsuccessful, then a consistent value is imputed from a hot deck, which bases the imputation on nearby persons or households that share similar characteristics". [11] The complete set of editing specifications for Census 2001 is available upon request from Statistics South Africa (Ref: 03-02-43).

6.6.6 Adjustments, Analysis, Results & Dissemination

Once data processing was complete the census results were assessed and compared with the PES results and various statistical processes were applied. The unadjusted (persons actually counted) and adjusted results (results after the PES and other statistical adjustments were made) were as follows:

Table 16: Census 2001 unadjusted and adjusted population figures per province

	Persons		Households	
Province	**Unadjusted count**	**Adjusted count**	**Unadjusted count**	**Adjusted count**
Eastern Cape	5 537 841	6 436 763	1 288 456	1 512 664
Free State	2 255 442	2 706 775	587 518	733 302
KwaZulu-Natal	7 392 274	9 426 017	1 572 591	2 086 250
Gauteng	7 270 597	8 837 178	2 079 100	2 651 244
Limpopo	4 543 051	5 273 642	1 000 619	1 179 965
Mpumalanga	2 641 152	3 122 990	617 505	733 131
Northern Cape	714 708	822 727	172 870	206 842
North West	3 108 050	3 669 349	753 410	929 004
Western Cape	3 839 068	4 524 335	985 411	1 173 304
South Africa	37 302 183	44 819 778	9 057 480	11 205 705

The census sub-committee reported that the 2001 census probably resulted in:

- An underestimate of the number of children below age five (this is a common feature of censuses, particularly in developing countries)
- An over-estimate of the number of teenagers aged between 10 and 20

[11] STATSSA, Census in Brief 2001 Report No 03-02—03 (2001)

- An underestimate of the number of men relative to the number of women (This is a common feature of censuses, particularly in developing countries)
- An underestimate of the white population's numbers
- Higher than expected numbers aged 80 and older, in the African population
- An underestimate of the number of foreign-born, since some identified themselves incorrectly as having been born in South African
- Age misstatement in the range 60-74
- An overestimate of the extent of unemployment
- An underestimate of those who were employed for only a few hours per week
- An underestimate of household income
- An overestimate in the number of paternal orphans and the number of fathers missing from the household.

In addition the census sub-committee noted that:

- "Scanning problems caused some births to be recorded in the wrong province. The number of cases is relatively small and should not lead to too much distortion for most purposes for which these data are used; however, it does produce obviously erroneous results when one tries to estimate the extent of inter-provincial migration of those born since the previous census."
- The fertility data (numbers of children ever born, children surviving) is problematic.
- Adjusted population figures by province, population group, sex and age, with 95% confidence limits are as indicated in the following table.

Table 17: Adjusted population figures with 95% confidence levels

95% Confidence Interval Limits			
Category / **Province**	**Estimate**	**Lower**	**Upper**
Eastern Cape	6,436,763	6,286,402	6,587,125
Free State	2,706,775	2,665,303	2,748,247
Gauteng	8,837,178	8,520,018	9,154,338
KwaZulu-Natal	9,426,017	9,030,906	9,821,128
Limpopo	5,273,642	5,244,376	5,302,907
Mpumalanga	3,122,990	3,081,917	3,164,064
Northern Cape	822,727	812,071	833,384
North West	3,669,349	3,608,191	3,730,507
Western Cape	4,524,335	4,439,010	4,609,661
Total	44,819,776	43,688,194	45,951,361
Population group	Estimate	Lower	Upper
Black African	35,416,166	34,923,119	35,909,213
Coloured	3,994,505	3,917,140	4,071,871
Indian or Asian	1,115,467	1,084,589	1,146,345
White	4,293,640	4,205,194	4,382,086
Sex	Estimate	Lower	Upper
Male	21,434,040	21,182,666	21,685,415
Female	23,385,737	23,108,636	23,662,839
Age group	Estimate	Lower	Upper
0-4	4,449,816	4,390,734	4,508,897
05-Jan	9,915,472	9,768,819	10,062,125
15-19	4,981,721	4,920,430	5,043,011
20-29	8,229,462	8,133,430	8,325,494
30-44	9,032,136	8,925,942	9,138,330
45-64	5,995,960	5,930,696	6,061,224
65+	2,215,211	2,191,652	2,238,771

Thus the population of South Africa according to STATSSA as a result of the 2001 Census is 44,819,778 people as compared with 40,583,573 people found in the 1996 Census, a summary per province is given in the table below.

Table 18: Comparative population data from Census 1996 and Census 2001

	October 2001		October 1996	
Province	**No.**	**%**	**No.**	**%**
Eastern Cape	6 436 763	14,4	6 302 525	15,5
Free State	2 706 775	6,0	2 633 50	6,5
Gauteng	8 837 178	19,7	7 348 423	18,1
KwaZulu-Natal	9 426 017	21,0	8 417 021	20,7
Limpopo	5 273 642	11,8	4 929 368	12,1
Mpumalanga	3 122 990	7,0	2 800 711	6,9
Northern Cape	22 727	1,8	840 321	2,1
North West	3 669 349	8,2	3 354 825	8,3
Western Cape	4 524 335	10,1	3 956 875	9,7
South Africa	44 819 778	100,0	40 583 573	100,0

Dissemination

STATSSA has effectively utilized a range of dissemination vehicles in both print and electronic format to disseminate their findings. In general their data is readily and easily available and requests to the organization are ordinarily well received and effectively addressed. Libraries, government offices and educational institutions have access to their data and in most cases make it available to the public. Essentially the data itself is available free of charge though fees are incurred for the services offered in printing, downloading, disseminating etc.

The STATSSA internet site is relatively user friendly and provides access to information of a generalized nature going down to ward level. For more detailed data which allows for focused searches down to sub-place name level a series of 12 CDs can be purchased (R1,000.00) and utilized in most GIS packages.

A variety of other census products are available from STATSSA including the following:

- Printed Reports (also available in PDF format on the internet):
- Key census results, a pamphlet aimed at the general public, which outlines briefly how the count was done and contains a few highlights of the results (Ref: 03-02-01).

- Census in brief, an A6 booklet consisting of over 80 tables and graphs at national and provincial level, for an extensive range of individual and household variables (Ref: 03-02-03).
- How the count was done (Ref: 03-02-02).
- Thematic and other posters.
- Primary tables, giving more detailed information on the results in tabular form, for the country as a whole (Ref: 03-02-04) and for each province (Ref: 03-02-05 to 03-02-13).
- Post-enumeration methodology (Ref: 03-02-17)
- Census review (Ref: 08-02-18)
- Key municipal data, which contains breakdowns at municipal level for a range of individual and household variables (Ref: 30-02-21).

Electronic products available on the internet or on request:

- Interactive Internet products: a series of interactive products, for users to compile tables according to their own specifications.
- Community profiles: for users who wish to arrange and combine information into their own unique tables, at different levels of geography (Ref: 03-02-22).
- Age tables by single-year breakdowns for the country as a whole (Ref: 03-02-30) and for each province (03-02-31 to 03-02-39).
- Census concepts and definitions: an alphabetical listing of concepts and definitions used during the census, with some methodological notes (Ref: 03-02-26).
- Other general and geographical metadata files. The general metadata files include, among other things, the exact wording of each question, the guidelines that were given to the enumerators on how to interpret the replies, and the final code lists for all census data (Ref: 03-02-24). The geographical metadata file explains the geography of the census and the coding of all the geographic areas in the country (Ref: 03-02-25).
- Demographic atlas. This product will display the demographic characteristics of various towns, cities and municipalities (Ref: 03-02-28).
- In addition, the following electronic products are available on request:
- CD Rom disks containing the community profiles described above (Ref: 03-02-22).

- My constituency: a CD with census findings for all electoral wards, designed to give parliamentarians more information about the wards they represent (Ref: 03-02-29).
- Special requests. A set of tables can be produced by Stats SA, either at head office or in each province, providing specific information, at any level of geography: EA, sub place, main place, municipal, magisterial district or provincial level.
- Sample database in SuperCross and ASCII. This sample of census records is designed for researchers wishing to do their own analyses. (Ref: 03-02-23).
- CD with spatial (GIS) data. This product is designed for users with their own GIS software. These digitised enumeration areas and boundaries can serve as a backdrop for any GIS system. The CD contains information about all geographical areas in the country, from provincial to the smallest area (Ref: 03-02-27).

Publications can be ordered from: Printing and Distribution, Statistics South Africa, Tel: (012) 310 8251, Fax: (012) 322 3374, E-mail: distribution@statssa.gov.za

6.7 Census 2001 Results

The Census 2001 population statistics per District and Local municipalities which fall within the Orange River basin are highlighted in **Table 11** of section 6.3 above.

6.8 STATSSA Post Census Statistics

Annually STATSSA publishes its “Mid-year population estimates” which is an updated overview of the population based on statistical growth rates. These estimates are limited in that they specifically apply to national and provincial level but not to municipal or local level. The mid-year estimates ordinarily give indications of assumptions and methods and are relatively comprehensive and informative. The latest release is given in the table below and it is notable that STATSSA has given some indications of alternative data sources in their release.

Table 19: STATSSA 2005 population data (compared to other sources)

Model	2000	2005
Estimated total population in millions		
ASSA 2002*	44,0	46,0
ASSA 2002**	44,0	46,2
BMR 2004	-	47.0
HSRC	43,1	45,1
Stats SA	44,5	46,9
Life expectancy at birth		
ASSA 2002*	55	46
ASSA 2002**	56	49
BMR 2004	-	46
HSRC	50	45
Stats SA	53	47
Infant mortality rate		
ASSA 2002*	65,6	68,0
ASSA 2002**	63,5	52,3
BMR 2004	-	72,1
HSRC	65,5	56,2
Stats SA	54,3	53,6
Total annual number of deaths in millions in the year starting 1 July		
ASSA 2002*	0,6	0,8
ASSA 2002**	0,5	0,8
BMR 2004	-	0,9
HSRC	0,6	0,8
Stats SA	0,5	0,7
HIV-prevalence rate for adults aged 15–49 years		
ASSA 2002*	15,4	20,3
ASSA 2002**	14,7	18,8
HSRC	17,0	16,3
Stats SA	14,2	16,7
Total fertility rate		
ASSA 2002*	2,7	2,5
ASSA 2002**	2,7	2,5
Stats SA	2,9	2,8
Birth rate		
ASSA 2002*	24,8	22,4
ASSA 2002**	24,8	22,3
HSRC	25,9	23,5

Model	2000	2005
Stats SA	24,6	23,8
Annual number of births in millions in the year starting 1 July		
ASSA 2002*	1,09	1,03
ASSA 2002**	1,09	1,03
BMR 2004	-	1,18
HSRC	1,12	1,06
Stats SA	1,09	1,09
Notes: ASSA 2002. Results from running ASSA2002 with "no" to interventions (see http//www.assa.org.za) ** ASSA 2002. Results from running ASSA2002 with "yes" to all interventions (see http//www.assa.org.za) BMR: Bureau of Market Research, 2004 HSRC: Rehle & Shisana, 2003		

6.9 Demographic Data from Local Government Sources

On account of the necessity to deliver services to people within their jurisdictions municipalities are one of the most significant users and generators of demographic data. In this respect it is pertinent to note the statistics municipalities are using in their official planning. It is also notable that in speaking to municipalities, which make use of STATSSA, figures, the claim is often made that the official figures reflect smaller populations than the real situation. This is often contentious in respect of bread and butter issues such as the extent to which there is a backlog of services, housing etc as official STATSSA figures may present a lesser problem than that faced by officials at municipal level (the coalface). It is also worth noting that in the annual division of revenue process municipalities with greater needs are able to present stronger cases for funding than their better off neighbours and thus municipalities have an interest in presenting an image of need.

6.10 Migrancy

It is very difficult to establish the complex nature of migration, especially with respect to a geographic area as large and as varied as the Orange River Basin. As a result there is a tendency either to establish broad migratory patterns on a macro scale or to focus on the micro scale and investigate migratory dynamics in particular communities.

Focusing on South African as a whole, migratory dynamics present a picture of significant out-migration by the white community (some 325,000 people between 1996 and 2001) and significant in-migration by people from SADC countries and to a lesser extent from other African Countries. Between the 1996 and 2001 census there was a recorded increase of:

- 158,000 people from SADC countries (excl SA)
- 21,800 people from other African countries (non-SADC), and
- 12,300 people from Asian countries.

Notwithstanding the above figures, it is possible that the number of in-migrants from African countries is higher than that officially reflected as many immigrants move to South Africa illegally in order to work and would deliberately avoid being included in any official statistics for fear of deportation. In addition, the in-migration from SADC and other African countries is expected to increase. With respect to the out-migration of the white population it is expected that this trend has peaked and will decline substantially over time.

With respect to the Orange River Basin, migratory dynamics differ from one area to another. In general the following trends are observed from a reading of the Census 2001 migratory statistics (see Appendix 1):

- The already sparsely populated areas of the lower Orange River Basin experience significant out-migration, particularly of those with skills in the economically active age groups.
- The rural areas in general experience significant out-migration.
- The larger and more economically robust urban areas experience the most significant in-migration.
- Within the basin there is a tendency to migrate to those urban nodes closest to one's original base rather than to those further away.
- Within the basin, particularly in the Northern Cape and North West, there is a tendency to migrate from poorer municipalities to those with urban nodes based on mines. For example 46% of those who migrated in to the Dikgatong LM (Francis Baard DM north-west of Kimberley) are from the North West Province.
- There are significant migratory trends between the rural areas such as the Eastern Cape, KwaZulu-Natal, and Western Cape to mining centres such as Kimberley (10% and 6% and 11% respectively of the total number of people who

migrated in to the Sol Plaatjie / Kimberley municipality), which echoes apartheid migratory trends.

- The establishing of provincial capitals in places such as Kimberley has boosted the economies of these centres and has led to significant in-migration.
- In the sparsely populated Northern Cape and North West there is a tendency to migrate to or from mining centres (depending on the economic viability of the new or old mines), which underlies the significance of the mining industry in these provinces. Though the numbers may be small, the percentage increase made by new in-migrants has a significant impact on the total population. For example some 51% (1,139 people) of the in-migrants to the Nama Khoi LM (Namakwa DM) came from the Western Cape. This represents an increase to the existing population in the area of some 2.68%.
- The area within the basin which reflects the largest number of people who moved from their original province to another province within the basin are those from North West (164,639 people).
- The in-migration from provinces outside of the basin or substantially outside of the basin (Eastern Cape & Mpumalanga) is as follows: 109,389 from Eastern Cape, 134,840 from KwaZulu-Natal, 120,794 from Limpopo, 60,268 from Mpumalanga. In all cases some 50% of those people migrating in to the basin went to Gauteng.

It is also significant to note that a trend highlighted by Schlemmer[12] may well be more broadly relevant that is that “in many areas (Northern Province, Central Mpumalanga, and the North West) employment prospects have ceased to be a factor in residential migration because of the exceedingly high levels of unemployment. Investments in housing, the presence of social services and important social networks are now the major factors that influence families’ movement or their disinclination to move, despite very low household incomes. These trends have important implications for service provision and affordability of service charges”.

12 The Distribution of South Africa’s Population, Economy and Water Usage into the Long Term Future. Schlemmer L, MarkData (PTY) Ltd and Eric Hall & Associates 2001.

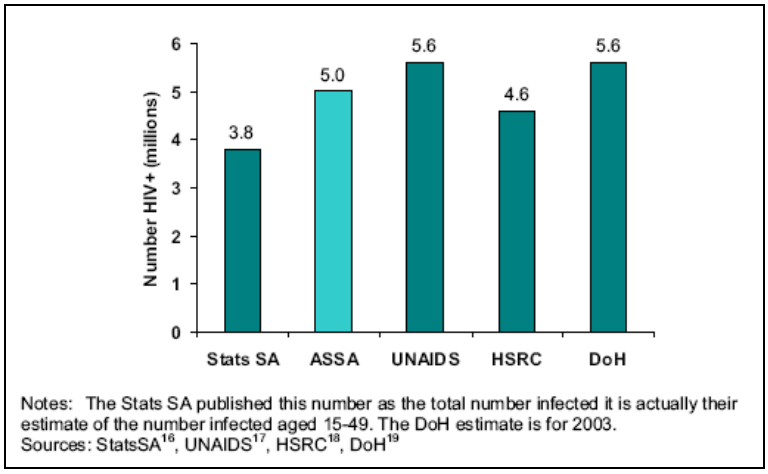
6.11 The Impact of HIV / AIDS on Demographics

Generally it is agreed that the impact of HIV/AIDS on South Africa is likely to be considerable. Demographically the impact will include:

- An increased general mortality rate,
- An increased infant mortality rate,
- A decrease in life expectancy,
- A decrease in the fertility rate,
- A decrease in the population growth rate,
- An increase in deaths amongst the economically active age groups.

Clearly these issues will result in a range of negative social and economic consequences for the country and thus it is imperative that interventions be made to reduce the impact of the disease. Regrettably, both quantifying the extent of the problem (a demographic issue) and planning and executing the interventions required to address the problem have become politicised with a number of different agendas being pursued. This document seeks to highlight some of the demographic issues.

Depending on factors such as data sources, assumptions made, the models used in analysis and so on, a range of statistics exist relating to the impact of HIV/AIDS. This is illustrated by the following graph from a report presented by the Actuarial Society of South Africa (ASSA) and the Medical Research Council (MRC), which compares data from, STATSSA, the ASSA, UNAIDS, the Human Sciences Research Council (HSRC) and the Department of Health.



Notes: The Stats SA published this number as the total number infected it is actually their estimate of the number infected aged 15-49. The DoH estimate is for 2003.
Sources: StatsSA[16], UNAIDS[17], HSRC[18], DoH[19]

Figure 12: Comparative data on HIV/AIDS prevalence in SA

Similarly the following graph compares the percentage of the population with AIDS from different sources.

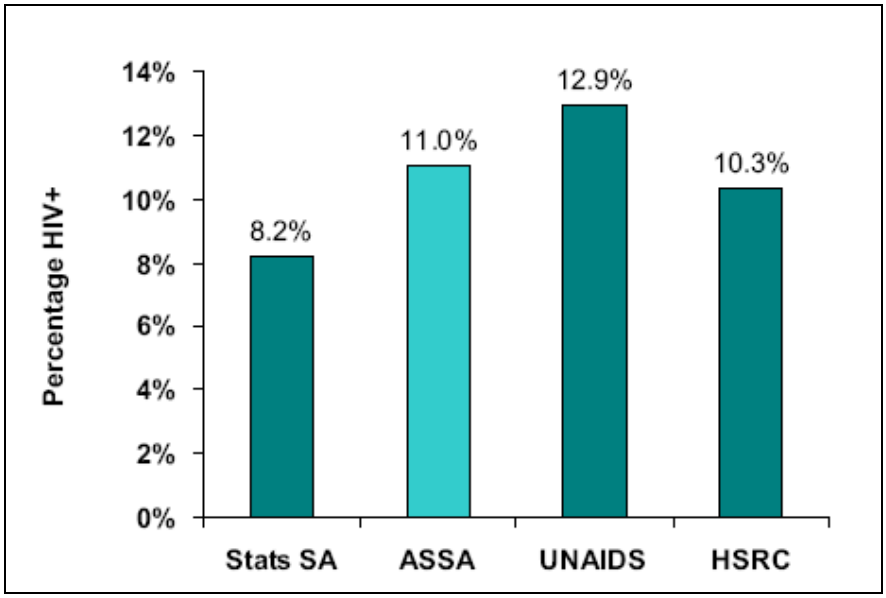


Figure 13: Comparative data on the Percentage of the population with HIV/AIDS

In respect of the impact of HIV/AIDS on the population of South Africa the following graph indicates the total deaths to date from a number of sources.

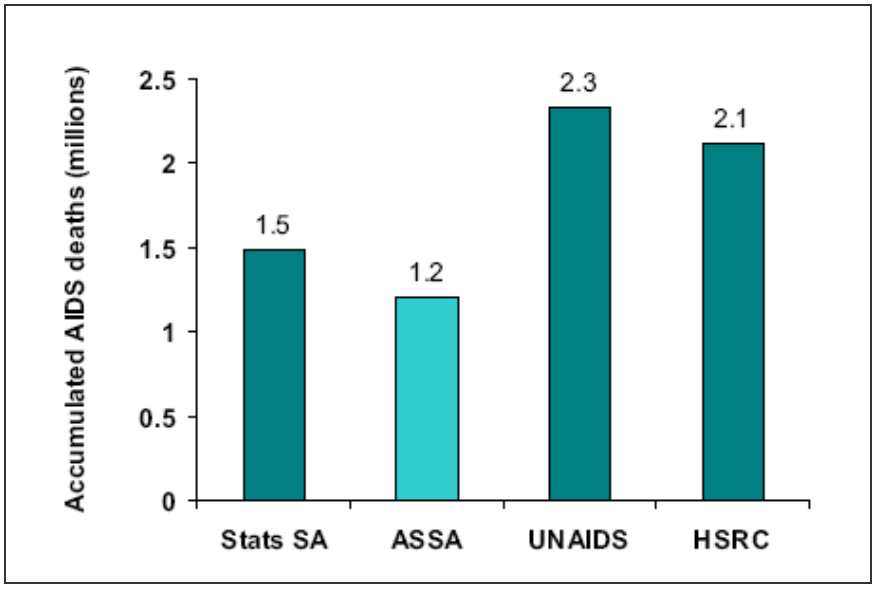


Figure 14: Accumulated number of AIDS deaths to mid 2004

Similarly the following table [13] from the STATSSA publication "Mid-year population estimates, South Africa 2005"[14] highlights estimates from various sources for the years 2000 and 2005. It is worth noting the differences between the two years for factors such as Life expectancy at birth, Total Fertility Rate and Birth Rate as these are significant indicators of the impact of HIV/AIDS.

Table 20: Selected statistics indicating the impact of HIV/AIDS

Model	2000	2005
Life expectancy at birth		
ASSA 2002*	55	46
ASSA 2002**	56	49
BMR 2004	-	46
HSRC	50	45
Stats SA	53	47
Infant mortality rate		
ASSA 2002*	65,6	68,0
ASSA 2002**	63,5	52,3
BMR 2004	-	72,1
HSRC	65,5	56,2
Stats SA	54,3	53,6
HIV-prevalence rate for adults aged 15–49 years		
ASSA 2002*	15,4	20,3
ASSA 2002**	14,7	18,8
HSRC	17,0	16,3
Stats SA	14,2	16,7
Total fertility rate		
ASSA 2002*	2,7	2,5
ASSA 2002**	2,7	2,5
Stats SA	2,9	2,8
Birth rate		
ASSA 2002*	24,8	22,4
ASSA 2002**	24,8	22,3
HSRC	25,9	23,5
Stats SA	24,6	23,8

[13] Some of the data in this table was included in an earlier table and is repeated here for the sake of convenience and further explanation.

[14] STATSSA - Mid-year population estimates, South Africa 2005, Statistical Release PO302, 2005

Model	2000	2005
Annual number of births in millions in the year starting 1 July		
ASSA 2002*	1,09	1,03
ASSA 2002**	1,09	1,03
BMR 2004	-	1,18
HSRC	1,12	1,06
Stats SA	1,09	1,09
Notes: ASSA 2002. Results from ASSA2002 with "no" to interventions (see: www.assa.org.za) ** ASSA 2002. Results from ASSA2002 with "yes" to all interventions (see www.assa.org.za) BMR: Bureau of Market Research, 2004 HSRC: Rehle & Shisana, 2003		

With respect to the impact of HIV/AIDS on the demographics of the Orange River basin there are different impacts to HIV/AIDS in different areas depending on a range of related factors. For example, a high HIV/AIDS death rate could lead to a reduction in the economically active population in an area and an increase in opportunities for those living outside the area who will be drawn to the jobs of those who are ill or who have died. Thus, whilst there will be an impact from HIV/AIDS on the sparsely populated areas of the Northern Cape, the overall population change in the area is more likely to be as a result of economic opportunities or the lack of economic opportunities, which will give rise to migratory shifts. In the case of a lack of economic opportunities and the out-migration of the economically active, the HIV/AIDS rate is likely to increase the rate of depopulation in the area.

6.11.1 STATSSA HIV/AIDS Data

As noted in the STATSSA publication, "Mid-year population estimates, South Africa 2005" the 2005 midyear annualised growth rates are calculated using the cohort-component method by "applying the Spectrum Policy Modelling System. The integration is based on DemProj, which supports many of the calculations in the other components – FamPlan, Benefit-Cost, AIM [version 4] and RAPID. DemProj is used to make the demographic projection, while the AIDS Impact Model (AIM) is used to incorporate the impact of HIV on fertility and mortality"[15].

[15] STATSSA - Mid-year population estimates, South Africa 2005, Statistical Release PO302, 2005. pg 3.

In determining the annualised growth rate STATSSA recognises the impact of HIV/AIDS thereon and makes use of the AIDS Impact Model to determine the estimated adult HIV prevalence rate, which it then uses in its various growth rate models. Thus the prevalence rates used by STATSSA are indicated in the following Table.

Table 21: STATSSA estimated adult HIV-prevalence rates, 2001–2005.

	2001	2002	2003	2004	2005
Women 15–49 years	15,8	16,3	16,7	17,4	18,1
Women 20–64 years	14,4	14,8	15,1	15,6	16,1
Men 20–64 years	14,4	14,8	15,1	15,7	16,3
Adults 20–64 years	14,4	14,8	15,1	15,6	16,2
Adults 15–49 years	14,7	15,1	15,4	16,1	16,7
Total population	8,4	8,7	9,0	9,4	9,8

The following graph, produced by the ASSA[16] indicates a similar pattern to the above data.

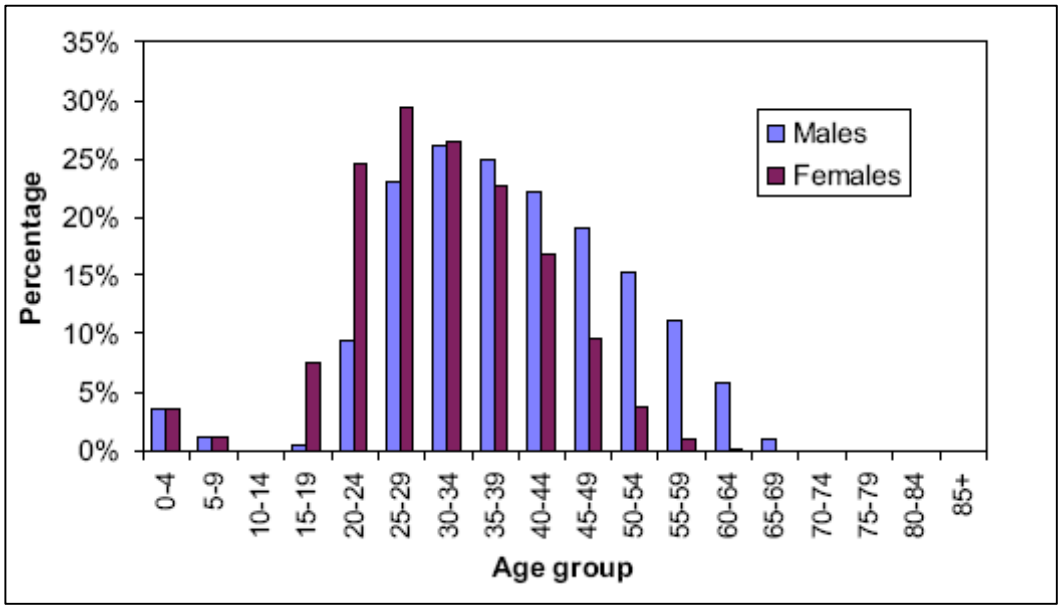


Figure 15: Estimated HIV-prevalence rate 2004

[16] "The Demographic Impact of HIV/AIDS in South Africa. National Indicators for 2004". Dorrington etal 2004.

6.11.2 ASSA HIV/AIDS Data[17]

The ASSA has developed an updated version of their ASSA2002 demographic model (ASSA2002), which integrates a range of epidemiological and demographic data including antenatal surveys. The updated model (ASSA2002) reflects two scenarios; the first considers the demographic situation where no interventions are made to counter the effects of HIV/AIDS, whilst the second considers the demographic situation where all possible interventions are made to counter the effects of HIV/AIDS. The presumption is that reality lies somewhere between these positions.

According to the ASSA model for the year 2004, there are some 5 million South Africans out of a total population of some 46 million[18] who are HIV positive. This translates in to a prevalence rate of 11%. The revisions in the model result in a population projection that is higher than previous estimates. This suggests that Anti Retroviral Treatment (ART) and the prevention of mother-to-child transmissions (PMTCT) have led to a reduction in the number of AIDS deaths per year. The model predicts that without ART and other interventions the expected deaths from HIV/AIDS in 2010 will be some 495,000, with ART and other interventions this will be reduced to approximately 380,000. It should be noted however that the model suggests that by mid-2004 approximately 500,000 people were in need of treatment yet by October 2004, only 19,500 people were receiving ART in the public sector. In addition the default scenario with respect to interventions assumes that approximately 50% of those who need ART will be able to access it. Nevertheless, life expectancy is projected to fall to just under 50 years by 2010 compared with the previous estimate of 43 years and the number of deaths in 2010 could be anything between 290,000 and 450,000.

Based on the default scenario the ASSA2002 model estimates the following approximations for 2004:

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[17] Most of the information in this section is taken from the following paper entitled "The Demographic Impact of HIV/AIDS in South Africa. National Indicators for 2004" by Dorrington RE, Bradshaw D, Johnson L, Budlender D. Cape Town: Centre for Actuarial Research, South African Medical Research Council and Actuarial Society of South Africa. 2004.

[18] The size of SA's population itself is a debatable issue. This in turn impacts on the calculation of the prevalence rate.

- AIDS deaths 311,000 (44% of total deaths –total deaths 701,000)
- Accumulated AIDS deaths mid-year 1,212,000
- Life expectancy of 48.5 years for males and 52.7 years for females or 51.0 years generally (it is presumed that it would be 63.9 years without HIV/AIDS).
- Infant mortality rate of 56 per 1000 live births.
- Over 1.2 million people have already died as a result of AIDS.
- Just over 5 million are infected with HIV.
- Just over 500 000 are AIDS sick.

The ASSA2002 model's default scenario reveals projected population, number of HIV+, AIDS sick and cumulative AIDS deaths for 1990-2015, in the following graph.

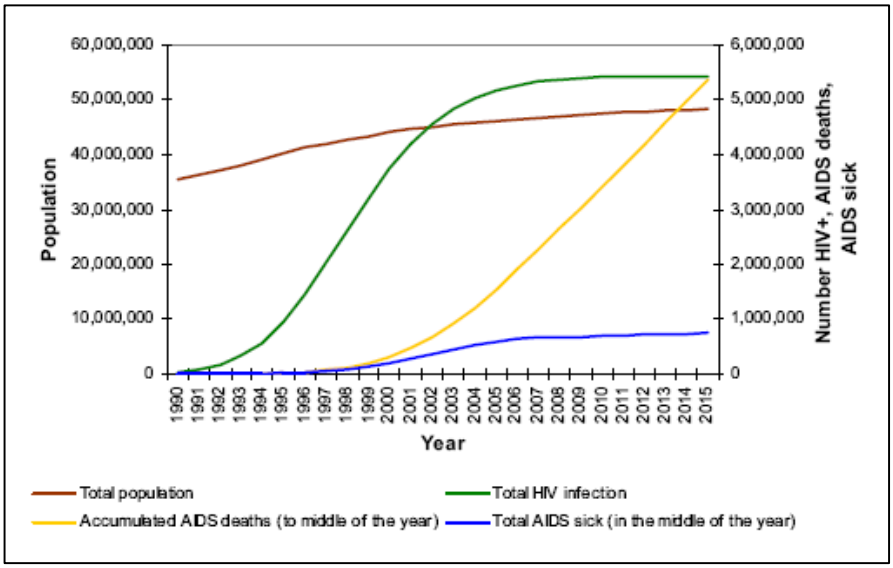


Figure 16: Various HIV/AIDS related factors impacting on population levels

This positive trend is believed to be a result of a combination of factors including the impact of ART, the PMTCT programme, behavioural changes (increased use of condoms) etc. Hence the rate at which these programmes are implemented (or not implemented) is integral to the demographic future of the country.

Like the downward revisions of the ASSA model, estimates by UNAIDS have also been revised downward (5.6m by mid 2004) and thus by the start of 2004, the UNAIDS model predicted 5.6 million infected people in South Africa.

Some projections made by the ASSA model between 1990 and 2015 include the following:

- The total population is expected to increase at a decreasing rate over the period.
- From 2011, the expected annual rate of increase is 0.4%.
- The number of people infected with HIV is expected to peak in 2013, at just over 5.4 million, after which it starts to decrease slowly.
- The number of people sick with AIDS in the middle of each year is expected to rise over the period, reaching nearly 743,000 in 2015.
- Accumulated AIDS deaths are expected to be close to 5.4 million by 2015.

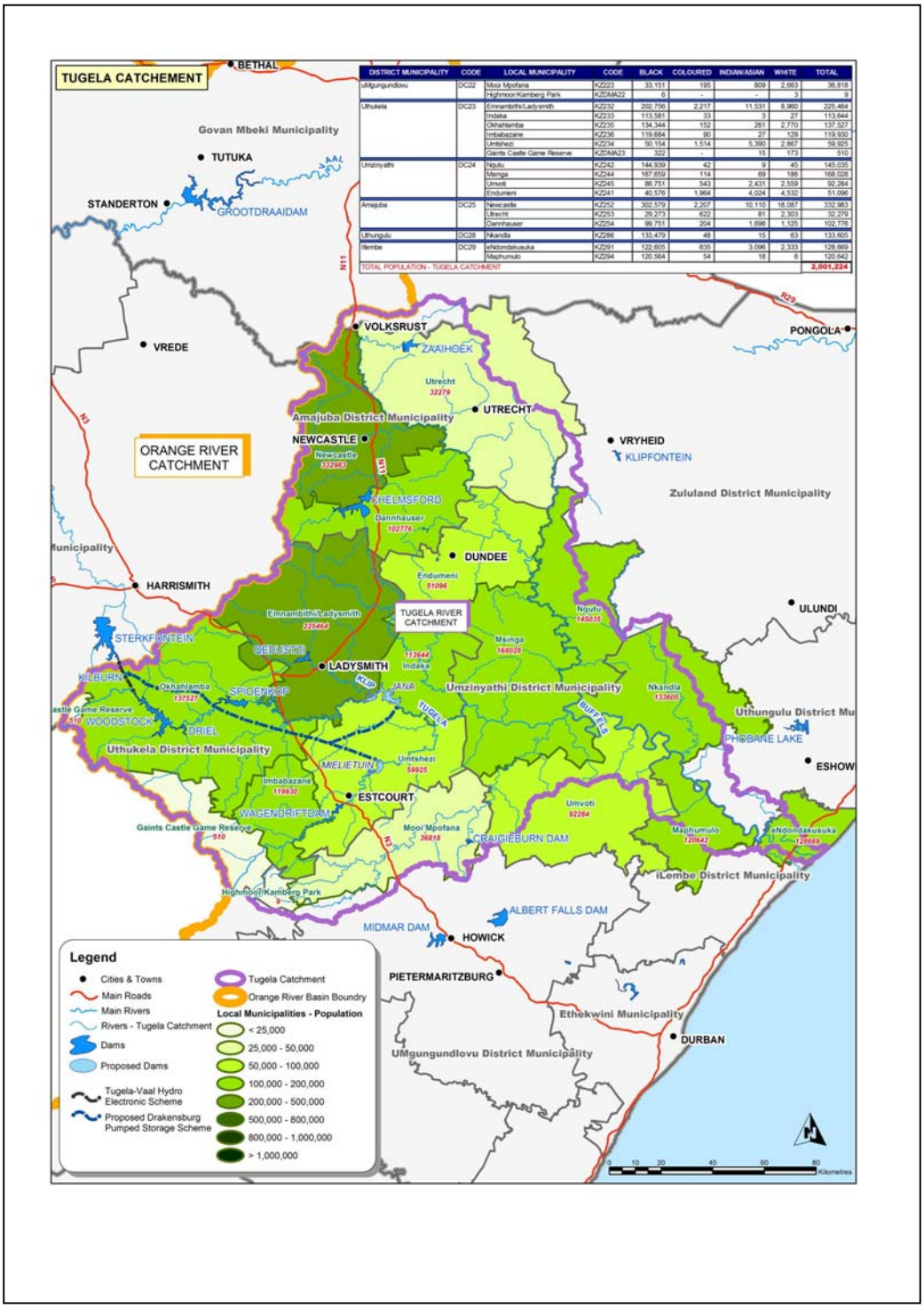
6.12 Demographics of the Inter-basin Transfer Areas

6.12.1 The Tugela-Vaal Transfer Scheme

The Tugela-Vaal transfer scheme (see **Figure 17** below) was completed in 1974 and transfers water from the Tugela Basin over the Drakensberg escarpment in to the Vaal Basin. The scheme allows for the storage of water from the Tugela in the Sterkfontein dam above the escarpment and when necessary water is released from Sterkfontein in to the Nuwejaarspruit River, which flows into the Wilge River and then into the Vaal Dam for use in the Witwatersrand area. As mentioned on the Rand Water website, “During the drought of 1995, when the level of the Vaal Dam was below 15%, the transfer of water from the Tugela River to the Sterkfontein Dam and releases from this dam to the Vaal Dam was the life blood of the Gauteng area. Without this supply, homes and industries would have run dry”. Although this drought occurred before the Lesotho Highlands scheme became operative it is clear that the Witwatersrand may well rely on water from the Tugela basin in times of need. Hence the population of the Tugela Basin could be affected by the extraction of water from the Tugela to the Vaal Basin and thus should be factored into deliberations on water demand in the Orange River Basin.

As an aside the Tugela-Vaal transfer scheme includes the Drakensberg Pumped Storage hydroelectric power station, which uses water pumped and stored above the escarpment in low electricity demand periods to drive turbines to produce electricity in high demand periods.

The Table 22 below, sourced from Census 2001 statistics reflects the approximate population in the municipalities falling within the Tugela basin.



DISTRICT MUNICIPALITY	CODE	LOCAL MUNICIPALITY	CODE	BLACK	COLOURED	INDIAN/ASIAN	WHITE	TOTAL
uMgungundlovu	DC22	Mooi Mpofana	KZ223	33,151	195	809	2,663	36,818
		Highmoor/Kamberg Park	KZDMA22	6	-	-	3	9
Uthukela	DC23	Emnambithi/Ladysmith	KZ232	202,756	2,217	11,531	8,960	225,464
		Indaka	KZ233	113,581	33	3	27	113,644
		Okhahlamba	KZ235	134,344	152	261	2,770	137,527
		Imbabazane	KZ236	119,684	90	27	129	119,930
		Umtshezi	KZ234	50,154	1,514	5,390	2,867	59,925
		Gaints Castle Game Reserve	KZDMA23	322	-	15	173	510
Umzinyathi	DC24	Ngutu	KZ242	144,939	42	9	45	145,035
		Msinga	KZ244	167,659	114	69	186	168,028
		Umvoti	KZ245	86,751	543	2,431	2,559	92,284
		Endumeni	KZ241	40,576	1,964	4,024	4,532	51,096
Amajuba	DC25	Newcastle	KZ252	302,579	2,207	10,110	18,087	332,983
		Utrecht	KZ253	29,273	622	81	2,303	32,279
		Dannhauser	KZ254	99,751	204	1,696	1,125	102,776
Uthungulu	DC28	Nkandla	KZ286	133,479	48	15	63	133,605
Ilembe	DC29	eNdondakusuka	KZ291	122,605	635	3,096	2,333	128,669
		Maphumulo	KZ294	120,564	54	18	6	120,642
TOTAL POPULATION - TUGELA CATCHMENT								2,001,224

Figure 17: Tugela Basin & Tugela-Vaal Transfer Scheme

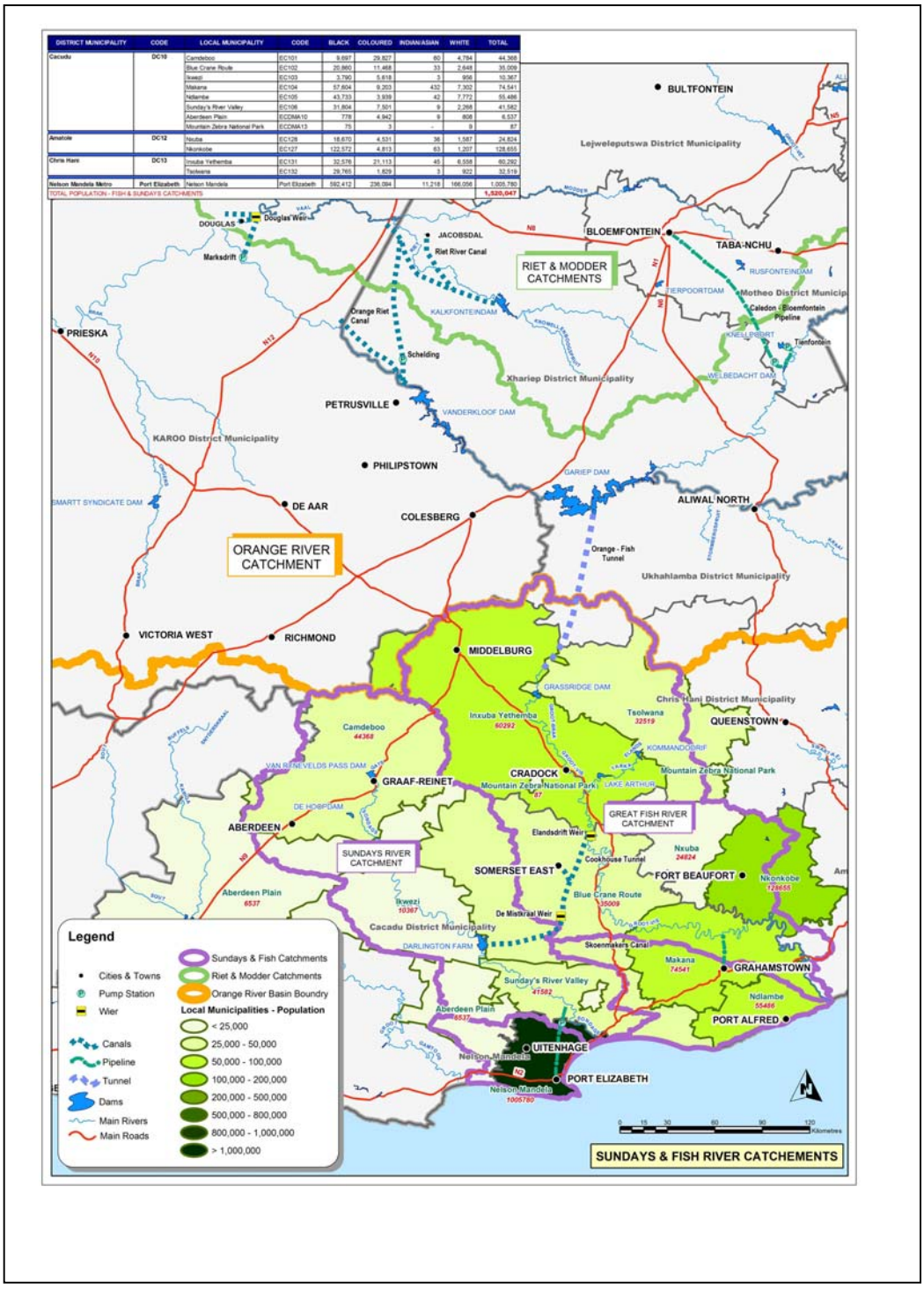
Table 22: Population per LM within the Tugela Basin

District Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	Total
Umgungundlovu	DC22	Mooi Mpofana	KZ223	33,151	195	809	2,663	36,818
		Highmoor/Kamberg Park	KZDMA22	6	0	0	3	9
Uthukela	DC23	Emnambithi/Ladysmith	KZ232	202,756	2,217	11,531	8,960	225,464
		Indaka	KZ233	113,581	33	3	27	113,644
		Okhahlamba	KZ235	134,344	152	261	2,770	137,527
		Imbabazane	KZ236	119,684	90	27	129	119,930
		Umtshezi	KZ234	50,154	1,514	5,390	2,867	59,925
		Giants Castle Reserve	KZDMA23	322	0	15	173	510
Umzinyathi	DC24	Nqutu	KZ242	144,939	42	9	45	145,035
		Msinga	KZ244	167,659	114	69	186	168,028
		Umvoti	KZ245	86,751	543	2,431	2,559	92,284
		Endumeni	KZ241	40,576	1,964	4,024	4,532	51,096
Amajuba	DC25	Newcastle	KZ252	302,579	2,207	10,110	18,087	332,983
		Utrecht	KZ253	29,273	622	81	2,303	32,279
		Dannhauser	KZ254	99,751	204	1,696	1,125	102,776
Uthungulu	DC28	Nkandla	KZ286	133,479	48	15	63	133,605
Illembe	DC29	eNdondakusuka	KZ291	122,605	635	3,096	2,333	128,669
		Maphumulo	KZ294	120,564	54	18	6	120,642
TOTAL POPULATION - TUGELA CATCHMENT								2,001,224

6.12.2 The Orange-Fish Transfer Scheme

The Orange-Fish River Transfer Scheme transfers water from the Gariep Dam on the Orange River to the Fish River Basin in the Eastern Cape. Thereafter some of this water is transferred from the Fish River Basin to the Sundays River Basin and since 1992, water from this basin has been transferred to Port Elizabeth.

The infrastructure of the scheme (see **Figure 18** below) begins with a tunnel transferring water from the Gariep dam to the headwaters of the Great Fish River where it flows down stream to the Elandsdrift Weir. From the weir water is channelled via a 65 km long aqueduct (which includes a 13km tunnel) into the Little Fish River near Somerset East (completed in 1978). At the De Mist Weir (completed in 1987) 40km downstream the water enters the Skoenmakers Canal, which leads to the Darlington Dam on the Sundays River. With the shortage of water in Port Elizabeth the scheme was extended to allow the drawing of water from the Sundays (some 60km downstream of Darlington Dam) and transfer it to the city. It is estimated that 200 million m^3 of Orange River water could be transferred to Port Elizabeth annually.



DISTRICT MUNICIPALITY	CODE	LOCAL MUNICIPALITY	CODE	BLACK	COLOURED	INDIAN/ASIAN	WHITE	TOTAL
Cacadu	DC10	Camdeboo	EC101	9,697	29,827	80	4,784	44,368
		Blue Crane Route	EC102	20,860	11,468	33	2,648	35,009
		Ikwezi	EC103	3,790	5,618	3	956	10,367
		Makana	EC104	57,604	9,203	432	7,302	74,541
		Ndlambe	EC105	43,733	3,939	42	7,772	55,486
		Sunday's River Valley	EC106	31,804	7,501	9	2,268	41,582
		Aberdeen Plain	ECDMA10	778	4,942	9	808	6,537
		Mountain Zebra National Park	ECDMA15	75	3	-	9	87
Amatole	DC12	Nxuba	EC126	18,670	4,531	36	1,587	24,824
		Nkonkobe	EC127	122,572	4,813	63	1,207	128,655
Chris Hani	DC13	Inxuba Yethemba	EC131	32,576	21,113	45	6,558	60,292
		Tsolwana	EC132	29,765	1,829	3	922	32,519
Nelson Mandela Metro	Port Elizabeth	Nelson Mandela	Port Elizabeth	582,412	236,094	11,218	166,056	1,005,780
TOTAL POPULATION - FISH & SUNDAYS CATCHMENTS								1,520,047

Figure 18: The Fish & Sundays Basins & Orange-Fish Transfer Scheme

In addition to the transfer from the Fish to the Sundays the lower Fish River Scheme was initiated in 1985 and completed in 1992. This scheme's primary objective is to provide water for irrigation purposes along the river, but it also makes provision for Grahamstown's increasing water demands.

Table 23 sourced from Census 2001 statistics reflects the approximate population in the municipalities falling within the Sundays and Fish River Basins and the Nelson Mandela Metropolitan area (Port Elizabeth).

Table 23: Population within the Fish & Sundays River Basins & the Port Elizabeth area.

District / Metropolitan Municipality	Code	Local Municipality	Code	Black	Coloured	Asian	White	Total
Cacudu	DC10	Camdeboo	EC101	9,697	29,827	60	4,784	44,368
		Blue Crane Route	EC102	20,860	11,468	33	2,648	35,009
		Ikwezi	EC103	3,790	5,618	3	956	10,367
		Makana	EC104	57,604	9,203	432	7,302	74,541
		Ndlambe	EC105	43,733	3,939	42	7,772	55,486
		Sunday's River Valley	EC106	31,804	7,501	9	2,268	41,582
		Aberdeen Plain	ECDMA10	778	4,942	9	808	6,537
		Mountain Zebra National Park	ECDMA13	75	3	-	9	87
Amatole	DC12	Nxuba	EC128	18,670	4,531	36	1,587	24,824
		Nkonkobe	EC127	122,572	4,813	63	1,207	128,655
Chris Hani	DC13	Inxuba Yethemba	EC131	32,576	21,113	45	6,558	60,292
		Tsolwana	EC132	29,765	1,829	3	922	32,519
Nelson Mandela		Nelson Mandela	PE	592,412	236,094	11,218	166,056	1,005,780
TOTAL POPULATION - FISH & SUNDAYS CATCHMENTS								1,520,047

6.12.3 Johannesburg Metropolitan Area

The Witwatersrand, as the name implies, is the watershed between the Vaal and Limpopo basins and the "rand" (range of hills) runs in an east-west orientation through metropolitan Johannesburg. The result is a metropolis that straddles the two basins and a water service provider, Johannesburg Water, that supplies water to the entire metropolis. Furthermore the water is sourced from Rand Water, which sources its water from the Vaal (Orange) basin. In this respect there is essentially a "transfer" of water from one basin to another. As a result, in determining the population within the Orange River Basin, the entire population of the Johannesburg Metropolitan area, some 3,225,812[19] people has been used.

6.12.4 The Lesotho Highlands Water Project

The Lesotho-Highlands Water Project (the first phase of which was completed in 1998) is located in the mountains of Lesotho and one of its principal aims is to store and transfer water from the Orange-Senqu River Basin within Lesotho to the Witwatersrand in South Africa. It does so by transferring water via the Ash River, near Clarens, which then flows in to the Saulspoort Dam from where it flows in to the Liebenbergsvlei River, which in turn flows in to the Wilge River and then into the Vaal Dam.

With respect to the impact of this scheme on the population of the Orange River Basin the transfer essentially is from one secondary basin within the Primary Orange Basin to another secondary basin – the Vaal Basin within the Primary basin. As a result, the population dynamics are not specifically considered in this study. Though it is recognized that the transfer of this water does have socio economic spin-offs on the populations within each of the secondary basins.

[19] STATSSA as per Census 2001 data.

7 REGIONAL AND INTERNATIONAL DATA

7.1 Demographic Health Surveys

There are a number of regional and international data sets that provide valuable information on demographic trends for the four Basin countries. One of these, the Demographic Health Surveys (DHS), funded by USAID, has already been referred to on a number of different occasions above. Here, it is pertinent to summarise what the DHS is, and how the data can be obtained.

Demographic and Health Surveys are nationally-representative household surveys with large sample sizes (usually between 5,000 and 30,000 households). DHS surveys provide data for a wide range of indicators in the areas of population, health, and nutrition. Typically, DHS surveys are conducted every 5 years, to allow comparisons over time, and mix basic indicators with flexibility. The use of a standardised core questionnaire allows for comparisons in indicators across different countries while special modules can also be added to the questionnaires to meet country-specific needs. The standard DHS survey consists of a household questionnaire and a women's questionnaire. A nationally representative sample of women age 15–49 is interviewed.

The DHS website indicated that the household questionnaire contains information on the following topics:

- Household listing: For every usual member of the household and visitor, information is collected about age, sex, relationship to the head of the household, education, parental survivorship and residence.
- Household characteristics: Questions seek to establish factors including the source of drinking water, toilet facilities, cooking fuel, and assets of the household. I n areas with a high prevalence of malaria, questions about the use of bed nets in the household are added.
- Nutritional status and anaemia: The height and weight of women age 15–49 and young children are measured to assess nutritional status. For the same individuals, the level of haemoglobin in their blood is measured to assess the level of anaemia.

The women's questionnaire contains information on the following topics:

- Background characteristics: Questions on age, marital status, education, employment, and place of residence provide information on characteristics likely to influence demographic and health behaviour.
- Reproductive behaviour and intentions: Questions cover dates and survival status of all births, pregnancies that did not end in a live birth, current pregnancy status, fertility preferences, and future childbearing intentions of each woman.
- Contraception: Questions cover knowledge and use of specific contraceptive methods, source of contraceptive methods, exposure to family planning messages, informed choice, and unmet needs for family planning. For women not using contraception, questions are included on knowledge of a source of contraception and intentions about future use.
- Antenatal, delivery, and postpartum care: The questionnaire collects information on antenatal and postpartum care, place of delivery, who attended the delivery, birth weight, and the nature of complications during pregnancy for recent births.
- Breastfeeding and nutrition: Questions cover feeding practices, the length of breastfeeding, and children's consumption of liquids and solid food.
- Children's health: Questions examine immunization coverage, vitamin A supplementation, recent occurrences of diarrhea, fever, and cough for young children and treatment of childhood diseases.
- Status of women: The questionnaire asks about various aspects of women's empowerment, including decision making and autonomy, and attitudes about domestic violence.
- AIDS and other sexually transmitted infections: Questions assess women's knowledge of AIDS and other sexually transmitted infections, the sources of their knowledge about AIDS, knowledge about ways to avoid getting AIDS, and high-risk sexual behavior.
- Husband's background: Currently married women are asked about the age, education, and occupation of their husbands.
- Other topics: Questions examine behavior related to environmental health and the use of tobacco.

Interim Surveys focus on the collection of information on key performance monitoring indicators but may not include data for all impact evaluation measures (such as mortality rates). These surveys are conducted between rounds of DHS surveys and have shorter

questionnaires than DHS surveys. Although nationally representative, these surveys have smaller samples than DHS surveys (2,000–3,000 households).

DHS survey results can be obtained at www.measuredhs.com. DHS data distribution is managed by a company called ORC Macro which is authorized to distribute, at no cost, unrestricted survey data files for legitimate academic research, with the condition that they are provided with an abstract or a detailed description of any project that will be using the data. Once received, the datasets must not be passed on to other researchers without the written consent of DHS. Copies of all reports and publications based on the requested data must be sent to the DHS Data Archive in sufficient number for DHS to forward copies to the countries whose data have been used.

In the cases of Botswana, Namibia and South Africa, it may be necessary to abstract from the raw data sets information on the specific areas of interest that fall into the Orange River Basin catchment. Lesotho is fortunate in this sense, as all national data are pertinent as the entire country is within the Basin.

It is worth noting that DHS assists institutions in developing countries in collecting and analysing data needed to plan, monitor, and evaluate population, health, and nutrition programs. By building data collection systems in developing countries, DHS works to increase local capacity in research design and implementation, sampling, data processing, analysis, and dissemination.

Equally important, it is pertinent that DHS has a section that specialises in gender. This section produces specialised reports either on specific countries or topics. For example, recent publications cover topics such as “Women's Status and Empowerment”, “Domestic Violence” and “Female Genital Cutting”.

7.2 World Bank Data

The World Bank website is a rich source of demographic and socio-economic data. The data are most useful when used to compare the status of any given country with others in the region (note the use of gender data earlier in the report). The World Bank derives its data either directly or indirectly, from official statistical systems organized and financed by national governments. The World Bank, in collaboration with many other agencies is actively involved in improving both the coverage and effectiveness of these systems. The World Bank offers multiple databases online, some free of charge and some on an annual subscription basis.

From a demographic and socio-economic point of view, HNPStats - the World Bank's Health, Nutrition and Population data platform, is the most relevant. HNPStats is described as "a one-stop data source for health, nutrition and population indicators from various national and international data sources". It provides direct access to more than 100 indicators, with time series for countries and country groups from 1960 to the most recent year, where data are available. In this single data platform, HNPStats compiles key health, nutrition and population indicators for data access, comparison and analysis. Its dynamic data query system is designed in a user-friendly format and creates ready-for-use reports. A section of HNPStats contains an atlas database where users can access and download maps, although these do not show regional variations within countries. HNPStats has links to many other websites of international agencies and country statistical offices. The website is continuously updated as new information becomes available.

7.3 Other Useful Data Sets

While it was beyond the scope of this study to list all international data sets it is worth highlight the usefulness and relevance of data available from two other agencies: UNAIDS, UNHABITAT and UNDP. In all cases these include critical demographic and socio-economic issues, although from different angles.

7.4 Data on Migration

The Terms of Reference for Task 10 make mention of the need to document "demographic movements" which essentially entails studying the migration patterns of the region. All the censuses discussed earlier were found to contain information on both internal and external migration. The most critical 'gap' identified in this regard relates to the census information from Lesotho. As noted earlier, because the last census was in 1996, the data on migration is largely out of date, especially as there have been important changes in Lesotho's socio-economic development (notably the growth of the textile factory and decline in migrant labour) between 1996 and 2005.

In addition to the information contained in the census reports there is now a very significant body of data emerging from the Southern African Migration Project (SAMP). SAMP was formed in recognition of the fact that "migration is one of the major development and management challenges confronting the SADC region in the 21st century". The Project was established in 1996 to encourage and support new regional approaches and policies on migration. SAMP believes that to have any chance of

success, national and regional immigration policy must be based on the best possible information and analysis.

SAMP is an international partnership network linking organizations in Canada and six Southern African states committed to collaborative research, training, public education and policy development on migration issues, funded by the Canadian International Development Agency. It has four main components: applied migration research, policy advice and monitoring, migration training and public education. During the period 1996-99, the primary focus was on cross-border migration to South Africa, from 2000 the program gained more of a regional character. According to the SAMP website, the key objectives are:

- To generate sound and reliable information on migration dynamics, trends and impacts and to disseminate such information to decision-makers; and
- To promote awareness of the role and contribution of migrants, immigrants and refugees to host societies.

The first objective above is of particular interest to ORASECOM as it provides a source of information on migration with details and discussions of issues at a level not generally available from census data. This information has been generated through a multi-year programme of cooperative research on key policy-related dimensions of contemporary migration in the Southern African region involving all the key partners. A series of workshops, conferences and seminars have been convened to discuss the findings and to develop new policy initiatives around the issue of intra-regional migration.

To achieve its objectives SAMP has a major ongoing programme of applied research focusing on priority themes that include:

- Establishment of electronic regional migration data base
- National household poverty and migration surveys
- Citizen attitudes to immigrants, refugees and migration policy
- Border management and regional cooperation
- Women's and children migration
- Regional labour market and economic impacts of migration
- Globalisation and transnational migration
- Immigration and refugee law
- Migration and HIV/AIDS

All of these themes should be of interest to ORASECOM as it moves towards developing an IWRMP.

SAMP makes information available on such topics in a variety of ways. Firstly, it manages a bibliography containing a large number of reports dealing specifically with migration. Many of these deal with migration into the Basin, in particular to Gauteng. A link to the SAMP bibliography will be created in the ORASECOM database, so there is no need to list all the publications in this report. However, a few examples of studies dealing with migration into South Africa (mostly to Guateng) are listed below:

Chimere-Dan, O. (1996). Migrants From Other African Countries in South Africa. SA Labour Bulletin, 20, 45-47.

Chirwa, W.C. (1995). Malawian Migrant Labour and the Politics of HIV/AIDS, 1985 to 1993. In J. Crush & W. James. (eds.) Crossing Boundaries: Mine Migrancy in a Democratic South Africa. Cape Town/Ottawa: Institute for Democracy in South Africa/International Development Research Centre.

Crush, J. (1991). The Chains of Migrancy and the Southern African Labour Commission. In C. Dixon & M.J. Heffernan. (eds.) Colonialism and Development in the Contemporary World. London/New York: Mansell Publishing.

Crush, J. (1992). Inflexible Migrancy: New Forms of Migrant Labour on the South African Gold Mines. Labour, Capital and Society, 25, 46-71.

Crush, J. (2000). Migrations Past: An Historical Overview of Cross-Border Movement in Southern Africa. In D. McDonald. (ed.) On Borders: Perspectives on Cross-Border Migration in Southern Africa. New York: St Martin's Press

de Vletter, F. (2000). Labour Migration to South Africa: The Lifeblood for Southern Mozambique. In D. McDonald. (ed.) On Borders: Perspectives on International Migration in Southern Africa. New York: St Martin's Press.

Fraser, G. (1993). An Economic Analysis of Factors Influencing Rural-Urban Migration to Southern Africa. Development Southern Africa, 10, 437-442.

Hough, M. (1995). Illegal Aliens in South Africa: Causes and Facilitating Factors. Strategic Review for Southern Africa, 17, 1-23.

Human Sciences Research Council. (1995). A Research Review of the Policies Surrounding the Issue of the Free Movement of People Across International

Borders with Specific Reference to Southern Africa and the Particular Effect Thereof on South Africa. Pretoria: Human Sciences Research Council.

International Labour Organisation, & SAMAT. (1998). Labour Migration to South Africa in the 1990s. Harare: International Labour Organisation/Southern Africa Multidisciplinary Advisory Team.

Isserow, M., Morrison, L., Belvedere, F., & Selabe, B. (1998). 'Voting With Their Feet': A Study of Cross-Border Migration into South Africa. Braamfontein: Community Agency for Social Enquiry (CASE).

The SAMP bibliography contains many other reports dealing with migration within the Basin, for example:

Cobbe, J. (1997). Labour Migration from Lesotho: Implications for South African Labour Market Policies. In H. Bass, R. Kappel, F. Messner, M Wauschkuhn, K. Wohlmuth. (eds.) Regional Perspectives on Labour and Employment: African Development Perspectives Yearbook. Münster: LIT Verlag.

Coplan, D. (2001). A River Runs Through It: The Meaning of the Lesotho-Free State Border. African Affairs, 100, 81-116

Gay, J. (2000). Migration Attitudes of Skilled Professionals in Lesotho. Africa Insight, 30, 65-74.

Matlosa, K. (1992). The Future of International Labour Migration in Southern Africa: Focus on Lesotho. International Affairs Bulletin, 16, 32-51.

Ulicki, T., & Crush, J. (2000). Gender, Farmwork, and Women's Migration from Lesotho to the New South Africa. Canadian Journal of African Studies, 34, 64-79.

What is striking about the bibliography is that there is no information on migration from Botswana and Namibia to South Africa, but a great deal on Lesotho.

The second important resource created by the SAMP project is its own reports. By September 2005 SAMP had published 39 reports, many dealing with topics that are not addressed in Census reports, such as “HIV/AIDS and Children's Migration in Southern Africa”, or ”Migration, Sexuality, and the Spread of HIV/AIDS in Rural South Africa”. Others address specific migration issues within Basin countries, such as: “Mobile Namibia: Migration Trends and Attitudes”; “Riding the Tiger: Lesotho Miners and Attitudes Towards Permanent Residence in South Africa” and “Botswana: Migration Perspectives and

Prospects". All of these can be downloaded from the SAMP website either in a summary format or in full. Again, a link will be created between the ORASECOM database and SAMP to facilitate access to these reports.

Before moving to the next section, it is pertinent to note that SAMP takes a special interest in gender. The SAMP website, for example, points out that:

"Research and policy debates on cross-border migration in Southern Africa have tended to focus on labour migrants, and hence on men. Women have traditionally been looked at as those 'left behind': as de facto heads of household and bearers of additional burdens of domestic and agricultural work. Over the past decade, although cross-border migration has remained male-dominated, more and more women have been crossing borders between Southern African countries. New social, spatial and temporal patterns of female migration are evolving, with various forms of cross-border mobility driven by a variety of social and economic motives. In direct and tangible ways, women are the agents by which goods and capital circulate in the region. They are thus potentially powerful agents of development. Yet most migration policy and law hinders rather than facilitates their mobility, discriminating against women and perpetuating the male bias in migration flows".

To address this SAMP "continues to prioritise gender concerns in its inputs into the policy-making process, and plans to conduct further gender-based research to inform ongoing policy debates in the region" (www.queensu.ca/samp)

7.5 Data on Gender

The review of available data indicates that SAMP is not the only source of information dealing with gender. Indeed, in each of the Basin countries the official census data can be disaggregated and analysed from a gender perspective, although in certain cases there are constraints to manipulating the data as they are not easily available electronically.

With respect to national overviews presented from a gender perspective data can be obtained from various international agencies. Earlier it was noted that DHS has a specific section dealing with Gender. Another example of this is the World Bank, which makes gender-specific data available for all countries, including the ORASECOM states. A useful feature of these data is that they enable comparison with other sub-Saharan countries. As can be seen from the sample below, Botswana is far better off socio-economically than the average Sub-Saharan country. Although life expectancy is lower (due to HIV/AIDS) there are no differences between males and females (both 39 years in 2000). Females are only

slightly less literate than males in Botswana, but are far more literate than their counterparts in other Sub-Saharan countries. The situation of young women, aged 15-24, is undermined by the HIV/AIDS pandemic with prevalence rates being twice as high as their male counterparts and over three times as high as the Sub-Saharan rate for women the same age.

Table 24: Gender Disaggregated Data on Botswana

INDICATORS	BOTSWANA				SUB-SAHARAN AFRICA	
	1980	1990	1995	2000	1980	2000
GNP per capita (US$)	1,110	2,750	3,190	3,040	660	480
POPULATION						
Total (millions)	0.9	1.3	1.5	1.7	383.2	658.3
Female (% of total)	52.2	51.7	51.4	50.3	50.2	50.5
Life expectancy at birth (years)						
Male	56	55	49	39	46	46
Female	60	59	51	39	49	47
Adult illiteracy rate (% of people aged 15+)						
Male	44.5	34.3	30.0	25.5	50.8	30.3
Female	40.9	29.7	25.0	20.2	72.4	46.8
LABOR FORCE PARTICIPATION						
Total labor force (millions)	0	1	1	1	173	290
Labor force, female (% of total labor force)	50	47	46	45	42	42
Unemployment						
Total (% of total labor force)			21.5	15.8		
Female (% of female labor force)			23.9	17.2		
EDUCATION ACCESS AND ATTAINMENT						
Net primary school enrollment rate						
Male	69	90	79	78		
Female	82	97	83	81		
Progression to grade 5 (% of cohort)						
Male	80	94	87	87		
Female	84	98	93	92		
Primary completion rates (% of relevant age group)						
Male		102	96	88		58
Female		126	107	96		49
Youth illiteracy Rate (% of people aged 15-24)						

INDICATORS	BOTSWANA				SUB-SAHARAN AFRICA	
Male	32.1	20.7	17.9	15.5	34.4	17.9
Female	24.9	12.8	10.0	7.9	56.2	27.5
HEALTH						
Total fertility rate (births per woman)	6.1	5.1	4.6	4.0	6.6	5.3
Contraceptive prevalence (% of women aged 15-49)						
Births attended by health staff		78	87	99		
Maternal mortality ratio (per 100,000 live births)				100		917
Child malnutrition prevalence, weight for age (% of children under 5)			17	13		
HIV prevalence rate (% of people aged 15-24)						
Male				15.8		4.4
Female				34.3		9

Source: The World Bank

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SECTION TWO

ECONOMIC ACTIVITY

AND THE VALUE OF WATER

9 ECONOMIC ACTIVITY

9.1 Introduction

The aim of this section of the Task 10 report is to provide a brief overview of the key water dependent economic activities of the Orange-Senqu River Basin, highlighting potential economic stimulants and growth areas.

Due to the time limitations in compiling this report, only information readily available on the internet or through primary contacts in the South African Department of Water Affairs or other consulting companies could be used in this report. It should be noted that information of this nature is not easily available over the internet, and the next phase of this project will have to allocate time to locating existing reports, which may not be readily available to the public.

Growth projections for any industry depend on a wide range of variables and assumptions, and are notoriously difficult to make with any degree of accuracy. This report has therefore focussed on those sectors and activities which are receiving priority attention and support from national governments or private investors.

The first half of section of the report provides an overview of the key economic activities in the different areas of the Orange River Basin, together with an indication of their relative share of water consumption.

The final portion introduces the strategic growth prospects of certain key water dependent sectors, namely irrigated agriculture, the urban-industrial sector, mining, and hydro-electric power generation.

It has become apparent that economic growth in South Africa has been more rapid than was anticipated. The South African government had outlined a set of interventions to boost the sum of all products and services in the country to 6% by 2010. This has important implications for water requirement projections, particularly with regards to power generation. In October 2004, Cabinet approved the implementation of the Vaal River Eastern Subsystem Augmentation Project (VRESAP) which is a 124 km pipeline to deliver water from the Vaal Dam into the Vaal River Eastern Sub-System. VRESAP is to be implemented to meet the growing water demands of Eskom, Sasol and Emalahleni/Middelburg local municipalities in the Mpumalanga Highveld region. More work is required nationally to revise growth estimates for all water intensive industries, and the implications for water demand throughout the country.

9.2 Overview of Major Economic Activities and corresponding water use

Economic activity in the Orange-Vaal river system is dominated by the urban-industrial centre in Gauteng, the economic hub of Southern Africa, which accounts for 38% of South Africa's GDP, and nearly 9 million people, or 20% of South Africa's population.

Other major water-dependent economic activities in the basin include mining, the energy sector, and irrigated agriculture.

The major water users in the Orange-Senqu and Vaal basins change over the length of the river, with urban-industrial uses predominating in the Upper Vaal area, while irrigation is the dominant water use in all of the other areas with the exception of the Upper Vaal urban-industrial centre, which includes much of Gauteng Province. Irrigation is the most important water consumer overall, accounting for over 60% of the local water requirements in the entire area in 2000.

Figure 19: Orange River Basin

The major demand centres of water demand supplied from the Orange River system include:

- The Vaal River System, which in turn can be broken up into Upper, Middle and Lower Water Management Areas;
- The Upper Orange River, including Lesotho, which extends as far as the Vanderkloof Dam upstream of the Orange/Vaal confluence. This area is also the source of transfers to both Gauteng and the Eastern Cape; and
- The Lower Orange River, which extends from downstream of the Orange/Vaal confluence to the river mouth, and includes the Common Border Area between Namibia and South Africa.

The table below shows the distribution of local water use between different sectors overall and in each of the areas.

Table 25: Water requirements for the year 2000 (million m3/annum)

Water Management Area (WMA)	Irrigation	Urban	Rural	Mining & Bulk Industry	Other	Total
Upper -Vaal	11%	61%	4%	17%	8%	26%
Middle Vaal	43%	25%	9%	23%		9%
Lower Vaal	82%	11%	7%	1%		16%
Upper Orange	81%	13%	6%	0%		24%
Lower Orange	95%	2%	2%	1%		25%
Total	**63%**	**23%**	**5%**	**7%**	**2%**	**100%**

Notes: Urban includes basic needs reserve of 25l/c/d and Mining & industrial that are not part of urban systems.
Source: DWAF 2004

9.3 Transfers

9.3.1 Lesotho Highlands Water Project (LHWP)

The LHWP was initiated in the 1970's as a dual-purpose project. The water from the LHWP feeds the industrial and domestic needs of six provinces of South Africa under normal circumstances. During severe droughts, water can also be channeled via the Caledon River to provide the needs of the central Free State, as well as the Eastern Cape provinces. The largest user of the Lesotho water is Gauteng Province, the industrial

heartland of South Africa, which relies mainly on the Vaal River System. The LHWP adds water to this system, as the residents and activities require more water than the Vaal River system can provide. The second purpose is to generate hydropower to meet the needs of Lesotho.

In addition to being the centre of financial and manufacturing activity in the country, the bulk of South Africa's energy is generated by water-cooled, coal-fired power stations situated in the central plateau, known as the Highveld. This region also relies on the LHWP - augmented Vaal River system for its water supply. The industrial development of Gauteng would simple not be sustainable without water supplied through the LHWP.

Vaal River Eastern Subsystem Augmentation Project (VRESAP)

On 6 October 2004, the South African cabinet approved the implementation of the VRESAP which is a 124 km pipeline to deliver water from the Vaal Dam into the Vaal River Eastern Sub-System (VRESS).

VRESAP is to be implemented to meet the growing water demands of Eskom, Sasol and Emalahleni/Middelburg local municipalities in the Mpumalanga Highveld region. The scheme transfers water via a 124 km long pipeline from the Vaal Dam near Vaal Marina to the Knoppiesfontein Diversion Structure which discharges into either the Trichardtsfontein or Bosjesspruit Dams near Secunda. The total anticipated capital cost is R2.4 billion. Each main user will be required to redeem the debt based on the cost allocation via a water use tariff based on actual use out of the VRESS and not just what is required from the VRESAP. Under this arrangement Eskom pays for 61% of the project, but is allocated 50 % of the capacity, likewise Emalahleni/Middelburg only pays for 15% of the project, but are entitled to 24% of its capacity.

9.4 Vaal River Basin

Domestic, mining and industrial water requirements predominate in the Vaal River catchment, and these activities account for most of the urban-industrial activity in the Orange System. Hydroelectric power generation, irrigation and mining are the major water users in the rest of the basin.

9.4.1 Upper Vaal Water Management Area

There are currently major water transfers both into and out of the Upper Vaal area including a major transfer from Lesotho in the Upper Orange. With the completion of the Mohale Dam in Lesotho, this amount will be increasing from 491 to 835 million m^3/annum.

More growth in water demand is expected in the area as a result of ongoing economic growth and continued urbanisation. With only marginal potential for further resource development, water allocation decisions are paramount for this area.

The Vaal River supplies water to the industrial hub of Southern Africa, which includes the Greater Pretoria and Johannesburg area, where mining, urban and industrial concerns predominate. This area produces around 50% of South Africa's GDP as well as more than 80% of the country's electricity requirements - more than 50% of all the electricity generated in Africa. (DWAF, 2005)

The Upper Vaal area also includes much of the gold and coal mining areas in Gauteng and the eastern North-West province. Economic activity in the remainder of the area consists mainly of livestock farming and rain-fed cultivation. The area stretches from Potchefstroom in the west, down to Qwa-Qwa in the south, while the northern part extends to the south of Pretoria and the Crocodile-Marico WMA.

The industrial hub of South Africa straddles the watershed between four international shared river systems, namely the Limpopo, Incomati, Maputo and Orange Rivers. A number of water transfer schemes have been developed to meet the water requirements of the area.

An important future development may concern the valuation of the economic impact of poor water quality on downsteam water users.

9.4.2 Middle Vaal Water Management Area

The Middle Vaal area extends from Klerksdorp in the North West Province to the Bloemhof dam to the west, and includes much of the north-western Free-State, extending almost to the border of Lesotho.

While there is some irrigated agriculture in the area, economic activity is dominated by gold mining, which accounts for 45% of the area’s gross geographic product. No significant economic growth is expected in future, in fact a slight decline in economic activity with the decline in gold mining is expected.

There is no more development potential for surface water, but this is not anticipated to be an issue due to the limited future growth prospects.

Water quality issues are most important, and are likely to increase in importance with poor quality, saline water. Water quality is carefully managed currently.

9.4.3 Lower Vaal Water Management Area

This area includes the Molopo River basin in the Kalahari, shared between South Africa and Botswana, down to Douglas and the confluence of the Orange and Vaal rivers. The largest urban centre in the area is Kimberley, with a population of approximately 200,000 people. It is situated on the southern edge of the area, and no significant growth in economic activity is expected.

Major economic activities currently include iron ore, diamond and manganese mining.

Irrigation accounts for 80% of the total water use, which is concentrated in the Vaalharts irrigation scheme.

Water quality is again a major issue, with the high salinity of leach water from the Vaalharts irrigation scheme. Water transfers currently take place from the Orange River to the Douglas weir for waste dilution. *The value of water quality management, such as through waste dilution, is likely to become increasingly important.*

9.5 Orange River basin

Most water used in the Orange River basin is for irrigation with a relatively small portion being used for urban and industrial purposes. River losses through evaporation also represent a large portion of the total requirement

Although irrigation is by far the largest user of Orange River water, some of the largest mines in the country are located in the Orange River basin. It is estimated that mining accounts for more than 50% of the Gross Domestic Product (GDP) in the Northern Cape Province compared to less than 15% generated from agriculture.

The mines use relatively small amounts of water, however, this water must be supplied at a very high level of assurance due to the large investment involved in any major mining concern. The mines in the Orange River basin are famous for diamonds, copper, manganese and iron.

9.5.1 The Upper Orange & Lesotho

The Orange River starts as the Senqu in Lesotho, where water demand stems primarily from domestic and stock-watering needs. Some potential for further development of water resources still exists in order to meet increasing transfer demands, particularly from the Gauteng region. The region covers much of the southern Free State up to Douglas in the Northern Cape and the confluence of the Vaal and Orange Rivers.

Transfers from Gariep Dam through the Orange/Fish tunnel are mainly used to support irrigation developments in the Eastern Cape. A transfer agreement of a maximum 643 million m^3 (capacity of current transfer system) is currently in place to meet the needs of users in the Fish-Sundays system, and future urban growth in the Nelson Mandela Metropolitan area. (Muir et al, 2003)

Maseru and Bloemfontein are the major urban centres in the area. There are no strong economic stimulants for economic growth, but urbanisation is expected to continue within the Free State, with continuing migration to Bloemfontein from within the Free State in particular.

There is potential for the development of approximately 4,000ha of new irrigated land in the Upper Orange, and an additional 4,000ha in the Fish-Sundays area. These areas have been earmarked for irrigation development for developing farmers.

The key water resource issue is the allocation of the available surplus, and realisation of development potential. Future growth demands are anticipated to come from the Nelson Mandela Municipality, Mangaung Municipality, Gauteng, and also Namibia.

9.5.2 Lower Orange and the Common Border Area

Current activities

The Common Border Area of the Lower Orange River falls in the Northern Cape Region in South Africa and in the Karas Region in Namibia. The economy of both regions is based on mining and agriculture, which is estimated to contribute between 80 and 90% of the region's economic activity. The local economy is generally seen as underdeveloped and unsophisticated. (Muir et al, 2004)

Both South African interests and Namibian interests are broadly the same with respect to water requirements for socio-economic development, domestic use, stock farming, mining, irrigation and tourism.

The economy of the **Northern Cape** is heavily dependent on the primary sector of the economy. The largest sector is mining, which has declined in contribution to the Provincial GDP from 25,8% in 1996 to 23,7% in 2002. Agriculture, however, increased its contribution from 6,2% to 7,3%. There is only a limited amount of processing of the primary commodity output in mining and agriculture, and manufacturing contributes only 4,2% towards the Provincial GDP.

There appears to be a trend in the Northern Cape for people from the more rural areas to migrate into the larger towns where access to opportunities and services are significantly better. This is reflected in the increase in the proportion of people living in urban areas from 75,2% in 1996 to 82,7% in 2001. (Northern Cape provincial Government, 2005)

The South African water demand is mostly from irrigation, but water is also transported to towns such as Pofadder, Aggeneis and Springbok. There is also a major rural water supply project in the Kalahari to the north of the river, as well as various mining developments.

The major urban consumers on the Namibian side are the towns of Oranjemund, Rosh Pinah (including the Skorpion Mine) and Noordoewer.

The major towns on the Fish River include Keetmanshoop and Mariental. There are currently 2 490 ha under irrigation at the two main irrigation projects in the Fish River Basin.

Water usage

The Lower Orange area is completely dependent on upstream flows. Over 90% of the water used in the Lower Orange is currently used for irrigation. Most of the high value irrigation takes place along the lower Orange River downstream of Prieska. Most of the area's wealth west of Douglas comes from either agriculture or mining, both of which depend to some degree on Orange River water.

The Namibian government has estimated long-term water requirements in the order of 200Mm3/annum. The current allocation to Namibia is 50 Mm3/annum, with approximately 35 Mm3/annum being used for irrigation. An additional 60 Mm3/annum has been allocated to Namibia until the end of 2007, when South Africa is estimated to need this allocation.

The South African water focus is on improving efficiency of current water use, in particular in irrigation, and the provision of water for socio-economic, rural community development.

9.6 Future growth

SA and Namibia have identified considerable development opportunities along the lower Orange River. In Namibia, such developments include:

- The Skorpion lead and zinc mine;
- The proposed Kudu gas-fired power station at Oranjemund, and Haib copper mine; and
- Irrigation projects for commercial and communal farmers.

Similar potential also exists in South Africa, with a particular need to develop irrigation opportunities for resource-poor farmers and to support poverty alleviation. The Northern Cape Government has also identified the possibility of growth in the agro and mineral processing sectors, along with manufacturing.

There are currently 4,115 ha under irrigation along the common border on the South African side of the Orange River. This is expected to increase for two main reasons; the South African Government has allocated 4,000 ha of irrigable land for the establishment of small farmers from previously disadvantaged groups, and there is likely to be further demand from commercial farmers for irrigation of high value crops in the area. (Muir et al, 2004) However no additional new water quotas are anticipated to be allocated in South Africa beyond that allocated for developing farmers. This policy may be revised if additional water can be made available.

A slight decline is population is expected on the Northern Cape side, and future economic activities will include a modest contribution from eco-tourism. Future growth opportunities are expected to consist mainly of the production of high value crops along the common border area. Approximately 60,000 ha has been identified on both sides of the border that is suitable for the development of high value crops, such as table grapes and dates which are discussed below. (Muir et al, 2004)

Most of the future irrigation potential lies on the Namibian side of the river, where there are government-backed plans to expand the land under irrigation, and to increase production of high-value crops such as export table grapes and dates. The Namibian National Development Plan (Phase II) and Vision 2030 aim to make Namibia food self sufficient,

with a key focus on development along the major rivers, including the Lower Orange. The Namibian Government is therefore seeking as much water as possible from the river.

Namibia is heavily dependent on the availability of water along the lower Orange River. The possibilities for socio-economic development in this area are limited to extensive small stock farming, mining, irrigation and tourism. The water requirements for domestic use, a number of diamond mines, 2 zinc mines and the future development of the proposed Kudu gasfield power station at Oranjemund will require an assured source of water. (Heyns, 2004)

The availability of water for large scale development may be a constraint to develop the full potential in the Lower Orange River. The following measures may affect this availability:

- Savings through water demand management initiatives, which are being investigated as part of the Lower Orange River Management Study (LORMS).
- Reduction of losses due to peak hydro power releases that do not coincide with peak irrigation demands.
- Reduction of operational losses in the river.
- The environmental requirements of the river.

However water savings through improved water use efficiency and Water Demand Management (WDM) initiatives upstream of the Common Border will not necessarily be available for use in the Common Border Area, and may possibly be used to support further development in the Upper Orange River Region.

9.7 Growth prospects by sector

This section focuses more broadly on the future growth prospects of key water dependent sectors in the Orange-River Basin, taking a sectoral view. The most important water using sectors from an economic point of view are:

- Irrigated agriculture;
- The Urban-industrial sector;
- Mining and mine-closures; and
- Power generation

The last section briefly addresses the issue of water dilution. Although not a sector itself, the quality of water has significant cost implication for all sectors.

9.7.1 Irrigated agriculture

The primary information sources for information on potential in the irrigated agriculture section were studies on the Lower Orange River. It was not possible in the time available to obtain detailed information on the potential for irrigation in the rest of the Orange basin, and more work will have to be done to identify other irrigation opportunities. However in terms of potential economic impact, the development of further land for irrigation in the area would provide employment and stimulate regional infrastructure development in an impoverished area with little other potential for development.

Current role of agriculture in ORASECOM countries

Agricultural production in **Lesotho** has declined substantially over the past decade. The sector's contribution to GDP has fallen from around 24% in 1990 to 15.4 % in 2001. The decline is particularly worrying given that about 75% of the country's population depends on agriculture for their livelihood. Apart from erratic weather conditions, several factors have constrained the development of agriculture in Lesotho. The quantity of arable land has declined from around 13 % of total land in the 1960s to around 9% today, putting pressure on the fertility of a limited land base. Approximately 40 percent of the population is landless.

The Agricultural sector has also depended heavily on external assistance. With the general decline of donor support in the country, the sector became the hardest hit. The average agriculture share of total development assistance declined significantly. The sector is however expected to show some recovery with implementation of the Agricultural Sector Investment Programmes. The challenge is for Lesotho to increase agricultural productivity to sustain food security in the country (Vision 2020)

The agricultural challenge in the **Northern Cape** in South Africa has been identified as growing the agricultural sector and increasing its contribution to provincial GDP, employment and income while at the same time increasing access to agricultural resources by the previously excluded sections of society. The Provincial government seeks to promote:

- New investments in primary agricultural production,
- The more efficient use of irrigation water, by promoting crop diversification and the reduction of levels of risk in agriculture,

- The development of agro-processing and the addition of value to primary agricultural output and by stimulating increased export of high value agricultural produce.

Government is also committed to promoting transformation in agriculture through land reform, the allocation of water rights, transfer of skills and knowledge and agricultural credit to emerging black farmers.

Agriculture is **Namibia's** most important economic sector. Although it provides only around 6% of GDP, it employs 37 % of the Namibian work force. With its low and highly-variable rainfall pattern, Namibia is the driest country in Sub-Saharan Africa. The most important challenge facing the country's agricultural sector is dealing with the low rainfall and exploiting the existing water resources sustainably. Although irrigation potential is limited in Namibia, there is room for expansion beyond present levels. As part of its policy of crop diversification, government is encouraging cultivation of high-value crops. Recent studies have shown that non-traditional crops such as table grapes, dates, cotton, tobacco, lucerne and devil's claw have potential for expansion. Fruit growing for export also has good potential as Namibia can harvest earlier in the season than South Africa, providing substantial price advantages in the European Union. Namibia's table grape production is expanding rapidly, mainly to meet demand in the European Union. The Namibian Government has completed a series of feasibility studies for the expansion of table grape production along the Orange river. (DTI, USAID-Namibia)

Preconditions for successful irrigation projects

The economic success of irrigation projects is difficult to predict due to its complexity. Very few irrigation projects in the world would have been viable without some or other form of subsidy. Even the currently lucrative table grape farming practices along the Lower Orange would be unlikely to be able to carry the present day costs of the dams and the other water supply infrastructure on which they are dependent. Add the market complexity of currency fluctuations, technology development and changes in world markets together with the influence of climatic conditions then it is clear that the irrigation potential is volatile.

The provision of large dams to regulate stream-flow, along with other infrastructure such as roads and airfreight facilities provided by the state creates an enabling environment for the implementation of irrigation projects.

The viability of irrigation schemes in the Orange River Basin can be enhanced through encouraging the cultivation of high value crops through marketing support incentives to the farmers. The use of more efficient irrigation systems will also allow a farmer with the same volume of water allocation to cultivate a larger area. (Muir et al, 2003)

The projections of future water demand in the Lower Orange depend largely on the development of further irrigation projects. In considering the potential of these future developments, the following factors need to be considered:

- The available irrigable land;
- The financial viability of irrigation;
- The availability of markets and the long-term prospects of the crops grown;
- Effective marketing of produce is essential, particularly as high value produce grown in the area will have to compete with other global players competing for the same markets; and
- The economic and socio-economic benefits to the region and to the country. Large profits and valuable foreign exchange can be earned from well-managed irrigation projects that grow high value crops. (Muir, 2003)

Potential Significant Irrigation Opportunities

Irrigation farming, particularly for high value crops, is labour intensive and the expansion of irrigation will provide many employment opportunities.

The development of further irrigation projects is not constrained by the amount of irrigable land, but rather by the cost of making the land suitable, transporting water, and of course, the availability of water.

In a recent study of the competitive potential of agriculture throughout Africa, the FAO identified several potentially competitive country-specific crops which are relevant to the Orange River Basin. The recommended crops included:

- sunflowers in Botswana,
- potatoes and wheat in Lesotho,
- and millet in Namibia. (Minoiu, 2003)

Both South Africa and Namibia have identified considerable development opportunities along the Lower Orange River. The bulk of the opportunities have been identified in Namibia, including irrigation projects for both commercial and communal farmers.

Similar potential also exists in South Africa, which has identified a particular need to develop irrigation opportunities for resource-poor farmers and to support poverty alleviation. It appears that the only irrigation developments for which new water rights will be released in South Africa in the Orange River system will be for small-scale farming. Three allocations have been made, including 4 000 hectares each for the Lower Orange WMA, the Upper Orange WMA and for the Fish to Tsitsikama WMA.

Irrigation potential also exists in the Eastern Cape for new initiatives such as sugar beet and chicory production.

The growth of crops produced according to organic principles may create further major opportunities in the international market if it is marketed correctly.

It is doubtful if the growing of low value crops will be viable at all, except for small scale production for own consumption due to the great distances to markets, high pumping costs, low value of products and other negative factors.

The presumed development of high value crops is related to high pumping cost, market advantages for certain crops, water quality, soil conditions and climatic factors. Although the growing of high value crops can result in substantially greater profits, this is also coupled to far greater capital investments, higher management inputs and higher risks.

There are a number of other crops that can be considered as alternatives, but none of these have proved to be as profitable as table grapes. In the long-term the role that table grapes are playing now can be taken over by dates, which are already being produced successfully along the Lower Orange River. Both dates & grapes have been identified as important growth sectors for the US market. (USAID) In future other crops may emerge that will equal or exceed the potential of dates and grapes.

Table grapes

An important growth industry in the Lower Orange River is the export table grape industry for the European and American market. Table grapes have been tried and tested in this region and are a viable crop for the immediate future. However the success of the table-grape growing industry depends on the early harvesting of crops due to a climatic

advantage, and getting goods to market before competitors, which results in very favourable prices.

Unfortunately the weakening of the dollar in recent years has reduced the economic viability of this industry relative to earlier expectations. (pers comm, P Pike, DWAF, 2005) which in most cases assumed an exchange rate of between R8 and R9 to the dollar (Muir, 2003). Production costs in the Orange River (due to its distant location) are relatively higher compared to other production regions. If table grape prices come under pressure, the profitability and return on capital investment will decline substantially.

The Lower Orange has traditionally produced a relatively small volume of table grapes early in the season. Production of table grapes early in the season in the Lower Orange soared in the late 1990's and early 2000's. However there have been concerns that the comparative advantage with regard to a relatively "small" volume early in the season will gradually be eroded.

The period of time during which the grapes fetch phenomenally high prices is so brief that it is virtually impossible to determine the extent of the demand during this period. It occurs during the first week or two that grapes become available from the Lower Orange. Within one week, the price drops to 50% of its highest level.

This dependence on a very narrow market window makes the table grape industry in the Lower Orange very vulnerable. The profitability of the grapes that are marketed at the right time slot is such that competition is likely to develop. There is even a risk that the increase in production along the Orange River can saturate the market for early-season, higher-priced grapes. New markets are however being investigated and developed, and the world markets currently being supplied by table grape growers in the region have the capacity overall to absorb substantial expansion.

Dates

While table-grapes appear to have the greatest potential in the short to medium term, they might be overtaken by dates as the table-grape industry becomes saturated. The market for dates is unlimited at this point in time, and dates appear to be more stable than table grapes in the long-term.

The fruit can be stored for longer periods of time and marketing is not subject to a window period that is determined by global climatic conditions. In terms of profitability dates can compete with grapes marketed in the peak period (Muir, 2003).

However the switch over to the production of dates will be a slow process. A major drawback to the production of dates is the time that it takes to come into production. Dates start to produce after five years and only come into full production after ten years. Land is unlikely to be switched over within a short period and the input costs, capitalised interest, and operating costs will have to be carried for long periods of time.

Vegetables

Most vegetables are highly profitable due to shortages caused by erratic weather conditions. Due to the considerable fluctuations in the market for vegetables, it is not possible to make medium or long-term predictions. However, vegetables have an inherent strong demand in the local market as part of a staple diet.

Because of the difficulty in market projections, as well as the relatively high management requirement, vegetables are considered to be high-risk crops. The three main vegetables grown in South Africa in terms of value of production are potatoes, tomatoes and onions. The per capita consumption of potatoes in South Africa is very low compared to other countries. This creates an enormous potential for market development, which Lesotho in particular is well placed to take advantage of, due to their comparative advantage in potato production.

Lucerne

As a major livestock-producing country, there is strong demand for lucerne in Namibia, particularly in years of low rainfall. At present most of the lucerne is imported from South Africa. Local production is increasing and expansion of lucerne production could significantly reduce the country's stockfeed imports. (DTI)

9.7.2 Urban-industrial sector

The growth of the urban-industrial sector will be determined largely by demographic trends which are dealt with under a separate report.

In general, the vast majority of future urban-industrial growth in the Orange Basin will take place in the Upper Vaal area. According to the State of the Cities Report (2004), the urban portion of Gauteng - comprised primarily of the cities of Johannesburg, Ekurhuleni and Tshwane will be a polycentric urban region with a projected population of some 14.6 million people by 2015, making it one of the largest cities in the world. This growth will be a significant source of growing water demand in the future.

With the possible exception of Bloemfontein which is expected to continue to grow, the urban-industrial sector accounts for a minor share of water consumption in the rest of the Orange River Basin, or 36% of water consumption overall.

Although the irrigation water demand along the Orange River far outweighs the urban, mining and industrial water demand, it is important to study these demands to identify mismanagement of a valuable resource. In general, effective water management is not practised along the Orange River for urban water consumption. Along the Lower Orange, this is mainly because domestic water is supplied without cost in mining towns, where the water account is paid by the mine and not by the consumer.

Certain towns situated in the Orange River Basin currently obtain water from their own sources, mainly boreholes. As these towns grow, it is possible that the local groundwater sources will not be able to sustain the growth of the towns and it is assumed that these towns will eventually obtain water from the Orange River. (Muir, 2004)

Both in **South Africa** and Namibia, manufacturing activities are normally concentrated in larger cities and towns. Although the contribution of the manufacturing sector to the **Northern Cape** provincial economy is extremely low, the Provincial Government is promoting economic diversification and the processing of primary mineral and agricultural products.

Lesotho's manufacturing sector grew rapidly in 2001, aided by the depreciation of the loti, which boosted demand for manufactured exports. In addition, investor sentiment has remained strong since the country's designation by the US government as one of the least developed countries to benefit from the Africa Growth and Opportunity Act (AGOA). The manufacturing sector is highly concentrated, with a few firms in the textile industry accounting for the bulk of total production in manufacturing as well as total manufactured exports. The lack of diversification exposes the sector to a high degree of risk. The manufacturing sector needs to diversify to reduce the reliance on textiles and clothing as the primary source of export earnings. The World Bank has identified three potentially profitable areas of investment: the bottling of mineral water, sandstone cutting, and the promotion of the tourism industry (DTI, 2005)

For **Namibia**, increased manufacturing, in addition to increased local value adding in the resource sectors of the economy such as mining and agriculture is a priority. Namibia's manufacturing sector is relatively small as compared to the other sectors of the economy

and it contributes little to the GDP. However the Namibian Government is currently focusing on programmes to achieve greater diversification in the manufacturing sector. (DTI, 2005)

9.7.3 Mining and mine closures

Current activities

Although irrigation is by far the largest user of Orange River water, some of the largest mines in the country are located in the Orange River basin. It is estimated that mining accounts for more than 50% of the GDP in the Northern Cape compared to less than 15% generated from agriculture.

The mines use relatively small amounts of water, however, this water must be supplied at a very high level of assurance due to the large investment involved in any major mining concern. The mines in the Orange River basin are famous for diamonds, copper, manganese and iron. Most of the country's gold mines are located in the Vaal River Basin. (DWAF, ORP website) The Northern Cape Manganese Deposits to the north and west of Kuruman are the largest manganese deposits in the world. It is estimated that more than 80% of the world's known manganese reserves are situated in the Northern Cape. (Minerals Bureau, 1992)

Mining activities normally have a limited life span and cannot be regarded as a permanent production source. They are therefore generally seen as a short to medium term demand. The success of mining activities is dependent on commodity prices and related global markets, as opposed to the availability of water.

The economic development of the Northern Cape in South Africa was based on a rich base of mineral resources, particularly the diamond, copper, manganese and iron ore deposits. Mining in the Northern Cape accounted for 23,7% of Provincial GDP in 2002.

The mining sector is the largest contributor to Namibian GDP after government services and is a major contributor to exports, accounting for 40 % of foreign exchange earnings; however, the sector's share of GDP declined considerably over the 1990s, falling from 20 % of GDP in 1990 to 12.5 % of GDP in 1999.

Growth opportunities

SA & Namibia have identified considerable development opportunities along the Lower Orange River. In **Namibia**, possible developments include:

- The Skorpion lead and zinc mine, which is earmarked to be the world's lowest cost zinc producer;
- The proposed Kudu gas-fired power station at Oranjemund, where seawater will most probably be used for the cooling operations of the power station. The only fresh water required from the Orange River will be the demineralised water used in the boilers;
- Haib copper mine. The water demand of Haib Mine would overshadow any other mining enterprises along the Orange River on the Namibian side. Estimates of the water which will be needed annually by the mine range from the initial figure of 60 million m3 to more recent estimates of approximately 20 million m3/. This high water consumption rate is as a result of the water intensive processes that the mine intends to use. There is a 25 year life span for the mine. The viability of the Haib Mine depends to a great extent on the world copper price which in turn depends upon demand and supply.

These proposed developments will lead to a substantial increase in water demand.

Lesotho is believed to have significant mineral deposits, but attempts at exploitation have been limited due to a lack of investment. Known deposits include diamonds, uranium, base metals, high quality stone and clay. Recent policy initiatives are aimed at encouraging greater private sector participation in the mining industry. To date interest has mainly focused on diamonds, although output is modest at around 1,000 carats a year. There are plans to revive the diamond industry by reopening the Letseng-la-Terae mine, owned by the Letseng Diamond Company, a company in which the government has a 24 percent shareholding. The mine was operated by De Beers between 1976 and 1992, but has been closed for more than a decade. The viability of mining Lesotho's reserves of uranium, base metals and clays is being evaluated. Reserves of coal and bituminous shale have also been identified in several areas of the country. (DTI)

The **Botswanan** government is currently focusing on diversifying away from the mining sector. The production of diamonds has reached a plateau, following the completion of the Orapa mine expansion in 2000, and no significant growth impetus is expected to originate from this sector in the near future. An aeromagnetic survey has identified three deep sedimentary basins in western Kalahari, and initial prospects for locating either oil or gas were considered good. (DTI)

Mine closures and acid water

In general, mining in the Orange River System is in its mature phase, and is expected to decline in the foreseeable future. There are concerns that current and impending gold-mine closures may result in devastating consequences for the environment unless managed properly.

Together, the South African Department of Water Affairs (DWAF) and Minerals and Energy (DME) intend to ensure that mining companies implement remedial measures towards final closure that will not only facilitate environmentally and socially sustainable future land use, but also secure a water use that will support such land use. It has been suggested that mines investigate establishing a water utility to process and sell the water, turning a potential environmental hazard into a job-creating asset.

DWAF has highlighted gold-mines in the Randfontein area where the western basin is decanting towards the Tweelopies spruit, and mines in the Boksburg and Benoni area where dewatering of the eastern basin is affecting the Vaal river system. There are concerns that unregulated dewatering will affect the sustained use of the Vaal as well as the agricultural industry. When gold-mining ceases, water levels in the basins will rise and eventually decant at the lowest geographical points in the Vaal river system, threatening the quality of the water resources.

DWAF, DME and the mining sector will have to cooperate to ensure that the Vaal river is protected from uncontrolled and illegal discharges of highly-polluted underground water from mines. The scale and allocation of the costs required to do so are at this stage both undecided, and contentious.

9.7.4 Power generation

South Africa's higher than anticipated economic growth has resulting in the country running out of generating capacity sooner than anticipated. In order to keep pace with higher than expected sales growth, Eskom has begun accelerating its return to service project, which includes demothballing 3 water-cooled coal-power stations. This has significant implications for water demand in the Vaal River System.

Demothballing the three power stations in Mpumalanga is expected to add an additional 3 500 MW of electricity to the South African power pool, the first coming on stream this year, the last by 2011. The Camden power station, near Ermelo in Mpumalanga will comprise the first phase of the programme. Two generating units with combined capacity of 380MW

will be brought on stream at Camden every year from 2005 to 2008. Grootvlei which is situated near the town of Balfour, will have one unit recommissioned in 2007, two units in 2008 and 2009, and one in 2010. The Komati plant between Middelberg and Bethal will recommission two units a year from 2010 to 2013 and one in 2013. At the end of the programme, Eskom will have additional generation capacity of 3612 MW. The three stations will each have an operating life of 15 to 20 years.

It was estimated that South Africa would need almost 65 000 MW of electricity capacity by 2024 to meet growing demand. However, the demand-growth projections going forward to 2025 were based on gross domestic-product growth of 4%. These figures need to be adjusted based on government's planned growth of 6%.

Eskom is the main beneficiary of the water to be transferred in the VRESAP scheme, discussed elsewhere in this report.

The most significant future hydro-electric power generation opportunities in the Orange-Senqu Basin are in **Lesotho**. Lesotho used to rely on South Africa for 98% of its power requirements until the implementation of the Lesotho Highlands Water Project (LHWP), which has changed Lesotho from an importer to an exporter of electricity. The royalties generated from these sales to South Africa will be an important source of income for Lesotho in coming years, in addition to the payment of water royalties for water transferred to the Gauteng region.

The Project (LHWP) is already generating enough hydroelectricity to meet almost all of the country's needs and provide a profitable source of export earnings. The project combines water storage and electricity generation, and involves the construction of an extensive system of pipelines and tunnels to deliver water to Gauteng province in South Africa. There is a possibility of a Phase 2 of the project, which has the potential to generate up to 2,000 MW of electricity. However, it has yet to be decided just what phase 2 will involve. Uncertainty stems from the fact that expectations of population growth in Gauteng province are lower than when the first projections were drawn up in 1980.

Uncertainty also stems from the focus in the African energy sector, which is generally on regional cooperation and on resources of sub-regional significance. This may lead to other schemes being implemented prior to or instead of Phase II of the LHWP.

Of Africa's technically feasible hydropower potential of 1 750 000 GWh/year, only 3% has been exploited. However, the location of hydro resources and the demand for power are

poorly matched. Few households have access to electricity, consumption is low, and industrial and commercial developments are practically non-existent. The result is a lack of demand for electricity to economically justify rapid exploitation of the vast hydro potential that exists. The role of regional hydropower is viewed as providing a sustainable, low-cost source of electricity. One of the most high-profile ways of attaining this is through the proposed Inga scheme in the Congo basin. It is hoped that a supply of cheap and plentiful electricity will help to stimulate industrial developments and help reduce poverty.

SADC is promoting regional electricity cooperation and power pooling through the extension of grid interconnections to cover all Member States and the transformation of the Southern African Power Pool (SAPP) from a co-operative to a competitive pool and create a regional electricity market. The SAPP is a core component in NEPAD's regional energy plans. It was created in 1995, to link SADC member states into a single electricity grid. Botswana, Lesotho, Namibia and South Africa all belong to the SAPP, which saw the bringing together of two main networks in the region, namely:

- A southern network (consisting of mainly thermal generation), with transmission links interconnecting South Africa, Namibia, Mozambique, Swaziland and Lesotho; and
- A northern network (mainly hydropower), with transmission links interconnecting Democratic Republic of the Congo, Zambia, Mozambique and Zimbabwe.

The proposed $1-billion Inga hydropower project in the Congo Basin involves an initial transmission line which will run from the power station in the Democratic Republic of Congo (DRC) through to South Africa via Angola, Namibia and Botswana. This is to be implemented by the Western Corridor Steering Committee (Westcor). Westcor was set up by SAPP to investigate the feasibility of this corridor and is a joint-venture between the power utilities of Namibia, Botswana, South Africa, Angola and the DRC. The goal is to complete the Westcor project by 2015.

Table 26: Hydropower – Macro plans and Key projects, by SADC country

Country	Major national plans and initiatives
Botswana	Internal electrical power is generated entirely from thermal sources at two major coal-fired plants Will benefit from regional hydropower initiatives such as Inga 3 and the Westcor transmission project. Could import from Angola
Lesotho	Sale of hydropower to SA is a significant revenue generator. The inauguration of the Muela hydroelectric power station now means that Lesotho no longer needs to import electricity from South Africa, but can instead export power to South Africa. There is considerable hydroelectric potential in Lesotho. Estimates have equaled 1260 GWh/year. Internal demand is low, with only 2% of the population currently electrified
Namibia	Current supply not adequate for industrial demand, imports most of its power. Will benefit from the Western Corridor Project (Westcor), part of the Inga3 project. Namibia and Angola are considering the development of a hydroelectric facility on the Cunene River that would provide electricity to both countries. Two possible sites for the dam are being considered, Baynes and Epupa Falls. The proposed facility would have a generating capacity of about 360 megawatts (MW) and provide power to the Angolan, Namibian and South African grids.
South Africa	Insignificant internal potential. Main international opportunities include the Westcor project to utilise DRC potential, and the recently completed Maguga Dam in Swaziland
Source: Reports compiled for SADC 2004, World Bank 2004.	

9.7.5 Water quality and dilution

Poor water quality increases the cost of water purification and decreases the productivity of irrigated agriculture. Water dilution is therefore practiced in an attempt to improve water quality. Upstream polluters are therefore passing on the costs of poor water management practices to downstream users both through lower quality water, and the use of water for dilution which could be better used elsewhere in the system.

Water dilution is a sub-optimal use of scarce water resources, and upstream users should be encouraged to improve their water-use practices to reduce the need to reserve water for this purpose.

The quality of the water in the Orange River system has systematically been degrading. Reasons for this include the increasing agricultural and industrial activities which are upstream from Upington, as well as the lessening of the inflow of high quality water from Lesotho.

The quality of the water varies with the seasons, as well as depending on which river feeds the main inflow. If it is the Orange River, the turbidity, sand and salt content is usually high. If the inflow comes mainly from the Vaal River one finds a light nutrient content which

leads to algae growth. The removal of large concentrations of both silt/sand and algae is problematic at times.

Salinity in the Orange River has increased due to the transfer of high quality water out of the Orange River (in Lesotho and the Upper Orange WMA) and as a result of high salinity irrigation return flows along the Orange River. Poor quality water from the Vaal River, which contains a high proportion of irrigation return flows as well as treated urban effluent, also enters the Orange. Salinity is at present still moderate along the main stem of the Orange River. Deterioration can be expected with increased upstream irrigation and the situation must be closely monitored.

Water quality of the surface water in the Upper Orange is generally good except for the high sediment load in the Caledon and the salinity problems in the Lower Riet. The water quality in the Lower Orange has, however, been severely impacted upon by extensive upstream developments. It is possible that the water quality problems in the Orange is coming from the Vaal as water quality in the Vaal becomes worse as one proceed along the Vaal. Under normal operating conditions very little water from the Vaal reach the Orange River and it is mainly under flood conditions that large volumes will enter the Orange.

The water quality issues in the catchment relate to the management of the water quality passed down between WMAs and can therefore not be solved on a WMA basis alone. An integrated water quality management tool is required to allow for the rational assessment of the factors that impact on water quality in the Orange River.

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11 THE ECONOMIC VALUE OF WATER

11.1 Introduction

11.1.1 Background

The Orange River Basin extends into four countries; The Kingdom of Lesotho, Republic of Botswana, Republic of South Africa and Republic of Namibia. It includes the total land area of Lesotho, most of the central part of South Africa and reaches to the southern part of Botswana as well as draining most of the southern half of Namibia. The Orange-Senqu River Commission (ORASECOM) came into existence on 3rd November 2000 by agreement among the four basin member states in terms of the SADC Protocol on Shared Watercourse Systems, with one of the primary aims being the integrated development and management of the water resources of the Orange River to the mutual and equitable benefit of all parties.

At the stage that ORASECOM was founded, extensive developments had already taken place with respect to water resource infrastructure and utilisation of the resource. Amongst others, large inter-basin transfer schemes have been developed which transfer water from several other basins into the Orange River Basin as well as from the Orange River Basin to other adjoining river basins. Plans have also been developed by some of the co-basin countries with respect to possible further developments and aspects pertaining to the future management and utilisation of the resources of the Orange River Basin. To facilitate the integrated development and management of the resources of the Orange River jointly by the four basin member countries, it is essential that common ground exist among the basin countries with respect to the principles and objectives salient to the joint management and that appropriate strategies and plans be developed to achieve this. A key component and common reference base being the development of an Integrated Water Resources Management Plan (IWRMP) for the Orange River Basin. This paper deals with the issue of the economic value of water in the Orange River Basin and is an output of Task 10.

11.1.2 Overview of the Paper

Water has an economic value in all its competing uses and should be recognised as an economic good.

Within this principle, it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Principle no. 4, International Conference on Water and the Environment, Dublin, January 1992

There is an extensive body of literature available on the economic value of water, and the various techniques for evaluating the economic value of water. However this report serves only as a summary introduction to some of the main concepts and techniques. Where possible this information has been tailored with regard to the major categories of water use in the Orange-Senqu Basin. References are supplied for readers who would like to investigate these methods in more detail.

In determining the optimal allocation of water resources, a system-wide perspective has to be taken. In the Orange-River Basin, extensive transfers out of the basin to the Gauteng and Fish-Sundays River System must be taken into account. For this reason, the water uses and values considered in this report will extend beyond the strict boundaries of the river basin itself.

It explores the generic conditions driving the demand for water in each of the major water-using sectors in the Orange-Senqu, and introduces some of the methods which are used to determine the economic value of water in each of these sectors.

Irrigation and urban-industrial users account for the bulk of consumption in the Orange basin, or 86% overall. The table below illustrates the major water users by sub-basin, and their relative share of total water consumption. The prospects for future growth and development are dealt with in other reports.

Table 27: Water requirements for the year 2000 (million m3/annum)

Water Management Area (WMA)	Irrigation	Urban	Rural	Mining & Bulk Industry	Other	Total
Upper -Vaal	11%	61%	4%	17%	8%	26%
Middle Vaal	43%	25%	9%	23%		9%
Lower Vaal	82%	11%	7%	1%		16%
Upper Orange	81%	13%	6%	0%		24%
Lower Orange	95%	2%	2%	1%		25%
Total	**63%**	**23%**	**5%**	**7%**	**2%**	**100%**
Notes: Urban includes basic needs reserve of 25l/c/d Mining & industrial that are not part of urban systems						

Source: DWAF 2004

The types of values allocated by the different users to water is explored, along with the role that water markets might play in improving the efficiency of water use in the basin. The report concludes with a brief discussion of the issue of affordability and access to water for the poor.

11.2 The Concept of Economic Value

Total economic value is loosely defined as the maximum amount a user would be willing to pay for the use of a resource, and derives from the specific use to which this resource will be put. (Gibbons, 1986) Economic value is the economic benefit derived from using a given quantity of water.

In a world of perfect competition for water, with perfect information, functioning markets, no externalities, and no distribution concerns, the public and private value of water are equal. Under these conditions, the economic value would be equal to the market price.

However, in the absence of these conditions, there is most likely a mismatch between price and value, and price is no longer necessarily representative of economic value. Public and private values differ because an individual's use of water at one time and place may impose unintended consequences, or externalities, on others.

To satisfy their highest priority needs, users are typically willing to pay a premium for the first units of water. In most cases the total value of water to a user will increase as the quantity used increases, but at a decreasing rate. This suggests that the marginal value of

each additional unit of water decreases as use increases because additional units are put to less valuable uses.

This assumption of decreasing marginal returns causes the familiar downward slope of the demand curve. This relationship between the quantity of water used and the marginal value of water holds for groups as well as for individuals. It is the marginal value of water (the value to the user of the last unit purchased or used) that will determine the user's economic value of it.

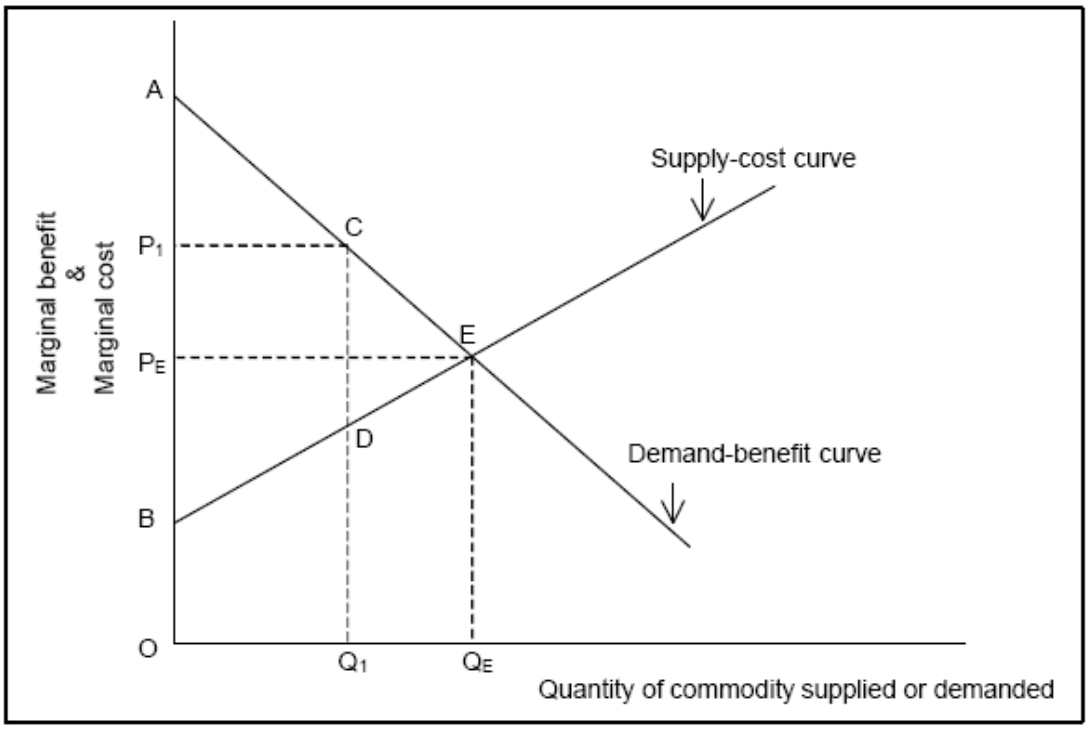

Figure 20: Economic Value

Source: Agudelo, 2001

Scarce water resources require that decisions be made as to how to allocate these resources. Demand curves can be derived which show the marginal benefit obtained from consumption and the willingness to pay. Supply curves can be deduced showing the marginal cost of supply and the willingness to supply at given prices. The point where the demand and supply curves intersect defines the theoretical price at which economic efficiency and welfare is maximised.

However, applying market principles to water management is complicated in practice, because water does not easily fit the economist's model of a perfect market. Often water providers have a monopoly, and there may be values attached to water (as for instance non-use values) which are difficult to quantify in monetary terms.

Both average and marginal values are used for estimating water values although marginal values are the relevant measure for assessing the efficiency with which water is allocated among alternative uses.

11.2.1 Different cost components

The economic cost of water does not only include the supply cost, which comprises operation, maintenance and capital costs. In addition to the direct financial costs, it also includes the external costs, and the opportunity cost for water.

There are three components to estimating the economic costs of water.

- *Use values,* also referred to as financial costs or full supply costs, are the costs associated with physically supplying water to a consumer. These are the traditional capital and operating costs, the financial expenses required to access the resource. This reflects the value of water to the user;
- *Economic costs, or full-use values* consist of the financial use costs, in addition to any externalities associated with a particular pattern of use. The standard economic approach is to define the system in such a way as to internalise the externalities. (Rogers, 1996) Externalities occur when the actions of one water user affect the interests or well-being of another. Externalities can be separated into economic and environmental externalities, and can be either positive or negative. Economic costs can be defined as either the maximum amount a user will pay for the use of a unit of water, or the cost of the least expensive alternative, or opportunity cost (see below);
- *Full values* consist of the full economic costs plus the non-use values attached to water. These relate to the benefits and costs derived from current use, both directly and indirectly. Information on these impacts is seldom available. (Gibbons, 1986; Grey, 2003: 20; Agudelo, 2001)

Direct uses include uses such as water as a factor of production in industry and agriculture, water for drinking, and waste disposal.

Non-use, indirect uses are those where water is not directly used to produce a commodity, for example supporting recreation and tourism, or water required to sustain a healthy environment. These are values placed on the mere existence of a resource and its physical, biological or cultural characteristics, even though the individual may not ever directly experience it. These values thus are not associated with any specific use, and the measurement of non-use values is more controversial than that of use values.

11.2.2 Characteristics and types of water use

As water use has a number of dimensions, such as quantity, quality, timing and location, many issues arise as soon as water uses are further specified. It is important to be aware of these other dimensions when comparing marginal values between sectors to assess the economic efficiency of allocations among them.

Quantity is the dimension considered most often in value estimates. Due to the law of diminishing marginal utility, the larger the quantity used, the lower the marginal value.

Water uses can be further grouped under several categories, namely subtractability, location and economic role.

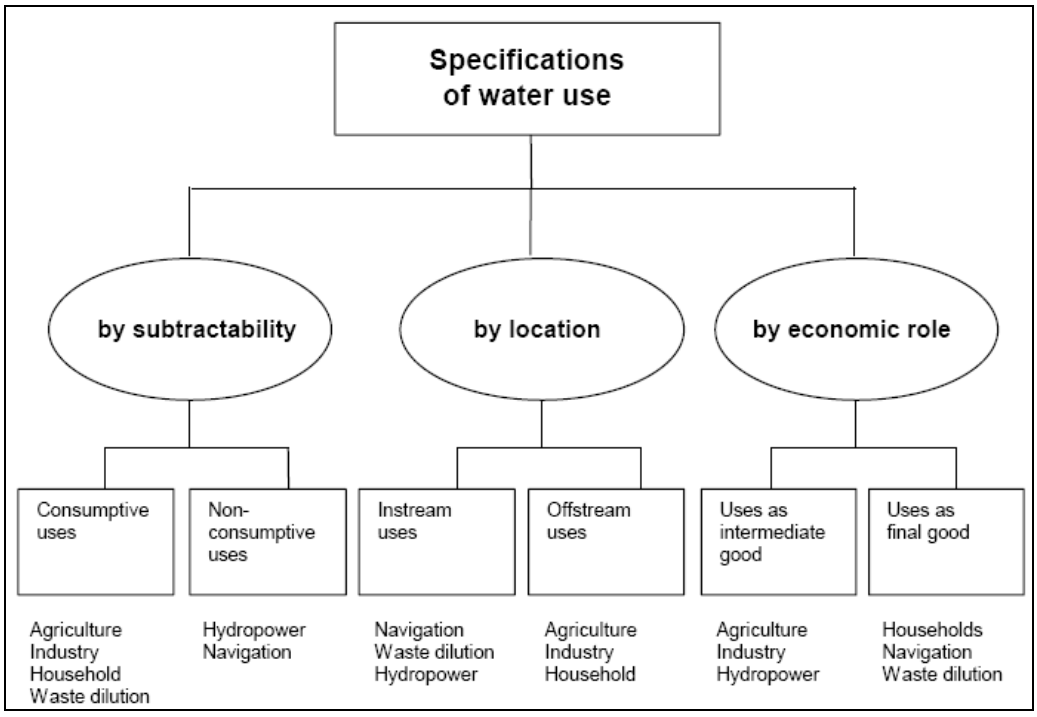

Figure 21: Properties of water-use

Source: Agudelo, 2001

Consumptive use is not only defined by a reduction in water quantity, but can also result from a loss of water due to a change in water quality. It is therefore not only a reduction in water quantity that defines a consumptive use.

Another way of classifying water use is by location – those uses occurring in a river and dependent on its flow characteristics are called instream uses, such as hydroelectric power generation, recreation and, importantly for the Vaal River, waste dilution. Off-stream uses include municipal, agricultural and industrial water demand.

The expense of transporting water means that it is important to be aware of location in describing use and allocating value. For example, for water values of an instream use to be comparable to those of an offstream use, adjustments have to be made to reflect the site-specific nature of any offstream water value.

Water can also be defined by its economic role as an intermediate producer or final consumer good. Water used in the production of another good, such as water used in irrigation or industrial processes or to generate electricity, is an intermediate good. Household demand and waste dilution are the only water uses where water is consumed directly, while navigation is a non-consumptive final use of water. The concept of economic value also differs slightly according to its economic role – water used by a consumer provides direct utility or improved well-being, while the value that a producer places on the use of water depends on the final value of the resulting goods or services. (Gibbons, 1986)

Timing can also have an important influence on a water value. Irrigation water is more valuable when applied during periods of critical plant growth and during times of drought, when crops are water stressed. This may in turn have an impact on related, usually complementary uses such as hydro-electric power generation. (Gibbons, 1986; Agudelo, 2001; Louw, 2003)

11.3 Economic value of water for individual water users

11.3.1 Introduction

The following section investigates the different methods of calculating the value of water to different water users in the Orange-Senqu Basin.

There are two main approaches to valuing all natural resources, including water. The first asks individuals directly what they would be willing to pay for a given amount of water, using methods such as contingent valuation surveys. The second, used where water is

being used as a factor of production such as by agriculture or industry, calculates the value of water as a residual after deducting the costs of all other inputs. The value of water can be calculated by taking the unit cost, less the unitised value of all inputs.

These methods and others will be discussed in reference to the major different types of water users in the Orange River.

The various different methods of calculating water value result in values which are not necessarily directly comparable. The estimates may have fundamental, definitional differences. For example, some values are specific to a certain time-frame, and short and long-run value can differ significantly. Average and marginal values are based on very different concepts of value that cannot be equated in most instances. Care must therefore be taken to be clear how values have been defined, and for what purpose. (Gibbons 1986)

The different valuation methods usually estimate on-site water values, which includes the costs of transporting water. For these values to be comparable to instream water values, and to water values in other on-site, offstream sectors that have been calculated at the source, the costs of transporting water to the site, on-site irrigation or pumping water from an aquifer would have to be subtracted. The economic value of water at the source of supply is generally less than the on-site estimated values.

There are several methods which are used to calculate the economic value of water. There are essentially 3 types of valuation methods, namely:

1) Methods that infer values from information regarding markets of water or water-related benefits.

2) Methods that infer values from the derived demand for water, where water is taken as an intermediate (production) good, i.e. as an input to the production of other goods or services; water is an intermediate good for instance in the cases of irrigation of crops, cooling, processing or manufacturing operations, or driving of turbines to make electricity; These include:

- *Residual approaches*, where financial budget information on a single productive process can be used to calculate the share of the total product value that can be attributed to water. If all factors of production are paid at their marginal productivities, the remainder, after subtracting all other inputs, is assumed to be the maximum economic return to the water input.

- The concept of *alternate cost* can also be used to value water. The cost of the least expensive alternative to water is used as a proxy for the maximum amount the user might be willing to pay for water
- Estimating production functions and simulating the loss of output which would result from the use of one unit less water.

3) Methods that infer values from a direct consumer demand, in cases where water is considered a final (consumption) good, used directly by the final consumer. (Agudelo, 2001)

- If there are any market-type transactions, payments of this kind for water indicate that the user is willing to pay at least a certain amount, which can be viewed as a lower limit on value for that sector. (Gibbons, 1986)
- If enough price and quantity data is available, a water demand curve can be estimated, from which estimates can be made of marginal values of the water use at different quantities. For example, Greengrowth Strategies (2003) derived demand functions of water for the Vaal River system areas for the different water user categories, and calculated the price elasticity of demand for water, in order to determine how responsive water demand is to changes in tariff. (These values will be presented in Section 4 of this report.)
- Using structured “contingent valuation” questions to determine what value user’s place on a given resource.
- Public goods such as the valuation of water for recreational or environmental purposes are estimated using techniques such as revealed preference (e.g. travel cost method, or hedonic pricing model) or stated preference approaches (also known as contingent valuation – used for valuation of in-stream flows and water quality benefits. (Gibbons, 1986; Agudelo, 2001)

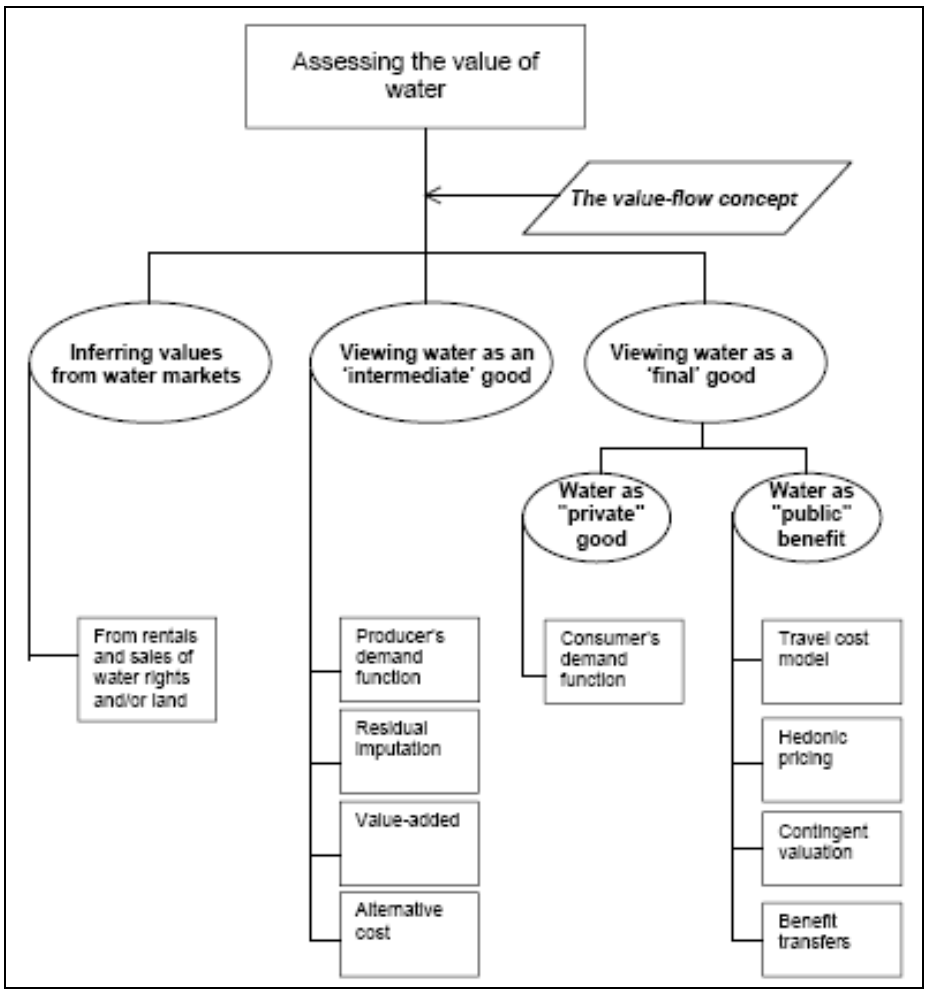

Figure 22: Water valuation methods

Source: Agudelo, 2001

11.3.2 Irrigation Water

Demand characteristics

Most irrigation in developing countries is used in the production of food grains, a high volume, low value use of water. It is also used for growing high value irrigation of fruits, vegetables and flowers. The supply cost of irrigation water is usually low, but when there is competition with either urban uses or high-value irrigation, the opportunity cost is high.

The challenge in treating water as an economic good, is to ensure that farmers consider these opportunity costs, and that there are institutional arrangements to facilitate movement of water to higher-valued uses.

Demand for irrigation water is a derived input demand, as irrigation is a factor of production. Demand for water for crop irrigation is influenced by season, location and quality requirements and effects, as the quality of irrigation water can affect crop yields.

The value of water will thus depend on the relative scarcity of water, for example in times of droughts, over the short-term farmers will be prepared to pay substantially higher amounts for additional water in order to save the current crop. In the short-run, with the growing season underway, irrigation water has a very inelastic price elasticity, and demand is very unresponsive to price changes. However over the longer run, farmers are able to increase irrigation efficiency, switch to a higher value or more water efficient crop, or reduce the land under irrigation, so demand is much more responsive to increased costs over the long run.

Valuation methods

Irrigation water value estimates are heavily dependent on crop prices. Each physical or financial method of determining values takes crop price or revenue as the basis for the value of water in crop production. All estimates depend on assumptions about the efficiency of the irrigation system.

The basic methods for estimating irrigation water values are crop-water production function analyses and farm crop budget analyses that use linear programming. In spite of the differences in methodologies used, the primary factors underlying the wide variations in the estimated irrigation water values are the crop grown, the location , the time-frame (long-run or short-run) and the year of the estimate rather than the methodology employed (Gibbons, 1986; Young, 1996; Louw, 2003).

The relationship between inputs and outputs of crop production can be expressed mathematically as the crop production function. If all other inputs are held constant, the marginal productivity of water for each unit of water used on the crop can be calculated. The marginal value of each cubic meter is the marginal physical product times the crop price. These values are therefore related only to the crop selling price and the physical productivity of the water unit. However in most places and for most crops the actual physical productivity of water is not known.

In crop-budgeting or residual analyses, water values are also dependent on non-water input costs. As the prices of other inputs go up, the estimated value of water declines. Representative farm crop budgets can be used to estimate the maximum revenue share of the water input. The total crop revenue less the cost of all non-water inputs results in a residual amount, the maximum amount the farmer could pay for water and still cover costs of production. This represents the on-site value of water. If supply costs are subtracted, the net value for irrigation is then comparable to in-stream water values. This amount, divided by the total quantity of water used on the crop, determines a maximum average value, or willingness to pay for water for that crop. Depending on whether or not fixed costs are included, such values can be short-run or long-run average values. (Gibbons, 1986) This method is most suitable when water is a significant factor of production in terms of the value of the output, as for irrigation. (Agudelo, 2001)

A variation on the theme of crop budgeting can be used where dry-land and irrigated production of a crop occur within a homogenous farming area. When all other factors such as soil type and climate are similar, the difference in net returns can be attributed to the irrigation water. According to Gibbons (1986) this method of calculating values is seldom used, but it is an interesting method in that it allows the separation of normal profits from the value of the water.

The negative indirect results of irrigation include water quality externalities. Not incorporating these negative effects into irrigation water values will result in an overestimation of the true value of irrigation water. (Gibbons, 1986)

11.3.3 Municipal Water

Demand characteristics

Municipal water demand consists of residential, commercial and public uses. It is influenced by several factors, such as climate, population density, income level and water price.

The marginal value of water in municipal uses depends on how much of it is available. Very little and the value will be high, an abundance and the value will be close to zero. In these cases the cost of water would be based completely on the actual physical, financial costs of transporting and providing water.

Residential demand consists of indoor uses, such as drinking, cooking, washing, and outdoor uses such as garden watering. These different uses tend to have different reactions to changes in price, as a different value is placed on the different uses.

Households place a higher value on the first units, and demand is inelastic for lower amounts, as water is essential for life. Residential water is not price responsive in the short run, confirming its status as an essential good. However, water demand is more price elastic in areas where outdoor water use is a larger part of consumption. Outdoor demand tends to vary between seasons, particularly where summers are hot and dry.

Household demand is also more responsive to price over the longer term, as there is frequently still plenty of opportunity for reducing consumption without hardship.

Conradie found (2002) that poor and wealthy households have similar price elasticity of demand for water. However the reasons for this are assumed to be different. Low income household demand for water is already fairly constrained to using water for basic needs, which is generally accepted as being essential, and therefore fairly inelastic. The inelasticity of demand for higher income households on the other hand is assumed to be due to the fact that the price of water is a smaller part of household income. However, the price elasticity of higher-income households for increases in water tariffs which double or more has not yet been established.

Valuation methods

The principle way to measure the marginal value of water to an individual is through the use of **water demand functions**. A consumer's willingness to pay for an increment of supply is the corresponding area under the demand curve, although the amount the consumer actually pays for the increment is the water price times the quantity.

For the value calculated for municipal water be comparable to the value of water in in-stream uses, the costs of bringing water to the urban user must be subtracted from the overall willingness to pay. The value of municipal water at its source is net of the water utility or supply costs and is represented by the consumer surplus.

The **contingent valuation method** is also frequently used for estimating domestic demand. This approach makes use of user surveys and questionnaires to determine the value that user's place on water. However the limitation of this approach is that outcomes are based on expectations, rather than being observed.

11.3.4 Industrial water demand and value

Demand characteristics

The elasticity of demand for water is expected to be low in sectors where the cost of water is a relatively small share of the value of the final product and where water cannot be replaced by other factors of production. A low price elasticity of demand implies that a high premium is placed on sufficient water and a high level of assurance.

Water costs are typically a fraction of total costs for industrial processes. As a result, decisions on water use are usually secondary to a firm's initial profit-maximising decisions on process technology, inputs, output mix and scale of operations. These primary decisions on technology and outputs usually determine the amount of water required per unit of output or time involved in the production process.

Since water for industrial and power purposes is required through-out the year, including the dry season, the provision of water for both of these uses results in high opportunity costs and high supply costs, due to higher infrastructure and storage costs required to provide this level of assurance. These costs should be taken into account while evaluating the benefits and costs of industrial water supplies. If it results in a smaller area under irrigation during the dry season, this has to be factored in when calculating the opportunity costs of water in the industrial and urban sectors.

Valuation methods

The most popular method for valuing industrial water is to use the opportunity or alternative cost of reusing water i.e. the costs of effluent water treatment as the economic value of water.

There is very little evidence of industrial water demand functions, due to the individual nature of each production process, and the small cost contribution of water to overall production costs. Due to methodological difficulties, value has sometimes been equated with the internal cost of water recirculation. (Gibbons, 1986)

There are also residual approaches, where financial budget information on a single productive process can be used to calculate the share of the total product value that can be attributed to water. If all factors of production are paid at their marginal productivities, the residual, after subtracting all other inputs, is assumed to be the maximum economic

return to the water input. However, this approach can be problematic due to the small cost contribution of water to the overall production process.

Waste assimilation and water quality

Different water uses require different intake water quality, and also result in different degrees of water quality. The capacity of a water body to assimilate or dilute wastes represents a real economic value when the costs of water quality effects are considered. Water managers rely on dilution flows in maintaining water quality standards in rivers. The release of water from storage for low-flow augmentation is a recognised use of multiple-purpose reservoirs. The value of water in this use is related to the variation in natural streamflows.

The value of water for waste dilution is usually calculated as either the waste-treatment costs foregone or downstream damages avoided. But damages are hard to estimate reliably. Although less direct than damage estimation, the economic value can also be calculated by using an alternate cost framework in which the value of dilution water is assumed to be no greater than the cost of providing the same water quality through pre-treatment of the effluent. Water quality can be maintained through the treatment of and reduction of wastes entering the river, which is usually less expensive as it doesn't require the construction of expensive storage. This is applicable to point-source pollution only.

Non-use values

Non-use, indirect uses are those where water is not directly used to produce a commodity, for example supporting recreation and tourism, or the water required to sustain a healthy environment. These are values placed on the mere existence of a resource and its physical, biological or cultural characteristics, even though the individual may not ever directly experience it. These values thus are not associated with any specific use, and the measurement of non-use values is by far more controversial than that of use values.

A variety of approaches have been developed, based on user surveys of actual or hypothetical behaviour: these include *observed indirect* (also called *revealed preference*) methods and the *hypothetical questioning* (or *contingent valuation*) method.

Related-market approaches are based on the links between environmental assets and markets for related private goods and services. If the use of water-based recreational services influences the demand for any marketed commodity, observations on purchasing behaviour related to that commodity can be analysed to derive information on the

preferences and WTP for the environmental amenity. Two of these methods are the *travel cost* approach and the *hedonic price* approach.

The **travel cost** method is the most widely used example of the observed indirect methods. The technique assumes that visitors to a particular site incur economic costs, in the form of outlays on time and travel, to visit the site. These economic expenditures reflect the 'price' of the goods and services provided by the site, and are an indirectly observable indication of the *minimum* amount a visitor is willing to pay to use the site (with all its associated attributes).

By observing the characteristics of individuals visiting the site, economists are able to estimate the derived demand for the site. That is, for any given or implicit price, the derived demand relationship will determine the number of visits consumers will 'purchase' at that site. (Agudelo, 2001)

The **hedonic pricing** method is applicable when data can be inferred from markets, which can then be used to measure willingness to pay for water supply or environmental quality differences. In their earliest applications these techniques were meant to capture the variations in property values, resulting from the presence or absence of specific environmental attributes recognised by purchasers, such as water views, noise, or air pollution. These attributes cannot be separated when purchasing the property. By comparing the market value of two properties which differ only in respect of these environmental features, economists may assess the implicit price of that feature as shown by the behaviour of buyers and sellers.

The hedonic technique is as yet relatively rarely applied to measuring values of water or water quality. To estimate economic values of environmental resources through hedonic methods is quite difficult in practice, and the technique is subject to serious limitations.

There are cases in which it is not possible to derive value measures from observing individual choices through a market. The methods developed to measure environmental values in such cases are referred to as 'hypothetical methods'. The most common form of questioning on hypothetical futures is called the **contingent valuation method**, the only method available for measuring 'existence values', the value that individuals place on simply knowing the natural resource exists in an improved state. It involves directly asking individuals what they would be willing to pay for particular goods or services *contingent* on some hypothetical change in the future state of the world. A limitation on ascertaining the

marginal value of water may occur, because the questions asked do not relate to incremental changes in water supply or quality, but to the value of the site or policy itself. However, the method has been able to provide useful estimates of the marginal value of streamflow for uses such as water for fishing, boating or streamside recreation. (Agudelo, 2001; Young, 1996)

11.4 Economic value and water allocation decisions

The previous sections discussed the various methods for establishing the value of water to different types of users, or economic sectors as the case may be.

However, when any resource becomes scarce, methods have to be found of allocating this scarce resource between different water users, in a way that is most economically beneficial. If water markets functioned perfectly, all users would be paying the true value, but this doesn't work in reality. The concept of opportunity cost is used to allocate resources under conditions of scarcity.

"When water is locked into uses that are no longer high-valued, inefficiency abounds. When the distribution of resource use cannot adapt to changing economic conditions, conflict escalates." (Gibbons, 1986)

To treat water as an economic good means that water should be produced and consumed in an efficient way. Efficiency means that a scarce good is allocated in such a way that it cannot be redistributed without someone loosing from this change (Hansson, 2004). Efficient consumption of water means that the value of water for the person consuming it must exceed or at least be equal to the cost to produce that good. If the value is less than the cost, it means that it is possible to use the water used to produce that good, in an alternative and more productive way.

The conventional strategy to cope with an increasing water demand has been to augment the supply, which is obviously an unsustainable strategy. Inefficient water use leads to an over-use of water, and over-investment in water supply facilities relative to investment in other methods of providing or conserving water and relative to expenditure on other goods and services. (Louw, 2003)

To decide which sectors should be given preference in water allocation during scarcity, information is needed on the value of water in these sectors. The economic valuation of water provides a basis for sharing the benefits of the river water between all potential users, thereby aiming to improve the net economic benefits and the efficiency of water

use. An examination of marginal benefits in competing uses can help to identify large disparities. Economic efficiency and fiscal responsibility are promoted where the marginal benefits of water use are equal to the marginal costs. (Gibbons, 1986)

11.4.1 Opportunity cost and allocative efficiency

Opportunity costs are the benefits that could have been generated had water been put to its next-best use. They address the fact that by consuming water, the user is depriving another user of the water, including non-consumptive uses. If that user had a higher value for the water, then there are opportunity costs to society for the misallocation of resources. Opportunity costs (or foregone opportunities) will outweigh the use value generated by water when it is not put to its highest value use. The opportunity cost of water is zero only when there is a surplus of water.

Ignoring opportunity costs leads to undervaluing water, failures to invest, and misallocation of resources between users. (Louw, 2003)

The opportunity cost of water cannot be captured properly if sectors are modelled separately. The opportunity cost is critical in modelling the value of water and the impact of water markets. Water markets act as a buffer when water becomes scarcer. If water can be sold or leased to anyone for any purpose, this provides an incentive to the owners of the water right to conserve water and sell the surplus to those willing to pay a higher price than the value that the present owner attaches to the right, thereby allowing water to be reallocated to higher valued uses.

11.4.2 Water trading and water markets

Water trading appears to be a more effective way of improving the efficiency of water use throughout a river system. In theory, a person having a low-value use could sell it to another person willing to pay more. The seller would not do so without getting paid more than the value they place on the good, while the purchaser would not do so if the price paid were not below the their maximum willingness to pay.

The existence of a market presents water users with the real opportunity cost of their water use decisions, and forces them to take this opportunity cost into account. If a water market is based on the opportunity costs, it creates a built-in incentive to conserve water and put it to the most productive use. (Hansson, 2004; Louw, 2003)

Water markets can provide a more flexible mechanism for reallocating water use among water users, and between riparian countries, within an agreed compensation structure. Water markets would allow users to buy and sell fixed-term water use rights that would not affect accepted water treaty rights. The price and quantity of water use rights could be decided by market forces or negotiated as a means of benefit sharing.

Tradable water rights can help to shift water to higher-value use in a way that is cheaper and fairer than building new infrastructure, confiscating water from farmers, or substantially raising water charges to force farmers to conserve water and to free-up water for higher-value uses. In addition, water rights may also serve as an asset that can be used as collateral for lower-interest loans. (Louw, 2003)

The efficient construction of any water market requires the existence of 3 conditions for trading to occur:

- Well-defined water rights;
- Public information on the supply of and demand for water, and
- The physical and legal possibility for trading to take place. (Louw, 2003)

While the National Water Act of 1998 provides the framework for water markets in South Africa, enabling CMAs to design water allocation strategies for each of the major catchments, preference is still given to administrative price setting for water resources. There is also uncertainty about the provision for legal transfer of water use licenses. Procedures are required for formalising water licenses and resolving disputes.

In light of the importance of high assurance for some users, the current licensing system may have to be amended. The current system provides for a license for a maximum of 40 years, renewable every 5 years with no guarantee that the user will receive the same volume of water. This insecurity may lead to a lower valuation of water.

In a water market allocation, potential buyers will bid for water in-stream, thereby removing their differential supply costs from the equation. However, the regulators of a water market will have to be careful to incorporate the external costs imposed on the resource, to ensure that the true economic costs of water are being reflected, and that private and public water values are equivalent. For example, the use of water by two farmers results in increased salinity downstream, which imposes costs on downstream users.

11.4.3 Environmental values

In South Africa, a certain volume of water is needed to ensure a water resource, such as an estuary, of a certain quality. Water sufficient for this purpose is therefore allocated from the available stream-flow, for purposes such as the in-stream flow requirement, or even water for dilution purposes where salinity has become a problem.

This therefore imposes costs on the system by removing water from the system that might have been used by productive uses. The amount that these users would have been willing to pay for the water has now been foregone. This method can be used to determine the opportunity cost of preserving a desired environmental quality.

Under conditions of scarcity, where water allocation decisions have to be made, there is therefore a direct trade-off between the quality of the environment preserved, and the economic value foregone.

11.4.4 Water transfers

Water transfers imply a water surplus in one system, and therefore a zero opportunity cost to the system providing the water. However there is a time dimension to this arrangement, as demand in both basins may change over time. To achieve an economically efficient allocation of water rights, if the opportunity cost is higher than the value to be derived from the destination, then water shouldn't be transferred. In other words, water should only be transferred if users in the destination basin are willing to pay more (at the source or in-stream value) than other users in the value, i.e. excluding the supply costs.

For example, when comparing the value that farmers in the Fish-Sundays, compared to farmers in the lower Orange, place on any given unit of water, it will have to be calculated at the source, less the supply costs of the Fish-Sundays transfer scheme. After subtracting supply costs, it is highly unlikely that, given the current market conditions for table grapes and dates, farmers in the Fish Sundays system will value water more highly than farmers in the Lower Orange. Under current market conditions, economic efficiency would seem to indicate that the quota to the Fish-Sunday system should be reduced, and allocated instead to farmers in the Lower Orange.

However, if changing demand patterns over time are taken into account, in particular the anticipated future urban-industrial demand from Nelson-Mandela Metro and Buffalo City, the current allocation may be economically efficient.

11.5 Maximising the system-wide economic benefits of water use

There are downstream externalities which result from any water use, whether through affecting water quality, or reducing the quantity of water available in the system. The economic cost of these effects should be deducted from the economic value of any given use, when calculating the combined economic gains of different water uses to the entire river system.

Sadoff and Grey (2003) have proposed that a *system-wide* approach be used to maximise the benefits from and "beyond the river", with particular reference to internationally shared river-courses. This requires discerning between the value of one water use within a river system (the user value) and the aggregate value of a pattern of multiple uses within the river basin (the system value). The system value is the aggregate value that a unit of water can generate as it moves through the river system before it is consumed or lost. Or to put it another way, it is the sum of benefits and costs to all the users under a specific configuration of uses or development path. By aggregating the value of water in all of its uses within the river basin, this approach effectively forces an integrated systems management perspective by internalizing the externalities (and opportunity costs) of a given development path or configuration of water uses in a basin.

This approach looks at the total economic value generated by a cubic meter of water in a particular water management strategy for all users in the river system, rather than the economic values of allocating a cubic meter of water to one particular user. The first level of economic benefits from cooperation is achieved with a shift from maximizing user values to maximizing system values.

Analysis of user values and system values can, however, identify potential benefits and clarify the benefit distribution associated with different management scenarios. When these are made explicit, the equity of various scenarios can be assessed and compensation mechanisms considered. While questions of equity are beyond the scope of user values and system values, these calculations can prove useful for quantifying the payoffs of alternative outcomes, thus providing the basis of comparison and information on which judgments on fairness can be made. (Sadoff, et al, 2003)

Direct payments might be made for water itself or for the benefits to be shared or forgone in the context of a cooperative scheme. The Orange basin already provides a good

example of this with the Lesotho Highlands Water Project agreement, where South Africa agreed to pay Lesotho for water delivered.

Where system values exceed user values, there is strong incentive for cooperative management. The economic benefits of systemwide cooperative management may not, however, be equitably distributed among riparian nations, and the optimal development path from a systems perspective may not be the best option for any single riparian. In the context of international rivers such as the Orange-Senqu, it is difficult to find interventions that result in improved efficiency, because someone almost always loses in large-scale investment projects. Given the transaction costs and political overtones of international shared waters negotiations, it is unlikely that a plan representing a potential efficiency improvement benefiting one country disproportionately would be accepted by all, much less preferred.

Yet cooperative action on international rivers can enable riparian nations to move closer to realizing the greatest potential system values of the river. Under such circumstances, compensation, the redistribution of benefits, or both will need to be explored to reach agreements among riparian countries. (Grey & Sadoff, 2003)

While it can't address equity issues, economic analyses can delineate efficient distributions of water and alternative distributions of the benefits derived from its use. Such information can serve as a basis for comparison for those who must make equity judgments. It can provide criteria for comparison among alternative investment and management strategies. (Grey & Sadoff, 2003)

Hoekstra (2001) has also proposed a method for finding the value of water throughout its movement along the hydrological cycle throughout a river system, known as the '*value-flow concept*'. This approach involves the consideration of the values of water in all its potential uses within a region. The value-flow concept is a conceptual tool for dealing with the fact that water uses and services within a river basin are not only or even largely competitive, but rather a combination of competitive and complementary. The value-flow concept allows the recognition of all those uses and services (and their interdependencies) and the 'routing' of their values throughout the whole basin over a given interval of time. This helps in making the correct comparisons that lead to efficient allocation of water among all water-using sectors within the basin.

A change in water quality resulting from one use can quite seriously affect a later, subsequent use. For example, a quantity of water may be diverted from a river for irrigation, after which it is be assumed to be lost as a water resource. Alternatively, the water may be left to flow in the river, to be used first for hydropower, then for industrial and finally for recreational uses downstream. In such a case, the power, industrial and recreational demands are complementary, but jointly they are in competition with the use of water for agriculture. In this situation, when demands are complementary instead of competitive, the marginal values for each use by the members of the complementary group have to be added up to determine a joint marginal value, for comparison with the marginal value of competitive demands. Therefore water should be divided among the agricultural use and the allied hydropower, industrial and recreational uses in such a way that the marginal value of water for irrigation equals the sum of the marginal values of the power, industrial and recreational uses. (Hoekstra, 2001)

11.6 Estimated economic value of water for major water users in the Orange-Senqu Basin

Very little work has been found in the compilation of this report that investigates the economic value of water in the Orange-Senqu River Basin itself. The WRC commissioned several research reports aimed at determining the value of water in different sectors of the country and different parts of the country. Water values were found to differ significantly between sectors, between geographic areas and within geographic areas. (Nieuwoudt, 2004)

The use of different valuation techniques means that it is very difficult to compare water values between different regions and uses. Values within the same sector or broad user types differ greatly, for instance according to whether they are marginal or average values, whether a short- term, or long-term view is taken (which affects the treatment of capital costs), the time of year, region, reliability of supply, access to water-saving techniques, type of crop or product, crop prices at the time of study, and so on. Care has to be taken therefore when using these values outside of the sector or location where they were derived. As Winpenny cautions, (1996) ‘exaggerated claims for water valuation should be avoided, and excessive precision in such estimates is a cause for suspicion’ (Agudelo, 2001).

However a US review of 500 water values from 41 different studies found that the methodology used was not as important as the crop grown, location, and year. Industrial

processing and domestic uses are generally the highest-value uses based on both average and median figures. On the other hand recreation use, fish and wildlife habitat and irrigation, which together accounts for nearly 80 percent of all the estimates, have the highest individual estimated values. Water values also tend to be higher in the drier, water scarce areas of the country (Louw, 2003).

Bearing in mind these caveats, the following values have been calculated for the Vaal River System.

Table 28: Economic value for water per sector in the Vaal River System

User	Value/m^3	% Share of Economic value of water	Share of water use*
Municipal use		82.4%	39%
High income household - indoor	R6.94		
High income household - outdoor	R7.91		
Low income household - indoor	R4.81		
Low income household - outdoor	R3.88		
Light industry	R9.86	37.6%	
Parks	R7.87		
Irrigation use	R0.07	1.2%	39%
Electricity use (cooling water)	R6.44	12.8%	4%
Heavy industry use	R3.68	3.6%	13%
*based on total water requirements in the 3 Vaal WMAs in 2001. Rural consumption accounts for the missing 6%			

Sources: Greengrowth Strategies, 2003; DWAF 2004

Agriculture is an inefficient user of water – the table above shows that while it used 39% of the water in the Vaal River system, it accounts for only 1.2% of the total economic value of water in the Basin.

A study by Conningarth (2001, quoted in Nieuwoudt, 2004) found that agriculture supports the lowest GDP per million m3 while it creates the fewest jobs per million m3. It found that 1m3 of water adds R1.5 in agriculture, R157.4 in industry, R39.5 in mining and R44.4 in eco-tourism.

Despite the current high values placed on water by non-agricultural users, they place a high value on water assurance, but little value on more than it already currently uses. For

this reason, Nieuwoudt et al (2004) speculate that although water is expected to transfer out of agriculture in the long-run, in the short-run agriculture may be its best use.

11.6.1 Municipal water

Conradie (2002) demonstrated that the price elasticity of municipal demand is low and that marginal water values are noticeably higher than irrigation values. He estimated demand functions for household, commercial and industrial consumption in the Nelson Mandela municipality. Urban users were found to attach a high value to assurance and a low value to additional water, with a price elasticity of -0.47.

Urban water use accounts for 39% of the total water requirements, which amounts to 82% of the total economic value of water use in the Vaal River system. Urban water supply is a low volume, high-value use. Supply costs are high, while opportunity costs are quite low. Therefore the priority issue for the economic management of urban supplies is the supply cost.

As expected, the value of high quality water for basic human needs is much higher than the value for discretionary demand, such as garden watering. Similar to the demand for industrial water, a key element of value is the assurance of supply. (Louw, 2003).

11.6.2 Irrigation

Commercial irrigation

Irrigated agriculture accounts for a large proportion of water use. The value of water for many low-value crops (such as food grains and fodder) is universally very low. Where reliable supplies are used on high-value crops, the value of water can be high, sometimes of an order of magnitude similar to the value of water in municipal and industrial end uses.

How much a farmer is willing to pay for irrigation water depends on factors such as the crop being cultivated, the amount of rainfall, the prices of agricultural products, and the prices of other inputs such as fertilizer and labour, but it is typically between $0.01-$0.25 per cubic meter internationally. The user value for large-scale irrigation of cereal crops such as wheat is at the low end of this range while the user value for the irrigation of high-value fruits and vegetables is occasionally at the high end of this range but depends to a great extent on market conditions and the transportation costs of delivering the produce to market (Grey & Sadoff, 2002).

In public irrigation systems in developing countries where the quality of irrigation supply is poor, food-grains are the major crop produced, and the value of water is typically only about US$0.005 per m3 (Louw, 2003).

It is estimated that 30% of the value of South Africa's agriculture is produced under irrigation. It also consumes 54% of the total water consumed in the country (Nieuwoudt, 2004). While no estimates could be found for the Orange-Senqu Basin, in the Vaal River System, irrigated agriculture accounts for 39% of the water used, while only generating 1.2% of the estimated economic value of water in the system.

In irrigated agriculture a high assurance of supply is needed where the capital value invested in orchards and vineyards is high and crops are of a long-term nature. Therefore table grape farmers along the Orange do not rent but purchase water rights, because the investment in table grapes is high and more assurance is required. Renting of water becomes more feasible where annual crops are grown.

To overcome the lack of assurance in water rights, South African farmers have in the past sought water rights for water surplus or additional to their normal needs, to cater for drought years in the Lower Orange River where capital investment is high (under riparian principles the share of all irrigators is reduced by the same fraction when river flows decrease during dry periods). They may not be able to do this in future if non-use rights (sleepers) are lost. Another practise is to include a low-income crop such as lucerne, from which water can be diverted in drought conditions at relatively low cost. However dams have resulted in fairly stable flow over recent years, and this practise is not used much currently.

Water rights between Kakamas and Keimoes were sold for between R8,000 and R10,000/ha, or an average of R0.60/m3 in 2003, while water rights in the Sundays River trade for about R2,000/ha orR0.22/m3. The market price of water in the Sundays River is therefore about a third compared to the Orange, and water would move from the Fish/Sundays to the lower Orange if transfers were permitted (Nieuwoudt, 2004).

Moller (2003) found that the selling prices of water are responsive to economic conditions such as the price of the product. Buyers of water rights were table grape farmers and had a higher return per unit of water. He concludes that "the water-market in the Lower Orange promotes the efficiency of water use" (Nieuwoudt, 2004).

Although agriculture creates few jobs per unit of water compared to other sectors, it generates more jobs per value of output than in other sectors (Conningarth Consultants, 2001) For instance production of R1 million in agriculture creates 24 jobs, mining creates 10.9 jobs, and manufacturing creates 9 jobs per R1 million. Agriculture also generates more jobs per R1million investment than the other sectors. This has more relevance to irrigation agriculture, which is not constrained by suitable land, but rather water availability and investment in irrigation could create more jobs in the fruit and vegetable enterprises. However agriculture creates the least employment per unit of water, as shown in the previous section. (Nieuwoudt, 2004)

Conradie (2002) analysed the economic efficiency of water allocation on the Fish-Sundays scheme, using the residual approach for valuing water in commercial irrigation. He found that the current allocation of water is not efficient, since it is possible to reallocate water from farms which do not need it at the margin, to municipalities who are willing to pay R0.256/m3 for additional water. It is possible to transfer 77 million m3/ year, or 13% of the water resource, away from irrigation at a zero opportunity cost or without direct loss to commercial irrigation, while 60% of the current allocation to irrigation can be bid away at a price of R0.0352 /m3. Up to this point all the water released will come from the Fish River, but at this level, the first water from the Sundays River becomes available.

Focusing only on significant differences between marginal water values, Conradie found that irrigators and stock farms consistently record low water values, while farm businesses value the marginal unit of water at between R150/ha and R200/ha. Dairy farms place a value about 3 times larger again, around R500/ha. He concludes that citrus producers as a group are able to bid water away from fodder crop producers in the Fish River region, and water is therefore expected to migrate from the Fish to the Sunday's area. Reallocating water between agricultural users could increase the current value of water to the sector by as much as 43% in the Upper Fish, and 100% in the Sunday's area.

While 77million m3 can be transferred out of the Fish River at a zero opportunity cost, there is currently a capacity limit of 18 million m3/year to the Sundays River, while they could currently absorb a maximum of 40 million m3 based on their valuation of water. After this point, some Sundays' Farms would attach a zero marginal value to additional water, so that the region as a whole would change from being a buyer to a potential seller of water. (Conradie, 2002)

Smallholder irrigation

Using a residual approach to calculate the value of water for smallholder irrigation in the Lower Fish River, Conradie (2002) found that the value of water for smallholders is negative, which means that in the face of water scarcity it is not economically efficient to allocate water to smallholders. The total value of water in the Fish-Sundays scheme is reduced by just over R500 000/year if water is allocated for 644ha of smallholder irrigation.

Conradie refutes the claim that small-scale traditional farmers are more efficient resource users than their commercial counterparts. He therefore finds that claims of fairness and equity considerations do have to enter into the water allocation debate, for small-scale traditional irrigation farming to be economically viable. Ignoring issues of equity with regards to water allocation will undermine existing water rights, and negatively effect the functioning of a water market.

He proposes that while economic theory offers no suggestions for awarding rights, once rights are defined, rights holders should not be locked into present use patterns. Instead, an institutional framework that allows the exchange of water rights through water trading will make society better off. Safeguards can be built into the framework to restrict the exchange of water rights where necessary.

11.6.3 Hydro-electric power generation

The value of water for hydropower is quite low, often the same as for irrigated agriculture. Long-run values are even lower. Whether hydropower is an economic proposition depends on the particular conditions of the economy, of the power sector and the water sector. Where water is abundant and there are few competing uses, hydropower is likely to be economically viable; where water is scarce and competition is therefore high, the case for hydropower is less clear-cut. It is sometimes argued that hydropower is a non-consumptive use. However, there is debate about this, as the modification of flow regimes and the timing of water to downstream users, imposes costs on downstream users. The key issue is therefore not if it is consumptive or not, but the value of the costs imposed on downstream users. (Louw, 2003)

In the Orange-Senqu basin, most of the consumptive requirements occur during the summer months from October through until March. This is to be expected due to the large influence of irrigation on the total requirement. It does, however, present problems with regards to hydro-power generation at the Gariep and Vanderkloof dams. ESKOM currently

use the two hydro-electric power stations for reducing peak system demand, and would therefore ideally like to generate most of the power during the cold winter months when demands for electricity are at their highest. However when water is scarce, power can only be generated in accordance with downstream requirements. Additional power can only be generated when the main storage reservoirs are at or near full supply level. This ensures that no water is wasted and that any excess water can be used productively to generate power. (DWAF, 2005)

11.6.4 Environmental reserve

Typical values for environmental purposes, such as maintenance of wetlands and river flows varies widely, but typically falls between agriculture and municipal values. Hosking (2002) estimated the value of freshwater inflows in the Keurboom Estuary using the Contingent Valuation Method, by asking how much respondents were willing to pay to prevent the loss of environmental services provided by the estuary due to reduced freshwater inflows. The total recreational value of water was estimated at R0.046/m3/annum.

11.6.5 Impact of water quality on water values

Water of differing qualities has different values associated with it, no matter what sector: domestic, industrial or irrigation.

Poor water quality imposes economic costs on irrigated agriculture through reduced yields on certain crops, and the loss or withdrawal of more profitable crops. Even where quality is affected on a seasonal basis, this contributes to both private and external costs. Private costs involve the need for artificial drainage, and the application of additional water to leach salts while external costs are imposed on downstream users in the form of more saline water.

Water quality is a major concern for users in the Lower and Middle Vaal. The Fish River in the Eastern Cape is also frequently flushed as the return flow is not suitable for irrigation.

Recent work by Viljoen and Armour (2002) provided an indication of the value of the dilution effect of Orange River water. Their results clearly indicate that irrigation waters of different qualities are different commodities for which different rates should be charged, and that the cost of poor quality, saline irrigation water can be calculated.

They found that small and resource poor farmers will be most affected by poor quality, saline irrigation water, and are forced out of production by poor quality water while larger farms are not as dramatically affected by the same water quality. One of the reasons for this is the smaller crop choice of smaller farmers due to management, labour and mechanisation constraints, and their generally poorer access to resources. At the worst-case scenario in terms of salinity conditions, farmers with below 60 ha water rights and who do not grow cotton, are forced out of production.

11.6.6 Water transfers

The economic value of water transfers in the Orange-Senqu Basin is most vividly illustrated by the sale of water by Lesotho to South Africa through the Lesotho Highlands Water Project.

The development of water resources in the Upper Orange-Senqu Basin has had a profound impact on Lesotho's economy. Hydropower sales and water transfer royalties are the main permanent benefits. The Government of Lesotho currently gets fixed and variable royalties from the transfer of water to South Africa. On average the royalties come to M15million/month. (www.lhwp.org.ls)

The Upper Orange WMA has also delivered between 65 and 95% of the water used in the Fish-Sundays scheme over the past 6 years. (Nieuwoudt, 2004)

Where significant differences in the value of water exist between areas in a river system, it should be possible to achieve economic gains by providing for trading in water licenses. Conradie (2002) found that for marginal water values for the Fish-Sundays System, citrus producers would be able to bid water away from fodder producers, while water will migrate from the Fish to the Sundays, due to the higher water rental and purchase prices. It is estimated that 77 million m3 or 13% of the resource can be redistributed away from irrigation at zero opportunity cost, while two-thirds of the current allocation can be bid away at a price of R0.035/m3. He concluded that the Fish-Sundays may be a possible source of cheap water for the Orange-Senqu, through the reduction of transfers.

The opportunity cost of diverting water from existing uses is the cost of expanding storage in the Orange River system. Limited additional capacity of 315 million m3/year can be created in the Orange Basin as an average cost of R0.05/m3 according to Basson (1999). Only after a second stage of development on the Orange River at an average cost of R1.27/m^3, might the Fish-Sundays be a possible source of further cheap water, where if

efficient reallocation takes place, the average value of water increases from 0.046 to R0.082/m^3/year.

11.7 Affordability issues and the economic value of water

Water is not only an economic good, but also a social good. It is therefore necessary to find a compromise between the goals of giving incentives for saving water to promote efficient water use, and equity concerns with ensuring that the poor have access to water.

The drive to maximise the overall economic value from water use must be moderated by recognition of the possible distributional effects of allocation decisions. Allocating the existing water supply to those with the highest willingness to pay, or highest value water use might prove regressive in its distributional impacts. For example, where wealthy farmers with more capital-intensive production capabilities can generate higher returns than poorer farmers, the allocation of water resources to their highest value uses will compound income disparities. An economically more efficient, and more complex, solution would be to allocate water resources to those who generate the greatest value for the economy, while charging those users an economic price for the water. This revenue could then be used to fund poverty interventions (Agudelo, 2001)

'Getting prices right' is seen as a reasonable way to allocate water efficiently, but how to accomplish it remains a debatable issue, since water pricing mechanisms are sensitive to the physical, social, institutional and political setting in each region. If water is viewed simply as a commodity, it would be reasonable to expect that it should be priced to cover at least supply costs, and priced so that low-value uses are discouraged and supplies are available for the higher-value users who are able and willing to pay for it. However, a strict application of these principles needs to be handled with some caution, to ensure that the poorest people in the community are not disadvantaged.

The development of a pricing policy to manage water demand requires a methodology for estimating the value of water, in order to determine in a reasonable and equitable fashion what prices are to be charged. In addition, it is necessary to ensure that the impacts of the pricing policy on all the affected stakeholders are understood and considered. While the concept of realistic pricing holds the promise of a better allocation of water, it has to be introduced in a manner that will not penalise communities whose opportunities were already limited.

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13 APPENDICES

13.1 Appendix A – South African Migration Statistics for the Orange River Basin by Province of Previous Residence

District Municipality	Local Municipality	Eastern Cape	% of people from E Cape	Free State	% of people from FS	Gauteng	% of people from GT	KwaZulu-Natal	% of people from KZN	Limpopo	% of people from Limpopo	Mpumalanga	% of people from Mpumalanaga	Northern Cape	% of people from N Cape	North West	% of people from NW	Western Cape	% of people from W Cape	Undetermined	% of people from an undetermined origin	Total Inclusive of Migrants	Total IN Migration	% increase in population on a/c of IN migration
Ukha-hlamba	Senqu	131,977		541	17	1,234	39	159	5	110	3	88	3	109	3	178	6	499	16	247	8	135,142	3,165	2
	Maletswai	35,906		487	35	345	25	133	9	51	4	30	2	33	2	79	6	223	16	21	1	37,308	1,402	4
	Gariep	30,195		208	19	303	27	66	6	33	3	63	6	113	10	38	3	212	19	69	6	31,300	1,105	4
	Oviston Nature Reserve	15		0																		15	0	0
Xhariep	Letsemeng	129	7	41,199		211	12	33	2	77	4	47	3	890	50	93	5	168	9	129	7	42,976	1,777	4
	Kopanong	393	22	54,176		385	22	136	8	127	7	85	5	242	14	103	6	135	8	161	9	55,943	1,767	3
	Mohokare	1,038	53	34,374		253	13	76	4	70	4	30	2	195	10	138	7	106	5	38	2	36,318	1,944	5
Motheo	Naledi	130	19	26,802		153	23	30	4	60	9	35	5	39	6	78	12	39	6	114	17	27,480	678	2
	Mangaung	5,253	20	619,576		5,044	19	1,976	8	1,033	4	782	3	3,444	13	2,968	11	2,122	8	3,245	13	645,443	25,867	4
	Mantsopa	133	10	53,981		412	30	148	11	70	5	84	6	57	4	84	6	228	17	148	11	55,345	1,364	2
Lejwele-putswa	Masilonyana	311	21	62,935		295	20	130	9	82	6	112	8	90	6	121	8	154	10	173	12	64,403	1,468	2
	Tokologo	64	4	30,811		160	10	46	3	21	1	36	2	602	37	374	23	30	2	307	19	32,451	1,640	5
	Tswelopele	108	8	52,431		299	23	50	4	15	1	189	15	67	5	406	32	55	4	89	7	53,709	1,278	2
	Matjhabeng	5,739	34	391,298		3,509	21	1,471	9	669	4	923	5	468	3	1,693	10	685	4	1,714	10	408,169	16,871	4
	Nala	126	5	95,904		275	12	79	3	39	2	830	35	46	2	780	33	63	3	115	5	98,257	2,353	2
Thabo Mofutsan-yane	Setsoto	327	9	119,551		1,035	28	297	8	172	5	131	4	660	18	176	5	189	5	653	18	123,191	3,640	3
	Dihlabeng	380	11	125,477		1,086	31	440	13	240	7	224	6	106	3	204	6	195	6	577	17	128,929	3,452	3
	Nketoana	61	7	61,080		373	43	141	16	46	5	45	5	9	1	54	6	25	3	123	14	61,957	877	1
	Maluti a Phofung	547	9	354,594		1,759	28	2,190	35	264	4	292	5	70	1	318	5	134	2	622	10	360,790	6,196	2
	Phumelela	58	4	49,600		383	29	334	26	76	6	223	17	24	2	57	4	52	4	94	7	50,901	1,301	3
	Golden Gate Highlands	6	100	169																		175	6	3

District Municipality	Local Municipality	Eastern Cape	% of people from E Cape	Free State	% of people from FS	Gauteng	% of people from GT	KwaZulu-Natal	% of people from KZN	Limpopo	% of people from Limpopo	Mpumalanga	% of people from Mpumalanaga	Northern Cape	% of people from N Cape	North West	% of people from NW	Western Cape	% of people from W Cape	Undetermined	% of people from an undetermined origin	Total Inclusive of Migrants	Total IN Migration	% increase in population on a/c of IN migration
	National Park																							
Northern Free State	Moqhaka	611	11	162,372		1,604	29	408	7	214	4	255	5	306	6	1,395	25	356	6	371	7	167,892	5,520	3
	Ngwathe	174	5	115,104		1,880	51	197	5	163	4	269	7	81	2	634	17	148	4	151	4	118,801	3,697	3
	Metsimaholo	1,013	11	106,434		5,294	55	595	6	588	6	748	8	170	2	538	6	251	3	350	4	115,981	9,547	8
	Mafube	247	10	55,263		745	31	154	7	211	9	391	17	55	2	107	5	85	4	373	16	57,631	2,368	4
Sedibeng	Emfuleni	4,442	14	11,781	38	627,683		2,873	9	2,962	10	2,195	7	380	1	2,541	8	707	2	2,858	9	658,422	30,739	5
	Midvaal	594	12	1,653	33	59,589		734	15	485	10	506	10	75	1	412	8	228	5	361	7	64,637	5,048	8
	Lesedi	262	6	745	18	67,497		590	15	369	9	1,279	32	64	2	274	7	160	4	305	8	71,545	4,048	6
Ekurhuleni Metro	Ekurhuleni Metro	28,000	15	13,510	7	2,294,241		40,347	22	47,419	25	27,143	15	2,565	1	8,550	5	6,717	4	11,777	6	2,480,269	186,028	8
Joburg Metro	Johannesburg	32,856	14	15,539	7	2,987,252		63,715	27	52,750	22	15,997	7	3,603	2	26,052	11	13,144	6	14,910	6	3,225,818	238,566	7
West Rand	Merafong City	4,226	30	2,260	16	135,432		1,698	12	778	6	617	4	149	1	3,401	24	331	2	461	3	149,353	13,921	9
	Mogale City	2,434	11	1,566	7	268,310		2,930	14	3,673	17	1,368	6	411	2	7,058	33	784	4	1,191	6	289,725	21,415	7
	Randfontein	908	10	929	11	120,109		627	7	1,120	13	546	6	197	2	3,539	40	273	3	601	7	128,849	8,740	7
	Westonaria	4,424	39	1,303	12	98,044		1,714	15	850	8	726	6	110	1	1,521	13	311	3	330	3	109,333	11,289	10
Govan Mbeki	Msukaligwa	355	10	228	6	904	25	1,084	30	262	7	121,215		81	2	189	5	163	5	332	9	124,813	3,598	3
	Lekwa	405	9	938	20	1,419	31	1,085	24	264	6	98,679		70	2	165	4	105	2	135	3	103,265	4,586	4
	Dipaleseng	73	4	319	17	912	49	203	11	120	6	36,750		33	2	69	4	42	2	94	5	38,615	1,865	5
	Govan Mbeki Municipality	2,524	19	1,872	14	3,241	24	2,231	17	1,302	10	208,445		247	2	670	5	476	4	741	6	221,749	13,304	6
	Seme	109	4	202	8	764	31	1,086	44	90	4	78,269		30	1	60	2	36	1	87	4	80,733	2,464	3
Kgalagadi	Ga-Segonyana	36	2	106	5	135	6	51	2	98	4	87	4	12,150		1,697	73	80	3	30	1	14,470	2,320	16

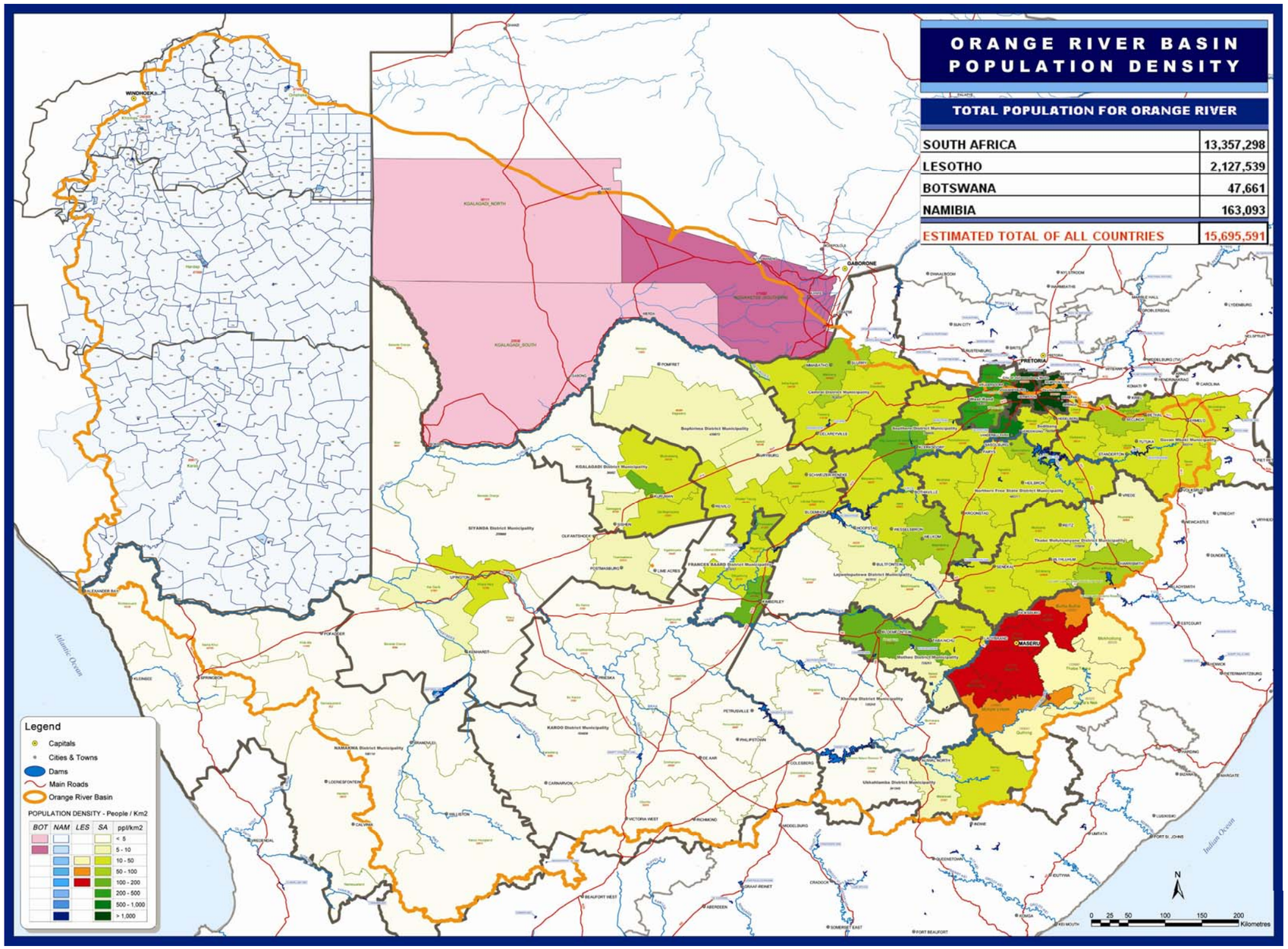
District Municipality	Local Municipality	Eastern Cape	% of people from E Cape	Free State	% of people from FS	Gauteng	% of people from GT	KwaZulu-Natal	% of people from KZN	Limpopo	% of people from Limpopo	Mpumalanga	% of people from Mpumalanaga	Northern Cape	% of people from N Cape	North West	% of people from NW	Western Cape	% of people from W Cape	Undetermined	% of people from an undetermined origin	Total Inclusive of Migrants	Total IN Migration	% increase in population on a/c of IN migration
	Gamagara	45	2	143	6	332	14	94	4	93	4	95	4	13,781		1,427	60	131	5	30	1	16,171	2,390	15
	Kalahari	63	6	61	6	120	12	24	2	57	6	39	4	5,234		597	60	27	3	12	1	6,234	1,000	16
	Moshaweng	63	6	122	12	131	13	56	6	84	9	55	6	425	43	83,119		31	3	18	2	84,104	985	1
Frances Baard	Phokwane	109	4	411	14	267	9	68	2	51	2	88	3	36,752		1,799	60	140	5	79	3	39,764	3,012	8
	Sol Plaatje	1,085	10	2,682	24	1,965	17	628	6	343	3	281	2	190,101		2,344	21	1,298	11	738	6	201,465	11,364	6
	Dikgatlong	126	7	207	12	301	17	66	4	54	3	57	3	33,975		819	46	90	5	64	4	35,759	1,784	5
	Magareng	30	4	117	15	190	24	39	5	18	2	15	2	20,936		312	39	63	8	15	2	21,735	799	4
	Diamondfields	70	22	51	16	30	10	9	3	6	2	9	3	4,200		86	27	33	10	21	7	4,515	315	7
Namakwa	Richtersveld	162	23	27	4	87	12	36	5	12	2	9	1	9,421		39	6	322	46	12	2	10,127	706	7
	Nama Khoi	256	11	129	6	235	11	115	5	79	4	69	3	42,517		125	6	1,139	51	83	4	44,747	2,230	5
	Kamiesberg	9	2	12	2	57	10	12	2	6	1	3	1	10,157		21	4	447	75	30	5	10,754	597	6
	Hantam	45	4	15	1	67	5	24	2	21	2	24	2	18,579		24	2	789	64	225	18	19,813	1,234	6
	Karoo Hoogland	40	7	9	2	27	5	6	1	6	1	3	1	9,954		9	2	439	78	21	4	10,514	560	5
	KhGi-Ma	63	5	64	5	112	8	21	2	21	2	36	3	9,991		795	59	223	17	12	1	11,338	1,347	12
	Namaqualand		0		0	6	15		0		0	3	8	771			0	27	69	3	8	810	39	5
Karoo	Ubuntu	123	15	69	9	66	8	60	8	3	0	18	2	15,579		9	1	427	53	24	3	16,378	799	5
	Umsombomvu	480	36	166	13	198	15	48	4	27	2	48	4	22,320		21	2	263	20	76	6	23,647	1,327	6
	Emthanjeni	363	25	177	12	221	15	73	5	24	2	30	2	34,070		88	6	452	31	51	3	35,549	1,479	4
	Kareeberg	33	5	33	5	88	13	18	3	15	2	12	2	8,805		39	6	324	47	123	18	9,490	685	7
	Renosterberg	36	8	122	28	91	21	27	6	6	1	9	2	8,633		24	6	90	21	30	7	9,068	435	5
	Thembelihle	113	13	198	23	165	19	27	3	33	4	75	9	13,105		75	9	155	18	39	4	13,985	880	6
	Siyathemba	30	6	64	13	110	22	33	7	18	4	18	4	17,014		51	10	143	29	27	5	17,508	494	3
	Siyancuma	100	6	366	22	260	15	51	3	24	1	63	4	34,130		502	30	254	15	67	4	35,817	1,687	5
	Bo Karoo	12	6	52	24	27	13	9	4	12	6	33	15	2,963		27	13	36	17	6	3	3,177	214	7
Siyanda	Mier	18	5	58	17	33	10	9	3	32	10	18	5	6,515		15	5	54	16	95	29	6,847	332	5
	Kai Garib	97	2	142	3	351	7	57	1	55	1	66	1	52,747		3,482	70	645	13	45	1	57,687	4,940	9
	Khara Hais	293	9	418	13	593	18	193	6	90	3	147	4	70,492		444	13	881	27	236	7	73,787	3,295	4

District Municipality	Local Municipality	Eastern Cape	% of people from E Cape	Free State	% of people from FS	Gauteng	% of people from GT	KwaZulu-Natal	% of people from KZN	Limpopo	% of people from Limpopo	Mpumalanga	% of people from Mpumalanaga	Northern Cape	% of people from N Cape	North West	% of people from NW	Western Cape	% of people from W Cape	Undetermined	% of people from an undetermined origin	Total Inclusive of Migrants	Total IN Migration	% increase in population on a/c of IN migration
	Kheis	27	5	77	14	193	35	39	7	12	2	42	8	15,480		49	9	103	19	3	1	16,025	545	3
	Tsantsabane	99	5	192	10	270	14	39	2	80	4	43	2	29,016		814	41	341	17	112	6	31,006	1,990	6
	Kgatelopele	150	13	177	15	154	13	39	3	60	5	39	3	14,264		449	38	88	7	27	2	15,447	1,183	8
	Benede Oranje	30	5	58	10	67	12	15	3	33	6	24	4	8,512		220	38	127	22	6	1	9,092	580	6
Central	Setla-Kgobi	33	6	60	10	319	54	12	2	39	7	33	6	50	9	103,740		21	4	21	4	104,328	588	1
	Tswaing	184	9	205	10	783	38	129	6	229	11	145	7	134	7	112,103		103	5	141	7	114,156	2,053	2
	Mafikeng	460	8	611	11	2,362	42	533	9	473	8	261	5	490	9	253,790		210	4	284	5	259,474	5,684	2
	Ditsobotla	249	9	391	14	1,193	43	128	5	208	7	169	6	210	8	144,803		116	4	134	5	147,601	2,798	2
Bophirima	Kagisano	100	11	55	6	127	14	62	7	70	8	64	7	280	32	95,495		45	5	82	9	96,380	885	1
	Naledi	102	6	184	10	408	23	109	6	93	5	63	4	512	29	56,332		105	6	199	11	58,107	1,775	3
	Mamusa	45	4	193	19	361	36	39	4	18	2	39	4	103	10	47,351		30	3	186	18	48,365	1,014	2
	Greater Taung	84	3	231	9	670	28	46	2	134	6	80	3	1,022	42	179,726		46	2	123	5	182,162	2,436	1
	Molopo	24	9	3	1	57	21	12	4	40	15	10	4	71	26	11,412		21	8	33	12	11,683	271	2
	Lekwa-Teemane	122	3	2,103	53	622	16	120	3	89	2	110	3	658	16	38,966		124	3	54	1	42,968	4,002	9
Southern	Ventersdorp	117	9	185	15	663	52	27	2	76	6	96	8	37	3	41,801		39	3	33	3	43,074	1,273	3
	Potchefstroom	381	5	2,054	28	2,693	36	381	5	403	5	381	5	426	6	120,912		286	4	433	6	128,350	7,438	6
	City Council of Klerksdorp	4,509	22	6,402	32	4,628	23	1,332	7	694	3	874	4	665	3	338,882		546	3	668	3	359,200	20,318	6
	Maquassi Hills	213	12	533	30	470	27	76	4	74	4	96	5	124	7	67,286		54	3	109	6	69,035	1,749	3
Total Number of people who left a province & moved into the basin or from one province within the basin to another		109,289		73,816		56,582		134,840		120,794		60,268		20,673		164,639		40,105		48,590		829,596		

13.2 Appendix B – Orange River Basin Population Density Map

Note: *The map below is a reduced copy of a georeferenced A0 map produced for the ORASECOM project and is inserted here to give a visual indication of the general demographic patterns within the basin. On account of the reduction from A0 to A3 format some of the detail has been lost.*

Figure 23: Orange River Basin Population Density Map



13.3 Appendix C – Orange River Basin Population Map

Note: *The map below is a reduced copy of a georeferenced A0 map produced for the ORASECOM project and is inserted here to give a visual indication of the general demographic patterns within the basin. On account of the reduction from A0 to A3 format some of the detail has been lost.*

Figure 24: Orange River Basin Population Map